8-3-2006

The Relation of Presence and Virtual Reality Exposure for Treatment of Flying Phobia

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THE RELATION OF PRESENCE AND VIRTUAL REALITY EXPOSURE

FOR TREATMENT OF FLYING PHOBIA

by

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Under the direction of Page Anderson

ABSTRACT

A growing body of literature suggests that Virtual Reality is a successful tool for exposure therapy for anxiety disorders. Virtual Reality (VR) researchers posit the construct of presence, interpreting an artificial stimulus as if it were real, as the mechanism that enables anxiety to be felt during virtual reality exposure therapy (VRE). However, empirical studies on the relation between presence and anxiety in VRE have yielded mixed findings. The current study tested the following hypotheses 1) Presence is related to in session anxiety and treatment outcome; 2) Presence mediates the extent that pre-existing (pre-treatment) anxiety is experienced during exposure with VR; 3) Presence is positively related to the amount of phobic elements included within the virtual environment. Results supported presence as the mechanism by which anxiety is experienced in the virtual environment as well as a relation between presence and the phobic elements, but did not support a relation between presence and treatment outcome.

INDEX WORDS: Presence, Virtual Reality Exposure, Anxiety Disorder, Mediation, Specific Phobia

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A Thesis presented in Partial Fulfillment of Requirements for the Degree of

Masters of Arts

in the College of Arts and Sciences

Georgia State University

2006

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August 2006

To Peggy,

I am, and shall forever be, eternally grateful for sharing my life with you.

Your endless love and devotion are felt each and every day.

I am blessed to share my achievements with you,

as your support is the source of my motivation.

Acknowledgements

I am honored to thank my advisor, Dr. Page Anderson, for her support on this project. I thank her for helping me throughout the entire project, from sifting through numerous ideas in order to discover this project until the conclusion with the defense. It is a pleasure to work and learn from her.

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The Relation of Presence And Virtual Reality Exposure For Treatment of Flying Phobia

Recent reviews suggest that Virtual Reality Exposure (VRE) is an effective treatment for anxiety disorders (Anderson, Jacobs, & Rothbaum, 2004). VRE uses a virtual stimulus to elicit anxiety, a critical element for therapeutic outcome (Foa & Kozak, 1986). The extent that a virtual stimulus elicits anxiety is related to the concept of presence. Presence is defined as interpreting an artificial environment as if it were real (Lee, 2004; Wiederhold & Wiederhold, 2005b). Despite a presumed theoretical association, the handful of studies that have empirically examined the relation between presence and anxiety have found mixed support (Huang, Himle, & Alessi, 2000; Krijn et al., 2004; Robillard, Bouchard, Fournier, & Renaud, 2003). Furthermore, this small group of studies contained methodological problems such as the use of nonclinical, nonrandomized, small samples. Thus, there is a need for additional studies with stronger methodology to examine the relation between presence and anxiety. The current study sought to test the relation between presence and anxiety and to examine the role of presence in VRE in a sample of flying phobics using a larger clinical sample with a rigorous methodology. The rationale for the current study will be presented by first discussing specific phobias and their treatments. Then treatments using VRE will be reviewed, followed by a comprehensive review of the literature on presence and anxiety including criticisms of prior research.

Specific Phobias

Specific phobias are classified as anxiety disorders within the Diagnostic and Statistical Manual, Fourth Edition (DSM-IV; APA, 1995). Phobias are the experience of an unreasonable,

intense amount of anxiety regarding a specific object or situation, causing the specific stimulus to be avoided or endured with intense anxiety. Specific phobias are set apart from ordinary fears by their impact on daily functioning. The distress caused by a phobia leads to impairments such as being unable to maintain a job or social relations (Mogotsi, Kaminer, & Stein, 2000). The DSM-IV has divided phobias into five categories based on the anxiety provoking stimulus: animal, natural environment, blood-injection or injury, situational, and other. Participants of the current study were diagnosed with a flying phobia, a member of the situational category.

Specific phobias have a prevalence of 11% within the North American population (Kessler, McGonagle, Zhao, & Nelson, 1994) and nearly 50% of community samples reported having symptoms of specific phobias (Curtis, Magee, Eaton, Wittchen, & Kessler, 1998). Fear of flying is reported to occur in approximately 4% of the population.

There are multiple theories that offer explanations for the etiology of phobias (Barlow, 2002; Foa & Kozak, 1986; Rachman, 1991). Barlow (2002) suggests that phobias result from an interaction between a disposition to physiologically experience fear and a psychological vulnerability to experience anxiety. Fear is defined as a warranted emotional state during the expectation of, or encounter with, danger (Rosen & Schulkin, 1998). Anxiety is defined as an uncontrollable emotional state characterized by the unwarranted anticipation of a threat (Barlow, 2000). After a negative event, individuals with these characteristics develop strong negative associations to stimuli related to the negative event, resulting in a phobia. Rachman's pathway of fear model suggests phobias may be caused by different pathways of learning. The first pathway, neo-conditioning, is a non-contiguous paring of the feared stimulus with an aversive outcome.

For example, experiencing a negative event while on a long distance trip could result in a fear of flying. The second pathway is the vicarious association of a stimulus with an aversive outcome, such as observing another becoming afraid when presented with the stimulus. The third pathway is learning to fear a stimulus because of relayed verbal information without a personal experience. For example, hearing about a plane crash could result in a fear of flying. The emotion processing theory suggests that phobias are maintained by a network of cognitions called the phobic fear structure (Foa & Kozak, 1986). Fear structures consist of three elements: information about the feared stimulus, a response to the feared stimulus and, the meaning of the stimulus and the response (Foa & Kozak; Lang, 1977). The information element consists of general knowledge of the feared stimulus (e.g. turbulence). The response element outlines the behavioral and physiological reactions that facilitate the escape from the feared stimulus (e.g., heart racing). Finally, the interpretation element consists of the negative associations with the feared stimulus, such as perpetual anxiety or death (e.g., "this must be dangerous") (Taylor, Koch, & McNally, 1992; Telch, Valentiner, Ilai, Petruzzi, & Hehmsoth, 2000). The fear structure becomes activated when a stimulus associated with an element of the fear structure is presented. Activation of one element causes the entire structure to activate through the process of generalized activation (Telch et al.; Watson & Marks, 1971).

Theories for Treatment of Specific Phobia

Although there are multiple theories for the etiology of specific phobias, there is a consensus that treatments involving exposure to the feared stimulus are the most effective (Barlow, 2002). Exposure involves presenting the stimulus to the individual in a fashion that

elicits anxiety. However, simply facing one's fear is not necessarily therapeutic exposure. The stimulus should be presented without interruption until anxiety subsides without using avoidance or escape behaviors. An example of avoidance and escape behaviors would be taking anxiety reducing medication prior to treatment. Presentation of the stimulus can take a variety of forms, such as presentation of the actual stimulus, known as in vivo exposure (Linden, 1981), or imagining the feared stimulus, as in imaginal exposure (Watson, Gaind, & Marks, 1971). In vivo exposure has been supported as a more effective treatment than imaginal exposure in the treatment of specific phobias (Linden; Marshall, 1985). Approximately 90% of phobics respond to in vivo treatment and are able to maintain their gains for at least a one year period (Ost, Brandberg, & Alm, 1997). Treatments are not lengthy and can be administered in period as short as 3 sessions (Watson, Gaind, & Marks) or even hours (Ost, 1989) with a high treatment success rate.

Achieving Positive Treatment Outcome

The goal of phobia treatments is for the phobic individual to be able to face their feared stimulus such that it no longer impacts their quality of life. Therapeutic exposure is accomplished through exposure to the feared stimulus without an avoidance or escape response or negative consequence, leading to habituation and the extinction of the fear. Habituation is experiencing minimal anxiety when presented with the feared stimulus.

Habituation is achieved through controlled, prolonged, and repeated exposure to the feared stimulus (Bouchard, Mendlowitz, Coles, & Franklin, 2004; Foa & Kozak, 1986). Controlled exposure allows the therapist to manipulate the feared stimulus to maximize the

duration of exposure to the most anxiety eliciting aspects of the feared stimulus. Also, control of the exposure allows the therapist to prevent any negative outcomes from occurring during the presentation of the stimulus that would perpetuate phobias. For example, during exposure therapy for a flying phobia, the therapist should be able to ensure there will not be a plane crash. Prolonged exposure enables anxiety to decrease while in the presence of the feared stimulus, which is necessary for habituation. Finally, exposure should be repeated to reinforce the previously learned lessons, and can be done within a session or across sessions (Ost, 1989). Phobics use escape to reduce anxiety when the feared stimulus is presented because of the anticipation of a negative outcome. Prolonged, controlled, and repeated exposure demonstrates to the client that anxiety decreases after a finite period of time, without a negative outcome or the need for an escape response, which in turn leads to habituation.

Virtual Reality Exposure

Despite its effectiveness, one of the difficulties of in vivo exposure is that it can be difficult to conduct in a therapeutic manner. That is, it is not always logistically possible to control, prolong, and repeat exposure to a feared stimulus. For example, a therapist may not have access to airports and airplanes to provide treatment to a flying phobic. Technology has helped to navigate the complications of producing a feared stimulus through the use of VRE (Pull, 2005).

VRE places the client in a three dimensional responsive environment that is completely generated by a computer. The VR environment is traditionally presented through a Head-Mounted-Display (HMD), a helmet that contains headphones and screens to present the virtual environment. The environment is presented visually from the first person perspective and the

headphones provide auditory input. Also, VR environments can include body tracking devices such that the VR is responsive to the user's body movements in that changes in body orientation correspond to real time shifts in the virtual environment.

VRE has proven successful at treating numerous anxiety disorders. It has been effective as an intervention for arachnophobia (Garcia-Palacios, Hoffman, Carlin, Furness, & Botella, 2002) , fear of flying (Maltby, Kirsch, Mayers, & Allen, 2002; Muhlberger, Herrmann, Wiedemann, Ellgring, & Pauli, 2001; Rothbaum et al., in press; Rothbaum, Hodges, Smith, Lee, & Price, 2000), and acrophobia (Emmelkamp et al., 2002; Rothbaum, Hodges, Kooper, & Opdyke, 1995). Also, it is effective at treating PTSD (Rothbaum et al., in press; Rothbaum, Hodges, Ready, Graap, & Alarcon, 2001), and fear of public speaking (Anderson, Rothbaum, & Hodges, 2003; Harris, Kemmerling, & North, 2002; Klinger et al., 2005). Additionally, VRE has been shown to be comparable to in vivo exposure (Emmelkamp, Bruynzeel, Drost, & Van Der Mast, 2001; Rothbaum, Hodges, Smith, Lee, & Price, 2000) and superior to imaginal exposure (Wiederhold, 1999) in the treatment of phobias.

VRE may offer several advantages when compared to in vivo exposure. VRE enables the therapist to repeatedly present the stimulus for a prolonged duration in a controlled manner (Rothbaum, Hodges, Kooper, & Opdyke, 1995). Also, the therapist can present the specific parts of the feared stimulus to enable more effective treatment. For example, a flying phobic who especially fears take off would only be able to be exposed to two take offs during a round trip exposure session. However, in VR, the duration of the take off can be extended to allow habituation during each stage of take off, and take off can be repeated numerous times.

Additionally, each exposure can be as similar or different as the therapist chooses because they have control over the environment. The amount of control VRE gives the therapist over the presentation of the feared stimulus enables VRE to be an effective treatment for specific phobias (Wiederhold & Wiederhold, 2005a). Another advantage of VRE is that it is less embarrassing to the client as they do not have to visit public locations and risk public displays of anxiety (Riva, 2003). Furthermore, people are generally excited to use VR and are more likely to seek treatment with the possibility of using an interesting intervention (Garcia-Palacios, Hoffman, Kwong See, Tsai, & Botella, 2001). In one study, 14 of 15 waitlist participants that were allowed to choose VRE or in vivo treatment selected VRE (Rothbaum, Hodges, Kooper, & Opdyke, 1995). The success and advantages of VR has led it to be referred to as the third most important therapeutic instrument to be used in interventions behind homework and relapse prevention (Norcross, Hedges, & Prochaska, 2002).

VRE could be conceptualized as falling between in vivo exposure and imaginal exposure on a continuum of exposure treatments. In vivo exposure uses an actual stimulus, imaginal exposure uses an imagined stimulus, and VRE uses a representation of an actual stimulus. As previously discussed, in vivo exposure has been show to be more effective than imaginal exposure, and this is attributed to the use of an actual stimulus as opposed to an imagined representation of the stimulus (Marshall, 1985). Therefore, VRE would be expected to be superior to imaginal exposure because it presents a stimulus, however it would not necessarily be expected to be as effective as in vivo exposure because it does not use a real stimulus. However, the limited amount of data available suggests that VRE is comparable to in vivo exposure

(Emmelkamp et al., 2002; Rothbaum et al., in press; Rothbaum, Hodges, Smith, Lee, & Price, 2000) and superior to imaginal exposure (Wiederhold, 1999) in the treatment of phobias. The similarity between the effectiveness of VRE and in vivo exposure is striking because it suggests that a virtual representation of the feared stimulus leads to the same anxious response and treatment gains as treatment that uses a real stimulus.

Presence

The theorized mechanism that allows VR to be an effective tool for exposure therapy is presence. Presence is a multifaceted concept that is not well understood (Lee, 2004; Lombard, 2000; Wagner & Rescorla, 1972; Witmer & Singer, 1998). The concept of presence has been used by a variety of fields that work with VR, such as aeronautics, electronic gaming, and psychology. Computer science was the first of these fields to conceptualize presence and so early definitions of presence were not applicable to VRE treatment (Shredian, 1992). The following sections summarize the development of the concept of presence, as it has evolved to become relevant to VRE.

Definitions of Presence

The first definition suggested that presence was the extent to which the senses were deceived by the physical existence of virtual objects; the more successful the environment is at deceiving the senses, the greater the sense of presence (Benedikt, 1991). This definition implies that presence is dependent exclusively on the senses. However, emotional experiences require more than sensation. For example, cognitions play a role in emotional responses in addition to sensory stimulation. A flying phobic's response to a virtual plane will be guided by the memories

and feelings associated with the plane, in addition to the stimulation of their visual system. Another early description suggested presence was being in an environment (Steuer, 1992) or being surrounded by virtual objects (Shredian, 1992). These broad definitions are not directly applicable to VRE because they fail to specify any interaction with the environment that would elicit anxiety.

More recent definitions of presence include the feeling of physically being in one place yet feeling as if you were in another or having an influence on another place (Huang & Alessi, 1999; Welch, 1999; Witmer & Singer, 1998). This definition specifies an interaction between the individual and the environment, which begins to explain how a response can be generated to a virtual stimulus.

The most recent definition of presence is the experience of virtual stimuli as actual objects (Lee, 2004; Lombard, 2000). In other words, presence is the extent "in which the virtuality of the experience is unnoticed" (Lee, 2004, p. 32). As applied to VRE, presence enables virtual stimuli to be responded to as real stimuli. Relating this definition to exposure therapy, habituation of fear to the virtual stimulus will generalize to the real stimulus.

Factors of Presence

Similar to the evolving definitions, the presence literature has specified numerous factors that contribute to a sense of presence. The first empirical examination of presence was conducted by Witmer and Singer (1998). Witmer and Singer suggested that presence consists of four primary factors: control, sensory input, distraction, and realism. The factor of control is the extent the user can interact with the VR environment and how appropriately the environment

responds. The factor of sensory input is the amount that the primary senses are stimulated by the VR environment. Also, sensory input is dependent upon the degree that sensory stimulation is consistent across all of the senses. Distraction factors are related to the extent the VR environment isolates the user from the real environment. Also, distraction is related to the extent that the user directs their attention to the VR and away from distractions. Finally, realism is the degree the user feels connected to the virtual world. This is related to the extent that the VR environment is consistent with the user's conceptualization of the corresponding real environment. Thus, Witmer and Singer suggest that presence can be maximized by the allowing interactions with the virtual environment to occur naturally, by increasing the amount of sensory stimulation, by attending towards the virtual environment, and by enabling the user to feel connected with the virtual world.

Schubert et al. (2001) suggested that presence was related to factors that were similar to Witmer and Singer's (1998); spatial presence, involvement, and realness. Spatial presence is the extent that the individual feels as if they are included in the virtual environment. Involvement is similar to Witmer and Singer's distraction factor as it is defined as the amount of attention dedicated to the environment. Realness is synonymous with Witmer and Singer's realism factor.

Other researchers have emphasized the role of personal memories as a factor of presence. Regenbrecht et al. (1998) suggest that presence is a psychological construct that is the result of an interaction between sensory experiences and memory. Sensory experiences are the information received through the senses and are similar to Witmer and Singer's (1998) sensory input factor. Memory consists of the specific and general knowledge associated with the VR

environment. Sensory information leads to the activation of memories that are associated with the VR environment resulting in a sense of presence. Mantovani and Riva (1999) propose that the extent that the virtual environment is a part of the user's culture affects presence. Cultural experiences provide information about the customary method of interaction with the environment. Therefore, an individual will have a greater sense of presence when presented a culturally familiar environment.

Lee (2004) hypothesizes that presence is the result of authenticity and sensory perceptions that are related to interactions with the environment. Authenticity is based upon prior cognitions that enable the virtual objects to be identified and used in a proper manner. Sensory perceptions are divided into two components; physical manipulability and interaction quality. Physical manipulability is the extent that the user can interact with the virtual environment and how well the environment responds. Therefore, according to Lee a sense of presence occurs when the environment can be correctly identified and interacted with in a fluid manner.

Despite the presence literature specifying multiple factors, there is considerable overlap amongst the theories (Table 1). The factors that have consistently emerged are attention, sensation, memory, and to a lesser extent interaction (Lee, 2004; Schubert, Friedmann, & Regenbrecht, 2001; Slater, 2002; Sutcliffe & Gault, 2004; Witmer & Singer, 1998). Presence is experienced when attention is directed towards the virtual environment, consistent sensory information is received from the virtual environment, and the virtual environment is similar to prior experiences with the actual environment. For example, consider an individual that is afraid of flying as they enter a virtual plane. The client's sense of presence is developed by focusing

Table 1

Factors of Presence

Source	Theorized Factors			
	Relating to Attention	Relating to Sensation	Relating to Memory	Relating to Interaction
Witmer & Singer (1998)	**Distraction Factors** Amount the environment isolates the user from distraction	**Sensory Input** Amount and consistency that primary senses that are stimulated	**Realism** Connection felt to the virtual environment	**Control Factors** How realistic the environment responds to movements
Schubert, et al. (2001)	**Involvement** Amount of attention directed to the virtual environment		**Realness** Connection felt to the virtual environment	**Spatial Presence** Feelings of inclusion in the environment
Regenbrecht, et al. (1998)		**Sensory** Experiences Information received through the senses	**Memory** Specific and general knowledge associated with the virtual environment	
Mantovani & Riva (1999)			**Cultural Reference** Extent the virtual environment is synonymous and prevalent with the user's cultural experience	
Lee (2004)			**Authenticity** Prior cognitions that enable the virtual objects to be identified and interacted with correctly	**Sensory Perceptions** The extent that the virtual environment enables the user to interact with it

attention on the virtual plane, receiving sensory information about the virtual environment, the client responds to the virtual environment as if it were an actual plane, with an anxious response. Robillard et al. (2003) suggest the hallmark of an individual experiencing presence is when she/he exhibits behavior during exposure that is congruent with behavior in the real world. As such, presence has be proposed as a mediator of a preexisting fear stimulus and the responses to a corresponding virtual stimulus (Lee, 2004; Lee & Nass, 2004; Schubert, Friedmann, & Regenbrecht, 2001). Presence is theorized to mediate the extent that a learned reaction is performed in a virtual environment. That is, the extent that a virtual environment elicits anxiety in a phobic individual is theorized to be dependent upon the amount of presence that is experienced.

The Relation Among Presence, Anxiety, and Treatment Outcome

From the first treatment study, the utility of virtual reality as a tool for exposure has rested on the assumption that virtual environments can elicit anxiety and provide the opportunity for habituation, a view which remains widespread today (Rothbaum, Hodges, Kooper, & Opdyke, 1995; Wiederhold & Wiederhold, 2005b). Presence has been presumed to be the mechanism by which virtual environments elicit anxiety (Banos et al., 2004; Huang & Alessi, 1999; Wiederhold & Wiederhold, 2005a). Despite widespread theorizing, the empirical relation between presence and anxiety is unclear. The relation between presence and anxiety is largely speculative and has been explored by only a few empirical studies. In addition to theoretical speculation that presence and anxiety are related, researchers also have suggested that greater presence in virtual environments used in anxiety treatment should lead to better treatment

outcome (Wiederhold & Wiederhold, 2005a). However, there also is a lack of research addressing this issue with one group of researchers suggesting that the relation between presence and treatment outcome is "highly speculative" (Glantz & Durlach, 1997). The following section will review the empirical studies that have examined the relation between presence and anxiety and presence and treatment outcome.

Presence and Anxiety

There have been a few empirical studies that have examined the relation between presence and anxiety. Regenbrecht et al. (1998) examined the relation between a sense of presence and the experience of anxiety in a virtual environment simulating elevated heights. Thirty seven non phobic participants were presented a virtual heights environment through a HMD. After performing a brief task in the virtual environment, participants were asked to rate their feelings of presence and anxiety. Correlations suggested there was not a relation between presence and anxiety. However, a more comprehensive multiple regression that included presence, trait anxiety, and avoidance behaviors as predictors of in session anxiety showed that presence was significantly related to in session anxiety. Therefore, this study offers mixed support for a relation between presence and anxiety because of the lack of a bivariate relation but support for a relation with the inclusion of other variables. However, a phobic sample was not used and so the results may not be applicable to people with phobias. The relation between presence and anxiety may be stronger in phobics as research suggests they show an anxious response when presented with only a vague representation of their feared stimuli such as a picture or shadow (Becker & Rinck, 2004; Levin, Cook, & Lang, 1982; Miller et al., 1981;

Williams, Watts, MacLeod, & Matthews, 1997). Therefore, the relation between presence and anxiety for phobic individuals may be stronger than the relation shown in a non-clinical sample.

In another study using a non-clinical sample, emotional content was shown to be related to presence (Banos et al., 2004). Banos et al (2004) placed 10 non-phobics in a virtual environment that represented a city street that was manipulated to be either emotionally neutral or emotionally relevant. After each exposure, presence was measured. The emotionally relevant environments promoted a sense of joy or sorrow through the use sunshine or rain clouds. Results indicate that the emotionally relevant environments were related to a greater sense of presence than emotionally neutral environment. However, this study did not specifically examine the relation between presence and anxiety within a phobic sample.

The only empirical study examining the relation between presence and anxiety using a sample that contained clinically diagnosed participants was conducted by Robillard et al (2003). The relation between presence and anxiety was examined by exposing 13 phobics and 13 nonphobics to a feared environment and assessing their level of presence and anxiety (Robillard, Bouchard, Fournier, & Renaud, 2003). The phobic group consisted of individuals with various specific phobias, such as acrophobia and arachnophobia. Various virtual environments were used to correspond to each specific phobia. Presence and anxiety were assessed by verbal self report while in the virtual environment and after the exposure. The results suggested a strong relation between presence and anxiety. However, this experiment contains methodological limitations. First, participants were exposed to the virtual environment for 5 minutes. Research has shown that there is an initial adjustment period when a virtual environment is presented that interferes

with the experience of presence (Wiederhold & Wiederhold, 2005a). Therefore, the validity of the presence measurements may have been compromised, as the participants were not allowed enough time to properly adapt to the virtual environment. Second, presence and anxiety measurements were taken concomitantly during and after the exposure. Measuring anxiety and presence together may have inflated the degree of correlation. Third, the study collapsed both groups of phobics and non-phobics when conducting analyses. This is problematic given previous research suggesting no relation between anxiety and presence among non phobics. Finally, the results were analyzed by a step-wise regression with presence and eight other variables. An analysis of nine variables requires a larger sample. In sum, Robillard et al does not provide substantial evidence for a relation between presence and anxiety.

Based on these studies, the relation between presence and anxiety for specific phobias are not strongly supported. All evidence comes from studies with questionable methodologies, small samples, and weak analyses. It is difficult to draw a firm conclusion regarding the relation of presence and anxiety. The only study that found a significant relation between anxiety and presence included a phobic sample, which suggests that further research with phobic samples is needed.

Presence and Anxiety Treatment Outcome

There has been only one study that has evaluated the relation between presence and treatment outcome for specific phobia (Krijn et al., 2004). Twenty two phobic participants undergoing treatment for acrophobia were exposed to either a high or low presence virtual environment. The high presence environment was created by a computer automated virtual

environment (CAVE). CAVE systems project the virtual environment on the floor and walls of a compartment rather than through the lenses of the HMD. The low presence environment was created by a HMD. Treatment consisted of three individual sessions that lasted for one hour. Four separate environments were used during the course of treatment to obtain outcome. Participants were not given homework or allowed to conduct in vivo exposure on outside of treatment sessions to provide a clear assessment of the effectiveness of treatment. Outcome measures were questionnaires pertaining to fears of heights and a behavioral avoidance test consisting of walking up a fire escape. Both treatment groups reported a marked decrease in their fear of heights. Results indicated that both presence conditions had the comparable treatment outcome despite having a significant difference in the amount of presence reported. Additionally, measures of anxiety and presence were not correlated across any of the sessions. These results suggest that the amount of presence experienced had no impact on treatment outcome and that there is no relation between presence and anxiety and between presence and treatment outcome.

In summary, the results from empirical work on the relation between presence and anxiety have been inconclusive. Though a few studies show a positive relation between presence and emotionality (Banos et al., 2004) and anxiety (Regenbrecht, Schubert, & Friedmann, 1998; Robillard, Bouchard, Fournier, & Renaud, 2003), these studies have used small, non-clinical samples, problematic analyses, and have methodological limitations. The only research using a clinical sample to examine the relation between presence and treatment outcome did not find a significant relation between presence and treatment outcome (Krijn et al., 2004). Given the widespread theoretical speculation about the importance of presence in the treatment of anxiety

using virtual reality and the results from empirical studies, further study of presence and anxiety is warranted.

The present study sought to further explore the relation of presence and anxiety in VRE by improving upon previous methodologies. First, the study used a clinical sample of individuals diagnosed with a fear of flying according to DSM-IV criteria. Also, the sample is the largest that has been used in presence and anxiety research to date ($N = 36$). Third, treatment lasted for eight sessions whereas previous studies have used shorter treatments and exposure durations. Finally, presence and anxiety was not be measured concurrently. The specific hypotheses are as follows:

Hypotheses

Presence is positively related to anxiety during exposure to VRE

The first hypothesis suggests that presence is positively related to anxiety during exposure to the virtual environment. This predication is based upon strong theoretical justification despite weak empirical support among the small group of studies examining this relation. The relation will also be evaluated as curvilinear.

The relation of pretreatment anxiety and in session anxiety is mediated by presence

To further examine the relation between presence and anxiety, presence is hypothesized to mediate the relation between pretreatment anxiety and anxiety during exposure. Phobics have been shown to feel anxiety when shown representations of their feared stimuli which may be attributed to a belief that the representation is the feared stimulus (Levin, Cook, & Lang, 1982). In VRE, a higher level of phobic anxiety should be related to a greater sense of presence. After feeling this sense of presence, they would then feel anxious. That is, the relation between

pretreatment anxiety of an actual airplane and in session anxiety when presented with a virtual airplane will be mediated by presence.

Presence is positively related to treatment outcome.

The third hypothesis suggests that increased presence is related to positive treatment outcome. The more present one is the better they are expected to respond to treatment. Furthermore, the extent that presence predicts treatment outcome is hypothesized to be mediated by the amount of anxiety elicited during exposure to a virtual environment.

Presence is positively related to the inclusion of phobic elements in the virtual environment.

Finally, presence is hypothesized to be related to the amount of phobic elements in the virtual environment. Phobic elements are the specific aspects of the feared environment that elicit intense anxiety. For example, a flying phobic that fears take off will feel a greater sense of presence in the virtual plane that includes take off.

Methods

The study used data collected during two randomized clinical trials comparing the efficacy of VRE to in vivo exposure for a fear of flying (Rothbaum et al., in press; Rothbaum, Hodges, Smith, Lee, & Price, 2000).

Participants

Participants were 36 individuals who met criteria for one of the following anxiety disorders: specific phobia, situational type; panic disorder with and without agoraphobia; agoraphobia without panic attacks according to DSM-IV criteria with flying as the predominantly feared stimulus (APA, 1995). Diagnoses were made during a pretreatment

assessment. All assessments were made using the Standard Diagnostic Interview for the DSM-IV (SCID: First, Gibbon, Spitzer, & Williams, 2002) administered by a licensed psychologist. A subset of the interviews were rated by a second psychologist and demonstrated excellent inter-rater reliability. Participants were randomly assigned to receive VRE for their phobia. All of the participants had a primary fear of flying.

Measures

The following measures were used to assess fear of flying and presence.

Fear of Flying Inventory (FFI: Scott, 1987): The FFI is a 33 item measure assessing fear of flying intensity (Appendix A). Fear of flying is rated on a nine point scale ranging from 0 (not at all) to 8 (very severely disturbing). The current Cronbach's alpha was $\alpha = .95$.

Questionnaire on Attitudes Toward Flying (QAF: Howard, Murphy, & Clarke, 1983): The QAF is a 36 item measure assessing fear of flying through specific instances of flying (e.g. how much fear to you feel while driving to the airport?) (Appendix B). Anxiety is rated on an 11 point scale ranging from 0 (no fear) to 10 (extreme fear). The current Cronbach's alpha was $\alpha = .94$.

Presence Questionnaire (P-BF: Witmer & Singer, 1998): The original presence questionnaire consisted of 32 items across six subscales: involvement/control, naturalness, auditory stimulation, haptic response, resolution, and interface quality. This measure was modified for the needs of current study because the subscales of haptic response, resolution quality, and interface quality were judged by two licensed psychologists not to be relevant to virtual reality as used for exposure (e.g. how well could you closely examine objects?). As a result, the Presence-BF was created from the questions of involvement (11/15 items), naturalness

of the environment (2/3 items), and auditory stimulation (2/3 items) subscales (Appendix C). Responses were measured on a 7 point scale ranging from 1 to 7. The current Cronbach's alpha was $\alpha = .86$.

Subjective Unit of Discomfort Scale (SUDS): The SUDS rating scale is a self report measurement of anxiety on a 0 to 100 point scale. Scores of 0 represent no fear and 100 represents the most fear the individual has ever felt in their life. SUDS ratings were taken throughout exposure treatment sessions.

Standard Interview for the DSM-IV (SCID: First, Gibbon, Spitzer, & Williams, 2002): The SCID is a diagnostic interview that is used to assess psychological disorders based upon the criteria of the DSM-IV. For the current project, the SCID was used as an assessment tool to diagnose participants.

Procedure

Participants underwent eight individual sessions of treatment across 6 weeks according to manualized treatment (Rothbaum & Hodges, 1997). The first four sessions of treatment consisted of anxiety management and skills training, including breathing relaxation and cognitive restructuring. Exposure to the virtual environment occurred during the final four sessions which took place twice a week in the therapist's office. During exposure, the individual was exposed to a virtual plane that is displayed through a HMD. Exposure sessions were conducted according to a fear hierarchy. The hierarchy consists of sitting on the virtual plane with the engines off; sitting on the plane with the engines on; taxiing on the runway; take off; a smooth flight; landing; and a turbulent flight. All of these conditions were controlled by the therapist. During the session, the

therapist remained in contact with the client through a microphone that broadcast to the headphones of the HMD. The therapist was able to provide encouraging comments, facilitate habituation and extinction of in session anxiety. In addition to the therapist communications, the headphones were able to play sounds traditionally associated with flying, such as safety instructions.

Measures were given to subjects at three periods during the study, prior to beginning treatment, mid-treatment being beginning exposure, and post treatment. The presence measure was administered after the first and last exposure session. Additionally, SUDS measurements were taken during each exposure session.

Results

Descriptive statistics for all variables are presented in Table 2. Variables conformed to the assumptions of normality according to the guidelines provided by Tabachnick and Fidell (2001). Each variable was assessed for outliers, which were defined as scores 1.5 times greater or less than the interquartile range. One outlier was identified, a score of 1 on the highest SUDS rating. This case was removed from the analyses reducing the sample size to 35.

The relation between presence and anxiety was assessed using a hierarchical regression (Table 3). Presence scores accounted for a significant amount of variance in SUDS ratings, F (1, 33) = 10.37, $p < .01$, $R^2 = .24$. This supports a linear relation between presence and in session anxiety. A curvilinear relation was then assessed. A presence quadratic term, created by centering and squaring the presence variable, did not account a significant proportion of variance in SUDS ratings beyond presence scores, F (1, 32) = 1.14 $p = .29$, $R^2_{change} = .03$. This does not

Table 2

Descriptive Correlation and Statistics of Variables

	1	2	3	4	5	6	7
1 Pre - FFI	1.00						
2 Post - FFI	0.49**	1.00					
3 Pre - QAF	0.82**	0.49**	1.00				
4 Post - QAF	0.43**	0.72**	0.44**	1.00			
5 Presence	0.34*	0.18	0.37*	0.08	1.00		
6 In-Session Anxiety	0.35*	0.37*	0.28	0.10	0.49**	1.00	
7 Phobic Elements	0.73**	0.42**	0.89**	0.36*	0.47**	0.31	1.00
Mean	3.55	2.89	6.17	3.86	4.65	63.00	10.26
SD	1.20	1.34	1.34	1.71	0.72	17.54	5.63
Std. Skew	1.67	2.48	-0.52	0.26	-2.13	0.43	-0.54
Std. Kurtosis	0.17	3.22	-0.59	-0.14	0.11	-0.24	-1.88

Note. n = 35. * = significant at $p < .05$. ** = significant at $p < .01$. Pre-FFI = Pre-treatment Fear of Flying Inventory. Post FFI = Post-Treatment Fear of Flying Inventory. Pre-QAF = Pre-treatment Questionnaire on Attitudes about Flying. Post-QAF = Post-treatment Questionnaire on Attitudes about Flying. Presence = Presence Brief Form.

Table 3

Multiple Regression Assessing the Relation Between Presence and In Session Anxiety

Step	Variables	b	Std. Error	*p*	R^2_{change}
1					0.24
	Presence	9.27	2.88	<0.01	
2					0.03
	Presence	10.65	3.15	<0.01	
	Presence Quadratic	0.02	0.02	0.29	

Note. Dependent variable = First Session Highest SUDS Rating.

support a curvilinear relation between presence and in session anxiety. The results support a linear relation between presence and anxiety such that higher presence is related to greater in session anxiety (Figure 1).

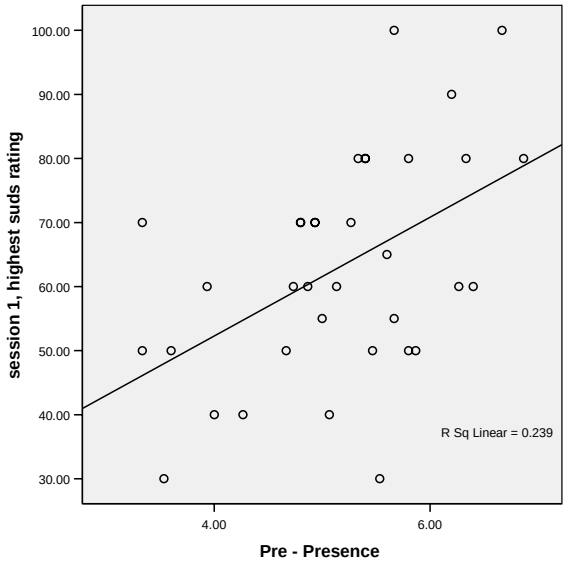

Figure 1

The relation between presence and in session anxiety was further examined by assessing if presence mediated the relation between pre-treatment anxiety and in session anxiety. The mediation was examined using the hierarchical regression technique specified by Cohen & Cohen (1983). As shown in Table 4, Pre-FFI scores were significantly related to SUDS ratings, F (1, 33) = 4.50, $p < .05$, $R^2 = .12$. This indicates that increases in pre-treatment anxiety were related to increases in anxiety during exposure. First session presence scores were entered in the second step as an intervening variable and accounted for a significant amount of variance in SUDS ratings beyond pre-treatment anxiety, F (1, 32) = 6.89, $p < .01$, $R^2_{change} = .16$. This

Table 4

Hierarchical Regression Assessing Presence Mediating the Relation Between Pre Treatment Anxiety and In Session Anxiety.

Measure	Step	Variables	b	Std. Error	*p*	R^2_{change}
FFI	1					0.12
		Pre-FFI	5.05	2.38	0.04	
	2					0.16
		Pre-FFI	2.97	2.33	0.21	
		Presence	7.96	3.03	0.01	
QAF	1					0.08
		Pre-QAF	3.69	2.19	0.10	
	2					0.18
		Pre-QAF	1.51	2.16	0.49	
		Presence	8.46	3.12	0.01	

Note. Dependent variable = Highest First Session SUDS ratings.

suggests that increases in presence were related to in session anxiety increases. Further, the relation between pre-FFI scores and SUDS ratings dropped from significance when presence was included in the equation, $b = 2.97$, $SE = 2.33$, $p = .21$. The analysis was conducted a second time using Pre-QAF scores. The amount of variance Pre-QAF scores accounted for in SUDS ratings approached significance, $F\ (1, 33) = 2.82$, $p = .1$, $R^2 = .08$. The mediation analysis was continued because the relation approached significance and the high correlation between the QAF and FFI suggests the discrepant findings can be attributed to measurement error, $r = .82$, $p < .01$. Presence accounted for a significantly greater proportion of the variance than Pre-QAF scores when added to the equation in the second step, $F\ (1, 32) = 7.33$, $p < .01$, $R^2_{change} = .18$. Further, Pre-QAF scores fell further from significance when presence was included, $b = 1.51$, $SE = 2.16$, $p = .49$. These findings supported the hypothesis that presence fully mediates the relation between pre-treatment anxiety and in session anxiety.

Another hierarchical regression was used to determine if in session anxiety mediated the relation between presence and treatment change (Table 5). After controlling for Pre-FFI scores, presence was not significantly relate to Post-FFI scores, $F\ (1, 32) = .01$, $p = .94$, $R^2_{change} = .00$. As a result, no further analyses were conducted as a relation between the independent and dependent variable could not be established. Similar findings were observed when the analysis was conducted using the QAF, $F\ (1, 32) = .32$, $p = .58$, $R^2_{change} = .01$.

The final hypothesis assessed the relation between presence and the amount of phobic elements included in the virtual environment. To calculate the amount of phobic elements in the

virtual environment, the items of the QAF were coded according to whether or not they were included

Table 5

Multiple Regression Assessing the Relation Between Presence and Treatment Outcome

Measure	Steps	Variables	b	Std. Error	*p*	R^2_{change}
FFI	1					0.24
		Pre-FFI	0.54	0.17	<0.01	
	2					0.00
		Pre-FFI	0.54	0.18	<0.01	
		Presence	0.02	0.24	0.94	
QAF	1					0.19
		Pre-QAF	0.56	0.20	0.01	
	2					0.01
		Pre-QAF	0.61	0.22	0.01	
		Presence	-0.18	0.32	0.58	

Note. Dependent variable =Post Treatment FFI scores for the FFI and Post Treatment QAF scores for the QAF.

in the virtual environment (0 = not included, 1 = included). The items from the QAF that referred to phobic elements included in the virtual environment were: i, j, k, l, m, n, o, p, q, t, u, v, y, aa, bb, cc, dd, ee, ff, gg (Appendix B). A tally was then created for each participant that reflected the number of items rated 8 or greater. A score of 8 or greater indicated feelings of extreme fear towards that specific aspect of flying. This new variable provides a measure of how many highly feared aspects of flying were represented in the virtual environment for each participant. Presence scores were significantly positively correlated to the amount of phobic

elements, $r = .47$, $p < .01$. This indicates increases in presence scores were related to an increased amount of phobic elements.

Discussion

The current study sought to add to prior work on presence by investigating the relation between presence and the following variables: in session anxiety, the number of phobic elements included in the virtual environment, and treatment outcome. The first hypothesis examined the relation between presence and in session anxiety. This majority of the literature on this topic has been theoretical and has suggested that increased presence is related to increased in session anxiety (Wiederhold & Wiederhold, 2000). The two studies that empirically examined the relation with a clinical sample had opposing findings (Krijn et al., 2004; Robillard, Bouchard, Fournier, & Renaud, 2003). In a sample of acrophobics, Krijn et al (2004) did not find a relation between presence and anxiety using two types of virtual reality technology, an HMD (n = 10) and a CAVE (n = 14). However, the null findings may be attributed to a lack of power in both groups. In a sample of specific phobics, Robillard et al (2003) supported a linear relation between presence and anxiety, but this study had methodological weaknesses. For example, presence and anxiety were measured by a one item self reported rating that were both taken during a brief five minute exposure. The temporal proximity in which the ratings were taken may have confounded the measurement. The findings of the current study corroborate those of Robillard and colleagues and also improved upon its methodological weaknesses by measuring the variables separately and assessing presence with a questionnaire with good psychometric properties. Thus, the results from the current study add to the small literature and support the

notion that an increased amount of presence is related to an increased amount of anxiety in individuals with a specific phobia.

The results of the present study further evaluated the association between presence and anxiety by supporting presence as a mediator of the relation between pre-treatment anxiety and in session anxiety (Figure 2). This result has several implications. First, it suggests presence functions as the conduit that enables phobic anxiety be felt during exposure. This implies that a sense of presence is necessary to experience anxiety during exposure to a virtual environment. Second, it suggests that those with greater phobic anxiety will experience more presence, which will lead to a greater amount of anxiety during exposure. The emotion processing theory, a theoretical framework for exposure therapy, suggests that effective exposure therapy requires activation of a phobic fear structure that contains information (take off) about the stimulus, a response (heart pounding), and a meaning (dangerous) (Foa & Kozak, 1986). Thus, VRE may be most effective for those that have a very prominent phobia, as they will experience the greatest amount of presence, which in turn will lead to fear structure activation. This interpretation is consistent with the only other study that has investigated presence and VRE with a clinical sample (Krijn et al., 2004). This prior study found that acrophobics who had lower fear prior to beginning treatment felt less present and anxious during exposure and ultimately dropped out of the study because they did not benefit.

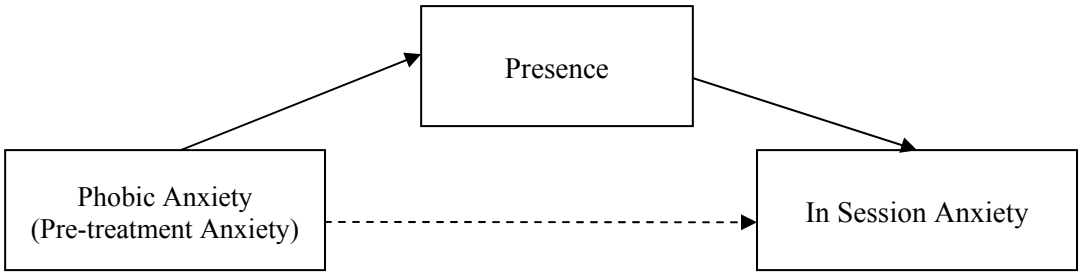

Figure 2

Conceptualizing presence as the conduit that enables anxiety to be felt during exposure illuminates the null findings from prior studies that failed to support a relation between presence and anxiety in a non-clinical sample (Regenbrecht, Schubert, & Friedmann, 1998). The anxiety of such non-clinical participants may have been lower than that of a clinical sample. This reduced anxiety may have prevented the non-clinical participants from experiencing sufficient presence to become anxious during exposure. A careful review of the descriptive statistics suggests that this may have occurred as participants did not endorse high levels of anxiety prior to exposure (M = 1.05, SD = .58, *Range* = 0-6). The contrast between Regenbrecht et al's null results and the significant findings of the current study suggest future research on presence and anxiety should be conducted with clinical samples.

Identifying presence as the mechanism that allows anxiety to be experienced during exposure suggests that presence should be maximized in a treatment setting. However, methods to manipulate presence have been a neglected area in the VRE literature. The present study supported a relation between presence and the amount of phobic elements in the virtual environments. Phobic elements are defined as the specific aspects of a stimulus that are highly feared by a phobic individual. Results from this study suggest that presence can be manipulated

by the amount of phobic elements that are included in the virtual environment. In treatment, the therapist should investigate the qualitative aspects of the client's phobia to discover their specific phobic elements prior to exposure. During exposure, the therapist should attempt to recreate the phobic elements to supplement the visual and auditory cues of the HMD. For example, a chair with a large subwoofer was used in the current study to simulate the tactile sensations of take off and landing, two of the highest endorsed feared aspects of flying. Recreating phobic elements may require the therapist to be creative. For example, a therapist in the current study used a cardboard box to recreate the highly feared sensation of claustrophobia on a plane.

Finally, the findings suggested presence was not directly related to treatment outcome. The emotion processing theory provides a theoretical framework to consider this null finding. The theory suggests that the phobic fear structure must be activated in order to obtain treatment outcome. Once activated, therapeutic outcome occurs through prolonged, repeated, and controlled exposure to the feared stimulus. This process of exposure is hypothesized to lead to habituation, defined as the extinction of fear. Exposure to the feared stimulus alone will not result in successful treatment outcome. Thus, presence may be necessary to elicit anxiety during exposure so that habituation can occur, but is insufficient by itself to obtain positive treatment change. The lack of support for the relation between presence and treatment outcome indicates that simply placing oneself in the virtual environment alone will not cause a reduction in anxiety. The clinical implication of this finding suggests VRE requires a trained professional to conduct the exposure sessions.

The study had several limitations of note, the most prominent of which is the small sample (N = 36). Although the study used a larger clinical sample than previous work, a power analysis indicates that the suggested sample to obtain a medium sized effect using a multiple regression with two independent variables at power = .8 is 68 (Faul & Erdfelder, 1992). Thus, the results should be interpreted with caution until they are replicated. The mixed findings of prior work, all of which used underpowered samples, further emphasizes the need for replication. Second, all of the measures used in the current study were self report, which makes it difficult to disentangle the measurements of in session anxiety and presence. Self report measures are prone to bias and so the measurement of presence may have been influenced by the anxiety felt during exposure. Future work should implement more objective measures of anxiety or presence. Future work on presence in VRE should reexamine the relations that were investigated in the current study and assess them in other anxiety disorders. A handful of empirical studies suggest that VRE is successful at reducing symptoms of social anxiety, panic disorder, and other phobias, but more work is needed to validate these results (see Krijn, Emmelkamp, Olafsson, & Biemond, 2004 for a review). Additional studies should determine the extent that other sensory modalities can improve an experience of presence. Hoffman et al. (2003) supported a relation between increased presence and the inclusion of tactile stimulation in VRE with spider phobics. A recent discussion of VR has suggested that presence may also be influenced by olfactory sensations (Fabrizio, Holmberg, & Lundstrom, 2001).

Finally, the current study focused on presence at the start of VRE. As habituation towards the feared stimulus is presumed to occur over the course of treatment, the relation

between presence and anxiety may change. It may be the case that the mediated relation between pre-treatment (phobic) anxiety, in session anxiety, and presence disappears at mid treatment because of a decrease in phobic anxiety. Alternatively, the relation between anxiety and presence may remain stable over treatment because of the use of fear hierarchies. A fear hierarchy is a list of adjustments to the feared stimulus that are made over the course of treatment. As a person habituations to a less feared items on the hierarchy, the person moves up the list to confront more highly feared aspects. For example, the first exposure session in the current study involved a flight without any disruption. The second exposure modified the flight by adding turbulence to elicit more anxiety. Fear hierarchies enable each exposure session to continue to elicit anxiety. Thus, the relation between presence and anxiety may remain stable over the course of treatment. Future studies should determine if the relation between presence and anxiety fluctuates over the course of treatment.

In summary, the current study explored the function of presence in VRE. The results support presence as a conduit that enables phobic anxiety to be expressed during exposure to a virtual environment. However, presence was not supported as contributing to treatment outcome. This suggests feeling present during exposure may be necessary but not sufficient to achieve benefits from VRE.

References

Anderson, P. L., Jacobs, C., & Rothbaum, B. O. (2004). Computer-supported cognitive behavioral treatment of anxiety disorders. *Journal of Clinical Psychology, 60*(3), 253-267.

Anderson, P. L., Rothbaum, B. O., & Hodges, L. F. (2003). Virtual reality exposure in the treatment of social anxiety. *Cognitive & Behavioral Practice, 10*(3), 240-247.

APA. (1995). *Diagnostic and statistical manual of mental disorders (4th ed.): Primary care version.*: American Psychiatric Publishing, Inc.

Banos, R. M., Botella, C., Alcaniz, M., Liano, V., Guerrero, B., & Rey, B. (2004). Immersion and Emotion: Their Impact on the Sense of Presence. *CyberPsychology & Behavior, 7*(6), 734-741.

Barlow, D. H. (2000). Unraveling the mysteries of anxiety and its disorders from the perspective of emotion theory. *American Psychologist, 55*(11), 1247-1263.

Barlow, D. H. (2002). *Anxiety and its disorders: The nature and treatment of anxiety and panic (2nd ed.).* Guilford Press.

Becker, E. S., & Rinck, M. (2004). Sensitivity and response bias in fear of spiders. *Cognition & Emotion, 18*(7), 961-976.

Benedikt, M. (1991). *Cyberspace: First Steps*. Cambridge, MA: The MIT Press.

Bouchard, S., Mendlowitz, S. L., Coles, M. E., & Franklin, M. (2004). Considerations in the use of exposure with children. *Cognitive & Behavioral Practice, 11*(1), 56-65.

Cohen, J., & Cohen, P. (1983). *Applied multiple regression/correlation analysis for the behavioral sciences* (2nd ed.). Hillsdale, N.J.: L. Erlbaum Associates.

Curtis, G. C., Magee, W. J., Eaton, W. W., Wittchen, H.-U., & Kessler, R. C. (1998). Specific fears and phobias: Epidemiology and classification. *British Journal of Psychiatry, 173*, 212-217.

Emmelkamp, P. M. G., Bruynzeel, M., Drost, L., & Van Der Mast, C. A. P. G. (2001). Virtual reality treatment in acrophobia: A comparison with exposure in vivo. *CyberPsychology & Behavior, 4*(3), 335-339.

Emmelkamp, P. M. G., Krijn, M., Hulsbosch, A. M., de Vries, S., Schuemie, M. J., & van der Mast, C. A. P. G. (2002). Virtual reality treatment versus exposure in vivo: A comparative evaluation in acrophobia. *Behaviour Research & Therapy, 40*(5), 509-516.

Fabrizio, D., Holmberg, M., & Lundstrom, I. (2001). Studies in the new technologies and practices in communication. In G. Riva (Ed.), *Communications through virtual technologies: Identity, community and technology in the communication age* (pp. 273). Amsterdam, Netherlands: IOS Press.

Faul, F., & Erdfelder, E. (1992). GPOWER: A prior, post-hoc, and compromise power analysis for MS-DOS Bonn FRG: Bonn University, Dept of Psychology.

First, M. B., Gibbon, M., Spitzer, R. L., & Williams, J. B. W. (2002). *Structured clinical interview for the DSM-IV-TR axis 1 disorders*. New York: Biometrics Research Department.

Foa, E. B., & Kozak, M. J. (1986). Emotional Processing of Fear : Exposure to Corrective Information. *Psychological Bulletin, 99*(1), 20-35.

Garcia-Palacios, A., Hoffman, H., Carlin, A., Furness, T. A. I., & Botella, C. (2002). Virtual reality in the treatment of spider phobia: A controlled study. *Behaviour Research & Therapy, 40*(9), 983-993.

Garcia-Palacios, A., Hoffman, H. G., Kwong See, S., Tsai, A., & Botella, C. (2001). Redefining Therapeutic Success with Virtual Reality Exposure Therapy., *CyberPsychology & Behavior* (Vol. 4, pp. 341-348): Mary Ann Liebert, Inc.

Glantz, K., & Durlach, N. I. (1997). Virtual reality (VR) and psychotherapy: Opportunities and challenges., *Presence: Teleoperators & Virtual Environments* (Vol. 6, pp. 87): MIT Press.

Harris, S. R., Kemmerling, R. L., & North, M. M. (2002). Brief Virtual Reality Therapy for Public Speaking Anxiety., *CyberPsychology & Behavior* (Vol. 5, pp. 543-550): Mary Ann Liebert, Inc.

Hoffman, H. G., Garcia-Palacios, A., Carlin, A., Furness Iii, T. A., & Botella-Arbona, C. (2003). Interfaces That Heal: Coupling Real and Virtual Objects to Treat Spider Phobia. *International Journal of Human-Computer Interaction, 16*(2), 283.

Howard, W. A., Murphy, S. M., & Clarke, J. C. (1983). The nature and treatment of fear of flying: A controlled investigation. *Behavior Therapy, 14*(4), 557-567.

Huang, M. P., & Alessi, N. E. (1999). Mental health implications for presence. *CyberPsychology & Behavior, 2*(1), 15-18.

Huang, M. P., Himle, J., & Alessi, N. E. (2000). Vivid visualization in the experience of phobia in virtual environments: Preliminary results. *CyberPsychology & Behavior, 3*(3), 315-320.

Kessler, R. C., McGonagle, K. A., Zhao, S., & Nelson, C. B. (1994). Lifetime and 12-month prevalence of DSM-III--R psychiatric disorders in the United States: Results from the National Comorbidity Study. *Archives of General Psychiatry, 51*(1), 8-19.

Klinger, E., Bouchard, S., LÃ©geron, P., Roy, S., Lauer, F., Chemin, I., et al. (2005). Virtual Reality Therapy Versus Cognitive Behavior Therapy for Social Phobia: A Preliminary Controlled Study. *CyberPsychology & Behavior, 8*(1), 76-88.

Krijn, M., Emmelkamp, P. M. G., Biemond, R., de Wilde de Ligny, C., Schuemie, M. J., & van der Mast, C. A. P. G. (2004). Treatment of acrophobia in virtual reality: The role of immersion and presence. *Behaviour Research & Therapy, 42*(2), 229-239.

Krijn, M., Emmelkamp, P. M. G., Olafsson, R. P., & Biemond, R. (2004). Virtual reality exposure therapy of anxiety disorders: A review. *Clinical Psychology Review, 24*(3), 259-281.

Lang, P. J. (1977). Imagery in therapy: An information processing analysis of fear. *Behavior Therapy, 8*(5), 862-886.

Lee, K. M. (2004). Presence, Explicated. *Communication Theory, 14*(1), 27-50.

Lee, K. M., & Nass, C. (2004). The Multiple Source Effect and Synthesized Speech Doubly-Disembodied Language as a Conceptual Framework., *Human Communication Research* (Vol. 30, pp. 182-207): International Communication Association.

Levin, D. N., Cook, E. W., & Lang, P. J. (1982). Fear imagery and fear behavior: Psychophysiological analysis of clients receiving treatment for anxiety disorders. *Psychophysiology, 19*, 571-572.

Linden, W. (1981). Exposure treatments for focal phobias: A review. *Archives of General Psychiatry, 38*(7), 769-775.

Lombard, M. (2000). Resources for the study of presence: Presence Explication. Retrieved July 11, 2002, from htttp://nimbus.temple.edu/~mlombard/Prescene/explicat.htm

Maltby, N., Kirsch, I., Mayers, M., & Allen, G. J. (2002). Virtual reality exposure therapy for the treatment of fear of flying: A controlled investigation. *Journal of Consulting & Clinical Psychology, 70*(5), 1112-1118.

Mantovani, G., & Riva, G. (1999). `Real' Presence: How Different Ontologies Generate Different Criteria for Presence, Telepresence, a., *Presence: Teleoperators & Virtual Environments* (Vol. 8, pp. 540): MIT Press.

Marshall, W. L. (1985). The effects of variable exposure in flooding therapy. *Behavior Therapy, 16*(2), 117-135.

Miller, G. A., Levin, D. N., Kozak, M. J., Cook, E. W., McLean, A., Carroll, J., et al. (1981). Emotional imagery: Individual differences in imagery ability and physiological response. *Psychophysiology, 18*, 196.

Mogotsi, M., Kaminer, D., & Stein, D. J. (2000). Quality of life in the anxiety disorders. *Harvard Review of Psychiatry, 8*(6), 273-282.

Muhlberger, A., Herrmann, M. J., Wiedemann, G., Ellgring, H., & Pauli, P. (2001). Repeated exposure of flight phobics to flights in virtual reality., *Behaviour Research & Therapy* (Vol. 39, pp. 1033).

Norcross, J. C., Hedges, M., & Prochaska, J. O. (2002). The Face of 2010: A Delphi Poll on the Future of Psychotherapy., *Professional Psychology: Research & Practice* (Vol. 33, pp. 316).

Ost, L. (1989). One-session treatment for specific phobias. *Behaviour Research & Therapy, 27*(1), 1-7.

Ost, L., Brandberg, M., & Alm, T. (1997). One versus five sessions of exposure in the treatment of flying phobia. *Behaviour Research & Therapy, 35*(11), 987-996.

Pull, C. B. (2005). Current status of virtual reality exposure therapy in anxiety disorders. *Current Opinion in Psychiatry, 18*(1), 7-14.

Rachman, S. (1991). Neo-conditioning and the classical theory of fear acquisition. *Clinical Psychology Review, 11*(2), 155-173.

Regenbrecht, H. T., Schubert, T. W., & Friedmann, F. (1998). Measuring the Sense of Presence and its Relations to Fear of Heights in Virtual Environments., *International Journal of Human-Computer Interaction* (Vol. 10, pp. 233): Lawrence Erlbaum Associates.

Riva, G. (2003). Virtual environments in clinical psychology. *Psychotherapy: Theory, Research, Practice, Training, 40*(1-2), 68-76.

Robillard, G. v., Bouchard, S. p., Fournier, T., & Renaud, P. (2003). Anxiety and presence during VR immersion: A comparative study of the reactions of phobic and non-phobic participants in therapeutic virtual environments derived from computer games. *CyberPsychology & Behavior, 6*(5), 467-476.

Rosen, J. B., & Schulkin, J. (1998). From normal fear to pathological anxiety. *Psychological Review, 105*(2), 325-350.

Rothbaum, B. O., Anderson, P. L., Zimmand, E., Hodges, L. F., Lang, D., & Wilson, J. (in press). Virtual reality exposure therapy and standard exposure therapy in the treatment of fear of flying.

Rothbaum, B. O., & Hodges, L. (1997). *Therapits treatment manual for virtual reality exposure therapy for fear of flying*. Atlanta: Virtually Better.

Rothbaum, B. O., Hodges, L., Smith, S., Lee, J. H., & Price, L. (2000). A Controlled Study of Virtual Reality Exposure Therapy for the Fear of Flying. *Journal of Consulting and Clinical Psychology, 68*(6), 1020-1026.

Rothbaum, B. O., Hodges, L. F., Kooper, R., & Opdyke, D. (1995). Effectiveness of computer-generated (virtual reality) graded exposure in the treatment of acrophobia. *American Journal of Psychiatry, 152*(4), 626-628.

Rothbaum, B. O., Hodges, L. F., Ready, D., Graap, K., & Alarcon, R. D. (2001). Virtual reality exposure therapy for Vietnam veterans with posttraumatic stress disorder. *Journal of Clinical Psychiatry, 62*(8), 617-622.

Schubert, T., Friedmann, F., & Regenbrecht, H. (2001). The Experience of Presence: Factor Analytic Insights., *Presence: Teleoperators & Virtual Environments* (Vol. 10, pp. 266-281): MIT Press.

Scott, W. (1987). Fear of flying inventory. In P. Kellar & S. Hayman (Eds.), *Innovantions of clinical practice* (Vol. 7): Publisher Resource Exchange.

Shredian, T. B. (1992). Musings on telepresence and virtual presence. *Presence: Teleoperators and Virtual Environments, 1*(120-126).

Slater, M. (2002). Presence and The Sixth Sense., *Presence: Teleoperators & Virtual Environments* (Vol. 11, pp. 435-439): MIT Press.

Steuer, J. (1992). Defining virtual reality: Dimensions determining telepresence. *Journal of Communication, 42*(4), 73-93.

Sutcliffe, A., & Gault, B. (2004). Heuristic evaluation of virtual reality applications. *Interacting with Computers, 16*(4), 831-849.

Tabachnick, B. G., & Fidell, L. S. (2001). *Using Multivariate Statistics* (4th ed.). Needham Heights, MA: Allyn and Bacon.

Taylor, S., Koch, W. J., & McNally, R. J. (1992). How does anxiety sensitivity vary across the anxiety disorders? *Journal of Anxiety Disorders, 6*(3), 249-259.

Telch, M. J., Valentiner, D. P., Ilai, D., Petruzzi, D., & Hehmsoth, M. (2000). The facilitative effects of heart-rate feedback in the emotional processing of claustrophobic fear. *Behaviour Research & Therapy, 38*(4), 373-387.

Wagner, A. R., & Rescorla, R. A. (1972). Inhibition in Pavolvian conditioning: Applications of a theory. In R. A. Boakes & M. S. Halliday (Eds.), *Inhibition and Learning* (pp. 301-336). New York: Academic Press.

Watson, J. P., Gaind, R., & Marks, I. M. (1971). Prolonged exposure: A rapid treatment for phobias. *BMJ: British Medical Journal, Vol. 1*(5739), 13-15.

Watson, J. P., & Marks, I. M. (1971). Relevant and irrelevant fear in flooding: A crossover study of phobic patients. *Behavior Therapy, Vol. 2*(3), 275-293.

Welch, R. B. (1999). How Can We Determine if the Sense of Presence Affects Task Performance?, *Presence: Teleoperators & Virtual Environments* (Vol. 8, pp. 574-577): MIT Press.

Wiederhold, B. K. (1999). *A comparison of imaginal exposure and virtual reality exposure for the treatment of fear of flying.*, Univ Microfilms International.

Wiederhold, B. K., & Wiederhold, M. D. (2000). Lessons learned from 600 virtual reality sessions. *CyberPsychology & Behavior, 3*(3), 393-400.

Wiederhold, B. K., & Wiederhold, M. D. (2005a). The Effect of Presence on Virtual Reality Treatment. In B. K. Wiederhold & M. D. Wiederhold (Eds.), *Virtual reality therapy for anxiety disorders: Advances in evaluation and treatment.* (pp. 77-86): American Psychological Association.

Wiederhold, B. K., & Wiederhold, M. D. (2005b). *Virtual reality therapy for anxiety disorders: Advances in evaluation and treatment.*: American Psychological Association.

Williams, J. M. G., Watts, F. N., MacLeod, C., & Matthews, A. (1997). *Cognitive psychology and emotional disorders* (2nd ed.). Chicester: Wiley.

Witmer, B. G., & Singer, M. J. (1998). Measuring Presence in Virtual Environments: A Presence Questionnaire., *Presence: Teleoperators & Virtual Environments* (Vol. 7, pp. 225-240): MIT Press.

Appendix A

Fear of Flying Inventory

A number of different aspects of commercial air travel are listed below. Please choose a number from the scale below to show how much you would be troubled or distressed by each of these items as they would occur if you were to fly today.

0	1	2	3	4	5	6	7	8
Not at All		Slightly Disturbing		Definitely Disturbing		Markedly Disturbing		Very Severly Disturbing

1. Making reservations for a flight ____
2. Traveling to the airport ____
3. Waiting in line for seat assignment ____
4. Getting an undesirable seat. ____Which is better, window or aisle?
5. Waiting in the boarding area ____
6. Standing in line on boarding ramp – boarding plane. ____
7. Walking through the cabin of the plane toward your seat ____
8. Demonstration of safety procedures ____
9. Looking out of window while on ground
10. Taxiing to takeoff area ____
11. Takeoff ____
12. Looking out of window during takeoff ____
13. Looking out of window while in the air ____
14. Being on a crowded plane ____
15. Being on a relatively empty plane ____

16. Thinking of your family while flying ____

17. Listening to engine sounds ____

18. Watching other passengers ____

19. Experiencing turbulence (plane lurches) ____

20. Listening to pilot's announcements ____

21. Eating a meal while in flight ____

22. Using the plane's washroom ____

23. Flying through clouds ____

24. Flying over water ____

25. Thinking about the altitude (how high you are in the air) ____

26. Thinking about the speed of the plane ____

27. Listening to announcements of landing preparation ____

28. Hearing landing gear moving into position ____

29. Feelings of descent during landing ____

30. Feeling of touchdown on landing strip ____

31. Braking of plane during landing ____

32. Taxiing to terminal after landing ____

33. Waiting in line to deboard plane ____

Appendix B

Questionnaire On Attitudes Toward Flying

1. Name _____
2. Male/Female _____
3. Age _____
4. Education _____
5. How many times have you flown? (Count place of departure to place of final destination as one trip) _____
6. How long (in hours) was your last trip? _____
7. Please circle the number on the scale below which you feel best reflects your feeling about flying at this time.

   0 – Would indicate absolutely no fear or distress about flying

   5 – Would indicate a considerable amount of fear of discomfort but not nearly as much as it is possible for you to experience

   10 – Would indicate the most extreme amount of fear or discomfort that is possible for you to feel

   No fear 0 1 2 3 4 5 6 7 8 9 10 Extreme fear

8. How long (in years) have you experienced a fear of flying _____
9. Are there any other activities or situations which you are afraid of? If so, please explain.

   _____

10. Are you currently being treated for anxiety while flying _____
11. Please rate your feelings towards the following situations by circling the number on the scale which best reflects your feelings about each situation

No fear 0 1 2 3 4 5 6 7 8 9 10 Extreme fear

A. Crowded places

B. Lifts

C. Heights

D. Confinement in a small enclosed area

E. Death

F. Traveling by car

G. Traveling by train

H. Traveling by boat

I. Traveling by bus

12. Do you ever get airsick? How much do you fear being air sick? _____

13. Imagine that you are in a plane that is going to make an emergency landing. Please indicate the number on the scale above, which you feel would best reflect your feelings in this situation.

14. What is the worst thing about flying for you? _____

15. If you have to fly, is there anything which helps you cope better with the situation? Please specify _____

16. Please imagine that you are in each of the following situations and are not flying with anyone you know. For each situation, circle the number on the scale which you feel would best reflect your feelings in that situation.

A. Thinking about the plane trip which you are scheduled to take in two weeks?

B. Ordering tickets and planning flight details

C. At home packing and preparing on the day of the flight

D. Driving to the airport

E. Arriving at the airport

F. Checking in your baggage at the ticket counter

G. In the passenger lounge waiting for your flight number to be called

H. Saying goodbye just prior to entering the boarding area

I. Boarding the plane

J. Getting seated

K. The cabin staff shuts all the doors

L. The engines start

M. The safety instructions are given by a hostess

N. The signs saying “extinguish all smoking materials and fasten your seat belts go on”

O. The plane taxis to the runway

P. The plane is cleared for take-off and you feel the sudden surge and thrust as the plane moves quickly down the runway

Q. You feel the plan lift off the ground

R. The plane begins to turn sharply as it climbs

S. The plane is climbing to cruising altitude

T. You are informed by the signs that you can undo your seatbelt and that smoking is now permitted

U. The plane is flying along in clear, calm weather

V. The noise of the engine suddenly increases

W. The food trolley is by your seat and completely takes up all the aisle space next to your seat, blocking you in

X. You look out of the window and can see a small town, miles and miles below you

Y. The plane is flying through heavy clouds

Z. The plane hits an airpocket, is rocked around and drops suddenly before recovering

AA. An announcement on the PA tells you to fasten your seatbelt

BB. You are flying at night, and it is impossible to see anything through the window, which are pitch-black

CC. The plan is flying through a turbulent area, and you are jolted and swayed in your seat

DD. The plane is descending at your destination

EE. You feel the jolt of the undercarriage as the wheels drop into position for landing

FF. The wheels touch down and almost immediately the engines roar into reverse thrust, slowing the plane noticeably

GG. The plane is taxiing back in the terminal

HH. You are getting out of the plane

II. You pick up your baggage inside the air terminal

JJ. You are leaving the airport

17. Please indicate the number on the scale above which you feel would best reflect your feelings when flying in each of the following types of aircrafit

A. Jumbo Jet

B. Medium sized jet passenger plane

C. Medium sized, four prep passenger plane

D. Two seater light aircraft

Appendix C

Presence Questionnaire

Characterize your experience in the virtual environment by circling the appropriate number on this 7-point scale, in accordance with the question content and descriptive labels. Please consider the entire scale when making your responses, as the intermediate levels may apply. Answer the questions independently in the order that they appear. Do not skip questions or return to a previous question to change your answer.

With regard to the virtual environment…

1. How natural did your interactions with the environment seem?

1	2	3	4	5	6	7
Extremely artificial			Borderline			Completely Natural

2. How much did the visual aspects of the environment involve you?

1	2	3	4	5	6	7
Not at all			Somewhat			Completely

3. How much did the auditory aspects of the environment involve you?

1	2	3	4	5	6	7
Not at all			Somewhat			Completely

4. How much did your experiences in the virtual environment seem consistent with your real world experiences?

1	2	3	4	5	6	7
Not Consistent			Moderately consistent			Very consistent

5. How completely were you able to actively survey or search the environment using vision?

1	2	3	4	5	6	7

Not at all Somewhat Completely

6. How well could you identify sounds?

1 2 3 4 5 6 7

Not at all Somewhat Completely

7. How involved were you in the virtual environment experience?

1 2 3 4 5 6 7

Not at all Somewhat Completely

8. How much delay did you experience between your actions and expected outcomes?

1 2 3 4 5 6 7

Not at all Somewhat Completely

9. How quickly did you adjust to the virtual environment experience?

1 2 3 4 5 6 7

Not at all Somewhat Completely

10. How completely were your senses engaged in this experience?

1 2 3 4 5 6 7

Not at all Somewhat Completely

11. To what extent did events occurring outside the virtual environment distract from your experience to the virtual environment?

1 2 3 4 5 6 7

Not at all Somewhat Completely

12. Overall, how much did you focus on using the display and control devices instead of the virtual experience and experimental task?

1 2 3 4 5 6 7

Not at all Somewhat Completely

13. Were you involved in the experimental task to the extent that you lost track of time?

1 2 3 4 5 6 7

Not at all Somewhat Completely

14. Were there moments during the vital environment experience when you felt completely focused on the task or environment?

1 2 3 4 5 6 7

Not at all Somewhat Completely

15. Was the information provided through different senses in the virtual environment (e.g. vision, hearing, touch) consistent?

1 2 3 4 5 6 7

Not at all Somewhat Completely