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Increasing the Efficacy of Virtual Reality Exposure Therapy for Fear-of-Flying

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has been found to be complete and satisfactory in all respects,
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the review committee have been made.

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Abstract

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Dissertation Submitted in Partial Fulfillment

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Abstract

Virtual reality exposure therapy (VRET) is a treatment often used to treat fear-of-flying (FOF), which research shows is effective for treating this phobia. Researchers have identified that the realism of the virtual environment is an important component in the efficacy of VRET and increased realism is likely to increase the efficacy of VRET. Guided by cognitive theory, emotional processing theory, and behaviorism, the purpose of this quantitative study was to demonstrate if a new generational technique called true reality-virtual reality exposure therapy (TR-VRET) is at least as efficacious as traditional VRET for treating the fear and anxiety associated with FOF. Repeated measures ANOVAs were used to compare the means between the pre-/posttests measuring fear and anxiety associated with FOF and between the control and experimental group. Both the active treatment experimental group (using TR-VRET) and the active treatment control group (using VRET) had a significant effect on reducing anxiety related to flying. The findings also revealed that both the active treatment experimental group and the active treatment control group had a significant effect on reducing fear related to flying. Notably, no significant differences were found between the active treatment experimental group and the active treatment control group, meaning the 2 treatments were equally effective at reducing the anxiety and fear related to flying. These findings can contribute to positive social change by allowing mental health professionals access to an advanced treatment tool (i.e., TR-VRET) that is just as effective as the older treatment tool (i.e., VRET). These findings can also contribute to positive social change by quickly allowing more tailored virtual environments to be created for clients at a lower cost.

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Chapter 1: Introduction to the Study

Introduction

Virtual reality exposure therapy (VRET) is a therapeutic technique that has been developed over the last 30 years (Malbos, 2015; Meyerbröker & Emmelkamp, 2014; Oskam, 2005). Modern day VRET is used to expose clients to a stimulus that is related to the client's fear (i.e., phobia); these fears can be related to many different stimuli like flying, heights, and crowds (Malbos, 2015; Meyerbröker & Emmelkamp, 2014; Oskam, 2005). During VRET, a client is exposed to the stimulus via a computer-generated environment that is usually viewed through a virtual reality headset (Malbos, 2015; Meyerbröker & Emmelkamp, 2014; Oskam, 2005).

The reason clients are exposed to the stimuli of their phobia within a virtual computer-generated environment is to ensure they are in a safe environment during the exposure (Malbos, 2015; Meyerbröker & Emmelkamp, 2014; Oskam, 2005). This exposure is gradual and results in the decrease in both the fear and anxiety related to the fear (Malbos, 2015; Meyerbröker & Emmelkamp, 2014; Oskam, 2005). Even though VRET has been shown to be effective in treating fear and anxiety related to various phobias, the therapy has been hindered by several factors including cost and outdated technology (Claudio, Carmo, Gaspar, & Teixeira, 2018; Oskam, 2005).

With this study, I specifically addressed the use of a new technology in VRET. By taking advantage of new 360-degree video technology, it is possible to produce virtual reality using "real-life" environments, referred to as true reality-VRET (TR-VRET). This new TR-VRET approach and the related technology can produce more realistic

environments, while also likely making the treatment of phobias more effective (Meyerbröker & Emmelkamp, 2014; Oskam, 2005). This effectiveness is related to the cognition, cognitive presence, emotional response, and overall generalizability (Oskam, 2005). Oskam (2005) showed that by increasing the realism of the virtual environment, all four of these factors should also increase, and this includes the overall efficacy of the treatment itself. The reason TR-VRET is likely to make treating phobias more effective is because it increases the realism experienced by the client within virtual environments. This increase in realism should lead to an increase in the overall effectiveness of the treatment itself (Meyerbröker & Emmelkamp, 2014; Oskam, 2005). In general, this increase in realism leads to an increase in the cognition and cognitive presence experienced by the client, which in turn leads to the client experiencing an increase in the elicited emotional response (Meyerbröker & Emmelkamp, 2014; Oskam, 2005). This increase in emotional response (i.e., cognition and cognitive presence) experienced by a client because of TR-VRET should allow the treatment to better generalize to the real world and the life of the client (Malbos, 2015; Meyerbröker & Emmelkamp, 2014; Oskam, 2005) and should make TR-VRET more effective in treating phobias (Oskam, 2005).

In this study, I specifically looked at the efficacy of this type of therapy as it relates to fear-of-flying (FOF). This study was necessary because it provided data showing how an increase in realism within a virtual environment using TR-VRET affects the overall effectiveness of treating FOF and how the effectiveness of TR-VRET compares to VRET. The findings of this study of the use of 360-degree technology

helped fill a meaningful gap in the literature because this is an area where little research has been conducted (Kallioniemi et al., 2017) on the use of real life virtual reality environments to treat any kind of phobias (Stupar-Rutenfrans, Ketelaars, & van Gisbergen, 2017) and no research has been done using the TR-VRET therapeutic technique for FOF. The results of this study provided data on a newly emerging and underresearched topic.

At present, the technology used by modern VRET is relatively old, according to North, North, and Coble (1997), and does not utilize recent technological advances. According to Servaies (2014), people integrating technology into other aspects of their lives has helped drive social change in the past. This study has the potential to promote positive social change by demonstrating how integration of new technology (i.e., TR-VRET) into an existing psychological treatment (i.e., VRET) can make this treatment modality more effective.

Chapter 1 begins with a general background of VRET, how it has been used, its effectiveness, and its related concepts. This is followed by the problem statement and an explanation of the purpose of the study. I then provide the research questions and related hypotheses as well as a discussion of the theoretical framework and nature of the study. Next, relevant definitions and assumptions are described. This is followed by the scope, delimitations, limitations, and significance of the study. Chapter 1 is concluded with a summary of the main points within the chapter.

Background

In this section, I discuss selected articles for VRET relating to its various uses, concepts, and effectiveness. Anderson et al. (2013) conducted a study related to the treatment of social anxiety disorder andevaluated VRET compared with exposure therapy, which is exposing a person to a feared stimulus in real life (i.e., in-vivo). The researchers were able to show that VRET was just as an effective tool for treating this kind of anxiety as traditional exposure therapy. Furthermore, the researchers were able to show the results of the treatment were still effective 1 year later.

Belloch et al. (2014) examined the utility of VRET in relation to obsessive-compulsive disorder (OCD) patients. Their study was conducted on four OCD patients to assess how they experienced the sense of presence, emotional engagement, and reality judgement as well as their anxiety and disgust levels in virtual reality environments. The participants in their study reported experiencing a good sense of presence and reality judgement and as the virtual contamination of the environment increased, their anxiety and disgust levels subsequently increased. Their findings also showed that the anxiety was related to the emotional engagement and sense of presence they had while in the virtual environment.

Botella et al. (2014) analyzed the preference of participants regarding two different forms of exposure therapy to treat FOF. The first form of therapy was VRET by itself and the second form was the use of VRET with cognitive restructuring (VRET+CR). Both VRET and VRET+CR were shown to be equally effective in their study. When evaluating satisfaction with the two approaches, both received high scores

with no significant differences between them; however, when asked directly about their preference for one approach or the other, all participants in their study indicated a preference for VRET+CR, believed it to be more effective, were more likely to recommend it to other people, and felt that VRET+CR was less aversive.

Gebara et al. (2016) tested VRET treatment for social phobia by exposing participants to phobia-inducing situations via computer generated, three-dimensional images (i.e., virtual reality). The researchers were able to show that these kinds of environments were cost-effective to create, encouraged clients to complete therapy, and effective at reducing anxiety related to social phobia. Giovancarli et al. (2016) primarily evaluated the effectiveness of cognitive behavioral therapy (CBT) used with VRET in comparison to CBT alone to prevent smoking relapse. Another purpose of their study was to analyze the use of VR in relation to presence, cyber-sickness, and the number of patients who completed the VRET program. Their study consisted of two groups, one that used only CBT, while the other used CBT+VRET. Their findings showed that patients who received CBT+VRET had a significantly higher likelihood of avoiding smoking relapse as well as a lower dropout rate than CBT by itself. Their results also indicated that CBT+VRET was more successful at decreasing anxiety and depression and increasing self-esteem, quality of life, and addictive comorbidities. Lastly, their findings showed that CBT+VRET increased participation and program completion as well as the patients' sense of presence; however, the one major drawback was that some patients experienced cyber-sickness (i.e., dizziness and nausea).

McCann et al. (2014) systemically evaluated the quality of VRET literature, quantified the extent to which quality research design characteristics were present, and examined whether the quality of each study was related to the treatment effect size. An additional purpose of their study was to see if there was a change in VRET and randomized controlled trial (RCT) study quality and treatment effect size over time. The researchers were able to show that the RCTs provided evidence that VRET was an effective tool for treating anxiety disorders.

Peñate Castro et al. (2014) compared the efficacy of virtual reality exposure combined with CBT (VRET) to the use of traditional CBT by itself. In their study, each of these therapies was used to reduce symptoms in patients suffering long-term agoraphobia with all participants receiving antidepressant medication and being split into three groups: VRET therapy, traditional CBT therapy, and medication only. According Peñate Castro et al., each of the three therapies were shown to be effective, both present immediately after treatment and during the follow-up assessment 6 months after treatment had concluded. Furthermore, the researchers concluded the VRET group continued to have the most lasting improvement from therapy based on the data collected at the 6-month follow-up visit. VRET was shown to be an intermediate procedure that can be used efficiently and effectively for exposure to phobic stimuli (Peñate Castro et al., 2014). VRET is also shown to have a higher treatment adherence and higher motivation to participants (Peñate Castro et al., 2014).

Gap

Oskam (2005) evaluated the use and effectiveness of VRET as a treatment of anxiety disorders. Oskam noted that for VRET to be effective, there are four factors that must be present, namely that virtual environments must have a strong cognitive presence, cognition, elicit strong emotions, and the effects of VRET must be able to be generalized to the real world. Furthermore, Oskam went on to argue that the general effectiveness of VRET is tied to the realism of the environment and that realism of the environment directly affects each of these factors. Oskam concluded by stating that the effectiveness of VRET could potentially be improved if the realism of the virtual environment is improved and that it is likely that improving realism within the virtual environments will also allow the effects to be more generalizable to the real world. However, the author noted that more research will have to be done in this area to determine exactly how this can be accomplished. Therefore, by conducting this research study, I aspired to fill this gap.

Need for Study

The level of realism has been shown to play an important role in the level of presence, cognition, and emotional response experienced by a client, the generalizability of the effects of treatment, and the overall efficacy of VRET (Oskam, 2005). To date, I could find no other study or research to have taken VRET to its logical extension of using real-life environments to measure how it affects the overall efficacy of VRET as it relates to FOF. This study was necessary to not only fill this gap in the field but was needed to

understand if TR-VRET is at least as efficacious as VRET as it relates to the FOF. Oskam (2005) noted that:

> If it is possible to let people experience more directed or more realistic stimuli, emotional effects will be greater. This can be done by representing important stimuli in such a way that cognition of these stimuli can only be done in one unified manner. With this, ambiguity can be prevented, which means that stimuli will be perceived in the way that they were meant to. (p. 5)

Problem Statement

VRET is rooted in systematic desensitization (SD), which is a behavioral therapy based on classical conditioning (Wolpe, 1958). SD is a therapy used to treat phobias through the removal of the fear response and in its place, substitute a relaxation response using counterconditioning (Wolpe, 1958). Counterconditioning is defined as when an unwanted behavior is replaced with a wanted behavior (Persons, 2012).

SD involves three phases: a client learning relaxation and breathing exercises, the creation of a fear hierarchy (i.e., ranking fear stimuli and the anxiety caused from the lowest to highest), and exposure to least unpleasant stimuli and using the learned breathing and relaxation techniques while working up the hierarchy (Wolpe, 1958). SD has been empirically tested and has been shown to reduce anxiety levels related to fear stimuli associated with phobias (Rothbaum et al., 2000). This has been show to be true with as many as 93% of clients who used the therapy (Rothbaum et al., 2000).

Exposure therapy (ET) is a form of cognitive-behavioral therapy rooted in respondent conditioning (Abramowitz, Deacon, & Whiteside, 2019). ET is used to assist

a client in reducing the distress he/she is experiencing when exposed to a specific object, situation, thought, or memory (Abramowitz et al., 2019). During ET, a client is exposed to progressively increasing fear-inducing stimuli in a controlled and safe environment; this is done in three different ways: exposing a client to the fear-inducing stimuli in real life, having the client imagine the stimuli, or through interoceptive exposure (Abramowitz et al., 2019). ET works by identifying the fear and avoidance patterns a client engages in when exposed to a fear-inducing stimulus (Abramowitz et al., 2019). ET helps to not only break this pattern, but also to teach the client coping skills to create a new positive pattern (Abramowitz et al., 2019). Research by Ost (1989) showed that ET is highly efficacious for treating phobias, finding that, after 4 years, 90% of clients reported a significant reduction in fear, avoidance, and impairment related to a phobia, while 64% reported no longer having any phobia.

VRET is a concept that was developed over the course of the last few decades (Malbos, 2015; Meyerbröker & Emmelkamp, 2014; Oskam, 2005). The aim of current VRET is for use in simulated virtual reality environments to expose a client to the stimulus for which they have a phobia (e.g., FOF) in a simulated environment. By doing this, the goal is to place the client in an environment where he/she feels safe while exposed to his/her fear, resulting in a decrease or elimination of the anxiety associated with that fear (Malbos, 2015; Meyerbröker & Emmelkamp, 2014; Oskam, 2005). Although VRET has been shown to be highly effective, it has one major drawback, which is cost (Claudio et al., 2018; Oskam, 2005). The cost of providing this form of therapy to clients can be substantial and prohibitive to clinical practitioners.

Some of the most important factors associated with successful VRET relate to cognition, cognitive presence, the overall ability of VRET to elicit strong emotions from the client, and the generalizability of effects (Oskam, 2005; Paliokas, Tsakiris, Vidalis, & Tzovaras, 2014). The term cognitive presence is synonymous with the term sense of presence. According to Nunez and Blake (2001), cognitive presence is defined as "the degree to which the virtual environment dominates over the real environment as the basis for thought" (p. 116). In general, what cognitive presence is referring to is the degree to which the client feels they are in the virtual environment and the how real the environment feels to them (Oskam, 2005; Paliokas et al., 2014). Cognition can refer to many things, but in the context of virtual environments this term has a specific meaning and refers to the level of realism experienced by a person within a virtual environment that allows for an emotional response to take place (Gleitman, 1999, Oskam, 2005).

Cognition, cognitive presence, emotional response, and generalizability have all been shown to increase in relation to the increase in the realism of a virtual environment and virtual stimulus (Andreano et al., 2009; Oskam, 2005). Furthermore, cognition and cognitive presence have been shown to work together to create the emotional response a person experiences, which plays an important role to the overall effectiveness of ET (Malbos, 2015; Meyerbröker & Emmelkamp, 2014; Oskam, 2005). The generalizing effects of VRET have been shown to play an important role in extending cognitive changes made within treatment to the client's outside world and real situations (Malbos, 2015; Meyerbröker & Emmelkamp, 2014; Oskam, 2005). The realism (i.e., cognition) a person experiences during VRET has been shown to be the foundation of the emotions

the person experiences during this kind of therapy. Increasing the emotional response experienced during VRET has been shown to play a crucial role in improving the effectiveness of this therapy (Andreano et al., 2009; Oskam, 2005; Triscari et al., 2015; Wiederhold & Wiederhold, 2005).

I conducted this study to determine if the efficacy of TR-VRET is at least equal to traditional VRET that uses simulated virtual reality environments if realism is increased using real-life virtual reality environments containing a specific fear stimulus, which for this study is flying. Previous VRET research has included measurement of cognitive presence, cognition, emotional response, and generalizing effect (Oskam, 2005). The scope of this study did not include these individual measurements but focused on determining the overall efficacy of this new TR-VRET technique and compare it with the existing VRET technique using standardized measurements.

There is little research using a 360-degree technique (Kallioniemi et al., 2017), and according to Stupar-Rutenfrans et al. (2017), there appears to be little research related to the use of real-life virtual reality environments for therapeutic purposes. This study addressed the gap in understanding how increasing the realism of virtual reality environments using real-life environments, as opposed to simulated virtual reality environments, effects the efficacy of VRET as it relates to FOF (see Oskam, 2005).

Purpose of the Study

The purpose of this study was to demonstrate if a new generational technique called TR-VRET, displaying real environments for use in treatment, is at least as efficacious as traditional VRET using simulated environments. In this study, I aimed to

increase the realism of VRET through the creation and use of real-life virtual reality environments in a technique called TR-VRET. This is done as opposed to using simulated virtual reality environment. I hypothesized the TR-VRET technique would result in more effective phobia treatment.

Research Question and Hypotheses

The following research questions and corresponding hypotheses directed this study:

Research Question 1: Does TR-VRET equal VRET in the reduction of anxiety when treating FOF?

$H_0$1: The reduction in anxiety after TR-VRET is not equal to the reduction in anxiety after VRET following treatment for FOF as measured by the Flight Anxiety Situations Questionnaire (FAS).

$H_1$1: The reduction in anxiety after TR-VRET is equal to the reduction in anxiety after VRET following treatment for fear-of-flying as measured by the FAS.

Research Question 2: Does TR-VRET equal VRET in the reduction of fear when treating FOF?

$H_0$2: The reduction in fear after TR-VRET is not equal to the reduction in fear after VRET following treatment for FOF as measured by the Fear of Flying Inventory (FFI).

$H_1$2: The reduction in fear after TR-VRET is equal to the reduction in fear after VRET following treatment for FOF as measured by the FFI.

Theoretical Framework

The three theories that served as the conceptual framework for this study were cognitive theory (Abramowitz, 2013), emotional processing theory (EPT; Kaczkurkin & Foa, 2015), and behaviorism (Mason, 2013). In general, cognitive theory states that a person's perceptions and thoughts about a situation, event, or stimuli will directly influence their emotions and behaviors (Abramowitz, 2013). This would apply to a person's irrational thinking or cognitive distortions as it relates to a phobia. VRET exposes a person to this situation, event, or stimuli, then works to transform the person's perception or thought about it, which in turn helps in changing the person's emotions and behaviors positively (Oskam, 2005; Triscari et al., 2015).

EPT states that fear is represented by cognitive fear structures that contain the information about the feared stimulus, the type of fear response, and the meaning behind them (Kaczkurkin & Foa, 2015). This can in turn lead to pathological behaviors when the fear response does not match reality (Kaczkurkin & Foa, 2015). VRET activates the pathological fear structure and provides new information that works to disconfirm the pathological and unrealistic associations within these structures (Kaczkurkin & Foa, 2015).

Behaviorism is a learning theory that concentrates specifically on objectively observable behaviors (Mason, 2013). This theory posits that learning relates to the acquisition of behaviors are the result of environmental conditions (Mason, 2013). Behaviorism focuses on conditioning as a universal learning processing (Mason, 2013). The two types of conditioning are classic conditioning and behavioral (i.e., operant)

conditioning (Mason, 2013). VRET exposes a person to a new and controlled set of environmental conditions through systemic desensitization, which in turn alters objectively observable behaviors in the person (Boundless, 2016).

Nature of the Study

In this study, I employed a quantitative approach using an experimental design to test the treatment efficacy of using the TR-VRET technique with patients referred for FOF. The specific design used in this study was a randomized control group, pretest-posttest design, which is also known as a *classic controlled experimental design* (Nestor & Schutt, 2014). This design was chosen because it allowed a direct comparison of the efficacy of two treatment modalities.

The randomized control group, pretest-posttest design has one control group and one experimental treatment group and allows for all participants to be randomly assigned to either group (Nestor & Schutt, 2014). The established method of VRET served as the active treatment control group and the new method of TR-VRET served as the active treatment experimental group, also known as active treatment concurrent control (see Chow & Liu, 2008). This was important because in this study I used VRET as the established method (i.e., active treatment control group) and TR-VRET as the new method (i.e., active treatment experimental group) that were compared and analyzed to one another (see Nestor & Schutt, 2014). The core analytical strategies used for this study were means, standard deviations, and repeated measures ANOVA.

Another reason I chose the randomized control group, pretest-posttest design was that it allowed for the control group and experimental group to receive both a pretest and

posttest, while also allowing for the differences between the two groups to be assessed (see Nestor & Schutt, 2014). This was important because there were two independent variables (i.e., VRET and TR-VRET) and two dependent variables (i.e., anxiety and fear) requiring a pretest and a posttest. Anxiety was measured using the Flight Anxiety Situations Questionnaire (FAS) and fear was measured using the Fear of Flying Inventory (FFI).

According to Triscari et al. (2015), the FAS comprises 32 items that measure the level of anxiety produced during flying situations on a 5-point Likert Scale with a range of 1 to 5. The three subscales included are Generalized Flight Anxiety (GFA), Anticipatory Flight Anxiety (AFA), and In-Flight Anxiety (IFA). GFA is related to anxiety associated with airplanes in general; AFA is associated with anxiety experienced before the flight starts; and IFA is associated with anxiety experienced during a flight, including the takeoff and landing (Triscari et al., 2015).

The FFI (Wiederhold et al., 2002) is a 33-item measure assessing the intensity of the fear related to flying on a 9-point Likert Scale with a range of 0 to 8. The scores for the FFI range from 0 to 264 and have been shown to be sensitive to changes after treatment for FOF (Wiederhold et al., 2002). According to Scott (1987), the FFI allows participants to rate the level of distress they experienced during the different aspects of flying. Some examples of the different aspects of flying a participant rates includes traveling to the airport, looking out of the window while on the ground, take-off, experiencing turbulence, and feeling of touchdown on the landing strip (Scott, 1987).

The population from which the sample was derived was people diagnosed with FOF, who were not currently undergoing therapy for FOF, were 18 years of age and older, and living in Central Wisconsin. I secured one clinical site as a participating organization for this intervention study to provide clinical oversight, initial screening and diagnosis of participants, conduct the therapy (e.g., VRET and TR-VRET), and provide the archival data for the study. The sample consisted of a purposeful sample of people who were screened by the participating organization for inclusion in the FOF intervention study.

The sample included two groups: Group A was the active treatment control group where participants only used traditional VRET to treat FOF, while Group B was the active treatment experimental group where participants used TR-VRET to treat FOF. The participants in both groups were asked to complete two questionnaires (i.e., FAS and FFI) before therapy began as pretests. After this the participants were then asked to complete the same two questionnaires at the end of therapy as posttests.

The demographic information collected from each participant included their age, years of education, annual income, gender, ethnicity, and marital status. The type of therapy (i.e., VRET or TR-VRET) the participant received was also identified along with any current psychoactive medications the person was taking during therapy, if any. I have provided a brief overview of the nature of this study in this section; however, the methodology of this study will be described in more detail in Chapter 3.

Definition of Terms

360-degree technique: A current technique used in traditional VRET where a computer-generated environment allows a person to view and interact in a 360-degree virtual reality environment, although the environment often resembles that of a video game (Kallioniemi et al., 2017).

360-degree virtual reality environment: An audiovisual simulation of an altered, augmented, or substituted environment that surrounds the user, allowing them to look around them in all directions, just as they can in real life (Soga, 2016).

Active treatment concurrent control: One group is given the treatment while the other group is given an existing therapy that is known to be effective (Chow & Liu, 2008).

Anxiety: Emotional distress associated with flying in general, the anticipation of flying, and while in-flight (Triscari et al., 2015).

Cognition: The level of realism experienced by a person within a virtual environment that allows for an emotional response to take place (Oskam, 2005).

Cognitive presence: The degree clients believe or feel they are in the virtual environment that they are experiencing (Oskam, 2005).

Emotional response: The degree virtual fear stimuli elicits an emotional response (i.e., general anxiety, fear, increased heart rate, increased breathing, increased blood pressure, etc.; Oskam, 2005).

Fear: Intensity of fear associated with flying (Wiederhold et al., 2002).

Fear-of-flying (FOF): An excessive fear caused by the presence of an airplane or the anticipation of any situation linked to it (e.g., airports, purchasing of airline tickets, thinking about airplane crashes), and exposure to airplanes provokes an immediate anxiety response, which can lead to a panic attack (Ferrand et al., 2015).

Generalizability: The degree that any fear extinction experienced during VRET generalizes to the real world and to real scenarios in the clients' life (Oskam, 2005).

Presence: The degree clients believe or feel they are in the virtual environment they are experiencing (Oskam, 2005).

Realism: Synonymous with the term, cognition; the level of realism experienced by a person within a virtual environment that allows for an emotional response to take place (Oskam, 2005).

Real-life: The 360-degree virtual reality environment depicting real-life environments as opposed to computer-generated ones (Stupar-Rutenfrans et al., 2017).

Simulated environment: Computer-generated virtual environment allowing a person to view a 360-degree virtual environment (Kallioniemi et al., 2017).

True reality: Term coined specifically for this study and refers to real-life 360-degree virtual reality environments.

True reality-virtual reality exposure therapy (TR-VRET): Term coined specifically for this study and is a version of VRET that uses real-life 360-degree virtual reality environments in place of computer-generated 360-degree virtual reality environments to expose patients to realistic environments and stimuli to assist in decreasing fear.

Virtual reality (VR): Refers to either a computer-generated virtual environment (Kallioniemi et al., 2017) or a virtual environment uses real-life environments (Stupar-Rutenfrans et al., 2017).

Virtual reality (VR) environment: Environment used to expose patients to realistic environments and fear stimuli (Oskam, 2005).

Virtual reality exposure therapy (VRET): Use of computer-generated 360-degree VR environments to expose patients to realistic environments and stimuli to assist in decreasing fear (Oskam, 2005).

Assumptions, Scope, Delimitations, and Limitations

Assumptions

The basic underlying assumption for this study was that as realism within a virtual environment increases, the efficacy of VRET will increase. This increase in efficacy would also result in the increase in cognitive presence, cognition, emotional response, and the overall generalizability of the effect of the treatment. I also assumed that as the realism of a virtual environment increased from a computer-generated virtual environment to one using real-life virtual environments, the efficacy of VRET in its new form as TR-VRET would continue to increase. Another assumption was that if true reality was used to treat FOF using TR-VRET, this would be more efficacious than traditional VRET.

The fundamental purpose of ET is to decrease or extinguish a fear that a person has towards a stimulus (Oskam, 2005). If increased realism is supposed to increase the efficacy of VRET, then it only makes sense to expose a person to the most realistic

virtual environment as possible within a safe and therapeutic space. Since the framework of this study hinged on literature supporting the increase in efficacy in VRET as the realism of the environment increases, it was necessary to assume that using true reality depicting real-life environments would increase the efficacy of the therapy. As a result, it was necessary to assume that using real-life environments relating to flying during TR-VRET would increase the effectiveness of treating FOF.

Scope and Delimitations

The scope of the study was limited to the treatment of clients with a diagnosed FOF, using VRET and TR-VRET for treatment, and the cost associated with this treatment. In this study, I compared the efficacy of traditional VRET and TR-VRET to see if increased realism in TR-VRET leads to a similar or increased efficacy of treatment. To compare the efficacy of VRET and TR-VRET, measurements were taken before and after treatment (i.e., pre- and posttest) relating to the anxiety and fear experienced by participants associated with flying and flying-relative situations.

The study population were participants who were diagnosed as having a FOF, not currently in therapy for FOF, were willing to use VRET or TR-VRET for treatment, and were willing to stabilize any current medications they were on. If these parameters were not met, a potential participant was excluded. I focused strictly on ET as it related to the use of VR in this study. This means any other type of ET not using VR was not included in this study. Only data generated during the study were considered for use, and no previously collected data related to VRET were used in this study.

In this study, I sought to substantially decrease the differences perceived by clients between the virtual world and the real world using a new technique called TR-VRET, which used immersive true reality 360-degree videos created in real-world environments featuring real-world fear stimuli. By following the logic put forth by Oskam (2005), if the difference detected by the client between the virtual environment and the real world is decreased, then the generalizability and sustainability, and therefore, the effectiveness, of TR-VRET should increase. Generalizability of the results of this study were inferred from the data and the treatment outcomes measured by the FFI and FAS.

Limitations

The two main issues associated with the randomized control group, pretest-posttest design relate to both internal validity issues and external validity issues. Internal validity issues include maturation (i.e., biological changes in participants that can affect the differences that show up in between the pretest and posttest) and history (i.e., external factors experienced outside of treatment that affect test scores; Nestor & Schutt, 2014). The single external validity issue noted is the interaction of pretest questions and treatment because a participant is influenced by one of the questions within the pretest (Nestor & Schutt, 2014).

I took measures within the study to address these threats to internal and external validity. Maturation and history may not have been a factor in this study because of its short length, but they could not be ruled out completely. To guard against these two threats to internal validity, each participant was screened for changes in their lives related

to the maturation and history effects. Any significant changes were noted in the study findings.

The one noted threat to external validity to the randomized control group, pretest-posttest was the design interaction of pretest questions and treatment because a participant is influenced by one of the questions within the pretest (Nestor & Schutt, 2014). This threat was minimized by using empirically supported scientific instruments to measure the dependent variables. This included the use of the FAS to measure anxiety associated with flying and the FFI to measure the intensity of fear associated with flying.

Another limitation of this study was the potential for response bias, which is when participants consciously or subconsciously provide a response in a self-report questionnaire they believe is the desired one by the researcher (see Monette et al., 2013). Response bias also occurs when participants believe they know the intent of the study and the expected findings of the study (Monette et al., 2013). This potential bias was minimized by restricting as much information from participants as possible concerning the purpose of the study and potential outcomes. Response bias was also limited by using empirically supported scientific instruments within the study, such as the FAS and FFI (see Scott, 1987; Triscari et al., 2015; Van Gerwen, Spinhoven, Van Dyck, & Diekstra, 1999; Wiederhold et al., 2002).

Significance

This project is unique because it addressed a remotely researched area of VRET and the use of real-life VR environments now available with modern technology. The results of this study provided much needed data and understanding of how the TR-VRET

technique and the use of real-life VR environments affect the overall effectiveness of this kind of therapy. The data, information, and understanding generated from this study should not only aid VRET practitioners to better understand how to help their clients, but it should also potentially provide access to an improved cost-effective technique using TR-VRET.

The use of technology and its integration into all aspects of people's lives has been a driving force for social change in general for many years (Servaes, 2014). The results of this study have the potential to integrate technology into psychology and psychological practices in a way never been done before. The reason for this is because currently VRET uses technology that is decades old (North et al., 1997) and does not currently take wide advantage of modern-day technological advances as prescribed by this study.

The findings of this study could contribute to social change by more effectively allowing people to overcome their fears to become better and more productive versions of themselves. This would be done, in part, by decreasing their anxiety, improving functionality, and mitigating or eliminating the symptoms of various phobias. This, in turn, would increase a person's overall quality of life.

Summary

VRET is a therapeutic technique that relies heavily on older and more expensive technology to work. There was a need to evaluate if recent technological advances would allow this kind of therapy to become more effective and cost efficient through a new therapeutic technique called TR-VRET. Examining the effectiveness and cost of TR-

VRET to that of VRET may lead to an increase in the efficacy of this type of treatment at a reduced cost and provide an opportunity for more people to use and be treated by this therapeutic technique in the future. The results of this study helped to provide data and information in an area where little research has been previously conducted. In Chapter 2, I review current extant literature and the current gap within this literature related to the efficacy of VRET. In this chapter, I provide a more detailed look at the variables and why it was necessary to conduct this study.

Chapter 2: Literature Review

Introduction

With this intervention study, I addressed the use of VRET techniques in the treatment of phobias, specifically FOF. As highlighted in the previous chapter, there are four main components necessary to make VRET effective: the degree of presence, cognition, ability to elicit emotions, and generalizing effects (see Oskam, 2005). All four of these components have been frequently studied but only as they apply to simulated VR environments (Malbos, 2015; Meyerbröker & Emmelkamp, 2014; Oskam, 2005). Past researchers have stated that increasing the realism of VR is likely to increase these four factors (Oskam, 2005). However, to date, there is little research using either the 360-degree technique (Kallioniemi et al., 2017) or the use of real-life VR environments for therapeutic purposes (Stupar-Rutenfrans et al., 2017). In VRET, the 360-degree technique is a commonly used technique with computer-generated environments that allows a person to view a 360-degree environment (Kallioniemi et al., 2017). Real-life VR environments refer to this 360-degree environment depicting real-life environments as opposed to computer-generated ones (Stupar-Rutenfrans et al., 2017). The overall purpose of this study was to demonstrate if a new generational technique for VRET was at least as efficacious as simulated environments, if not more so. Throughout this study, this new VRET technique is referred to as TR-VRET, since this technique is making use of recorded true reality environments, as opposed to computer-generated environments.

The purpose of this chapter is to provide a comprehensive overview of the VRET literature. This chapter will include a review of SD, traditional ET, and other therapies

that have provided the foundation for VRET. In this chapter, I provide an outline of the literature search strategy, the theoretical foundation, the conceptual framework, and an exhaustive review of the current literature related to VRET. The challenges of TR-VRET are also examined as they relate to cost, limits of the technology, and access to real-life virtual environments. Where relevant, each of these concepts are explored through the lens of EPT, cognitive theory, and behaviorism. This chapter concludes with a description of the need for this study, how the results fill an identified gap in the literature, and how it could potentially extend the knowledge in related disciplines.

Literature Search Strategy

I used several electronic databases accessed through the Walden University Library to search for relevant scientific articles, including PsycINFO, PsycArticles, PsycBooks, PsycCritiques, PsycExtra, PsycTests, and Google Scholar. The key terms used in the searches were *VRET, VRT, VRIT, CCBT, virtual reality immersion therapy, virtual reality exposure therapy, virtual reality therapy, computerized CBT, cognition, cognitive presence, virtual environments, simulated environments, 360 cameras, 360 environments, real-life virtual environments, systematic desensitization, traditional exposure therapy, cognitive theory, emotional processing theory,* and *behaviorism*. All these terms were used either in searches as part of a combination of the terms that were interchangeable or for independent searches. All the sources of information obtained were in digital format, and no sources were obtained through the use of traditional hard copy formats, such as books or journals. In this review, I primarily focused on the current and relevant literature from studies published between 2013 to 2018. However, a small

section of the literature was sourced from older foundational materials that were necessary to provide context for the theoretical framework and foundational principles associated with ET in general and VRET specifically.

360 VRET vs. 360 TR-VRET

Original 360 VRET approaches used computer-generated environments; that is, the images seen by the patient were like a video game and lacked realism (Miloff et al., 2016). Over time and with technological advances, patients were exposed to 360-degree environments where they had control over where in the scene they chose to look and where they were able to go within the environment, making the environment seem more realistic (Kallioniemi et al., 2017). Currently, the 360-degree technique is a commonly used technique in VRET with computer-generated environments that allow a person to view and interact with the 360-degree environment, although the environment often resembles that of a video game (Kallioniemi et al., 2017).

However, despite increasing the degree of realism with a 360-degree viewpoint, the images in VRET remain largely computer generated (Stupar-Rutenfrans et al., 2017). To increase the reality of the environment being experienced, there is currently a move toward creating 360-degree real-life environments (Stupar-Rutenfrans et al., 2017). Real-life VR environments refer to this 360-degree environment as depicting real-life environments experienced by the patient as opposed to the computer-generated ones (Stupar-Rutenfrans et al., 2017). However, to date there is little research on the efficacy of using a 360-degree technique (Kallioniemi et al., 2017). Although there appears to be

little research related to the use of real-life VR environments for therapeutic purposes (Stupar-Rutenfrans et al., 2017), some techniques do exist.

Scarcity of Literature

An abundance of literature exists regarding the use of VRET and the concepts of cognitive presence, cognition, emotional response, and generalizability (Oskam, 2005) because this field has been in existence since the mid-1990s (North et al., 1997). However, the recent advent of technological advances that allows for the VRET environment to be enhanced with real-life scenarios has not been well researched, although some research does exist (Stupar-Rutenfrans et al., 2017). In the current study, I focused on the addition of the real-life element to the treatment, which has produced little research on the efficacy of this approach.

Theoretical Foundation

The three theories that served as the theoretical foundation for this study were cognitive theory (Abramowitz, 2013), EPT (Kaczkurkin & Foa, 2015), and behaviorism (Mason, 2013). These theories also served as the lynchpins that helped to tie together the concept of VRET for this study. In general, cognitive theory states that a person's perceptions and thoughts about a situation, event, or stimuli will directly influence their emotions and behaviors (Abramowitz, 2013). This would apply to a person's irrational thinking or cognitive distortions as it relates to a phobia. VRET exposes a person to this situation, event, or stimuli, then works to transform the person's perception or thought about it, which in turn helps in positively changing the person's emotions and behaviors (Oskam, 2005).

Cognitive theory covers important aspects that play a key role in VRET and addresses how the mind processes information; all of these processes are defined as cognition (Valmaggia, Latif, Kempton, & Rus-Calafell, 2016). Cognition in itself is made up of three important aspects (i.e., perception, attention, and memory), and each plays an important role in VRET (Valmaggia, Latif, Kempton, & Rus-Calafell, 2016). People use these processes to manipulate information as it is perceived and is then coded either as being new or not new (Kellogg, 2015).

Another underlying theory in the current research is EPT, which states that fear is represented by cognitive fear structures that contain information about a feared stimulus, the type of fear response, and the meaning behind the fear structures (Kaczkurkin & Foa, 2015). This can, in turn, lead to pathological behaviors when the fear response does not match reality (Kaczkurkin & Foa, 2015). VRET activates the pathological fear structure and provides new information which works to disconfirm the pathological and unrealistic associations within these structures (Kaczkurkin & Foa, 2015).

EPT also provides other important aspects that are directly related to the use of VRET. For example, the fear structure is a cognitive network of negative and dysfunctional thinking that is activated through fear or anxiety (Kaczkurkin & Foa, 2015). Another important aspect of EPT is habituation. which relates to the process whereby fear structures are systematically broken down (Kaczkurkin & Foa, 2015); this can be accomplished using VRET. This process of systematically breaking down fear structures consists of exposing a person to their fear- or anxiety-inducing stimulus until the fear or anxiety starts to decrease on its own (Kaczkurkin & Foa, 2015). This process

is repeated until the person learns that their feared consequence does not actually occur (Kaczkurkin & Foa, 2015). This experience eventually leads to the creation of new and competing associations for the individual that in turn lead to a decrease in fear and anxiety (Kaczkurkin & Foa, 2015).

Behaviorism is a learning theory that specifically concentrates on objectively observable behaviors, which was pioneered by psychologists such as Watson, Thorndike, and Skinner (Watson, 2017). Watson is considered the creator of behaviorism and believed that classical conditioning was able to explain every aspect of psychology (Watson, 2017). Watson is largely known for applying the theory of behaviorism to child development, positing that a child's behavior is shaped by the environment more so than their genetic makeup or general temperament (Watson, 2017).

Thorndike is best known for laying the groundwork for what would later become known as operant conditioning, which refers to the learning of behavior based on consequences (Shiraev, 2014). Much of Thorndike's research and studies involved cats specifically (Shiraev, 2014). Thorndike put forward what is called the Law of Effect, which refers to the likelihood of behaviors being repeated such that behaviors with positive consequences are likely to be repeated, while behaviors with negative consequences are not likely to be repeated (Shiraev, 2014).

Skinner (2011) believed that human behavior was complex and classical conditioning was too simplistic to completely explain it. Skinner built off the foundation developed by Thorndike and is known for work on the idea of operant conditioning, which involves the process of an organism operating within its environment and

community. Operant conditioning refers to the change in behavior using reinforcement after engaging in a desired behavior (Skinner, 2011). For example, a reinforcer (whether positive or negative) is a response from the environment that increases the chances of a behavior happening again, while a punishment is a response from the environment that decreases the chance of a behavior happening again (Skinner, 2011). Skinner argued that the best way to understand behavior is to study both the causes and consequences of the behavior.

The theory of behaviorism posits that learning relates to the acquisition of behaviors and are the result of environmental conditions (Watson, 2017). Behaviorism focuses on conditioning as a universal learning process (Skinner, 2011; Watson, 2017). The two types of conditioning are classic conditioning and behavioral (i.e., operant) conditioning (Skinner, 2011; Watson, 2017).

VRET is used to expose a person to a new and controlled set of environmental conditions through SD, which in turn alters an individual's objectively observable behaviors (Boundless, 2016). Behaviorism has some important concepts that are integral in explaining how VRET works and why it is used (Brandt, 2016). Essentially, researchers and psychologists can use behaviorism to define people as passive learners who respond to the stimuli present in their environment; thereafter, people only have their behaviors shaped by either positive or negative reinforcement (Blackman, 2017).

The most relevant concept from behaviorism that applies to VRET is positive reinforcement. VRET uses the process of positive reinforcement to help change unwanted behaviors (Villani, Cipresso, & Repetto, 2014). Positive reinforcement is defined as

adding a pleasant event or desirable stimulus to the environment after the desired behavior is exhibited (Blackman, 2017). In the context of VRET, this could consist of kind or encouraging words or a show of approval from a therapist to the client after the desired behavior is demonstrated. However, what is a positive reinforcement to one person may not be the same for another. Positive reinforcement can be highly subjective and may differ dramatically between individuals, which is to be considered during therapy (Blackman, 2017).

The literature review indicates studies have provided solid evidence that VRET is used to reduce fear-related symptoms associated with a phobia and that this approach has its roots in cognitive theory, EPT, and behavioral theory. The following literature review provides support that traditional ET and VRET using computer simulations are both effective in treating phobias. This literature also documents the importance and promise of using recent technological advances and technologies (i.e., VRET using computer simulations) that can at a minimum be used as an ET treatment that is at least as effective as the existing approaches. The chapter concludes with a review of the obstacles that may exist for the use of recent technological advances and technologies as tools for VRET.

A Review of the Literature

Quantitative Methodological Approach

In general, the quantitative methodological approach focuses on objective measurements, the establishment of cause/effect relationships, contains numerical data that is obtained using standardized measures (i.e., questionnaires, surveys, or preexisting statistical data) and attempts to provide generalizable findings (Barker, Pistrang, &

Elliott, 2015). The general quantitative methodological approach chosen for this study is the pretest-posttest experimental design. The pretest-posttest experimental design is when a baseline measurement (i.e., pretest) is taken from a variable of interest before participants are randomized into treatment and control groups and the application of the treatment of interest. Once the treatment has been administered, the participants are given a posttest to evaluate the effectiveness of the treatment of interest. This is done by comparing and analyzing the data collected from the pretest, posttest, and control group (Bonate, 2000).

The specific design used in this intervention study is the randomized control-group pretest-posttest design, which is also known as the classic controlled experimental design (Nestor & Schutt, 2014). This design includes one control group and one treatment group. The main components of this design include:

- All participants randomly assigned to the control group or treatment group
- Both groups (i.e., control and treatment) receive pretest
- New treatment method used in the treatment group and standard method used in the control group
- Both groups (i.e., control and treatment) receive posttest
- Differences between the two groups are assessed (Nestor & Schutt, 2014).

The two main issues associated with the randomized control-group pretest-posttest design relate to both internal validity issues and external validity issues. Internal validity issues include maturation (i.e., biological changes in participants that can affect the differences that show up in between the pretest and posttest) and history (i.e., external

factors experienced outside of treatment thus affecting test scores; Nestor & Schutt, 2014). The single external validity issue noted is the interaction of pretest questions and treatment because a participant is influenced by one of the questions within the pretest (Nestor & Schutt, 2014).

This type of pretest-posttest design is being used, in part, because of its empirically supported ability to assist in the understanding and determining the effects that result from a selected intervention. This is what this study did in relation to the TR-VRET and VRET interventions (Dimitrov & Rumrill, 2003). In fact, the randomized control-group pretest-posttest design is popular with researchers when evaluating the effectiveness of various exposure related interventions (Bissonnette, Dubé, Provencher, & Moreno Sala, 2015; Castro et al., 2014; Shiban et al., 2017; Stupar-Rutenfrans, Ketelaars, & van Gisbergen, 2017; Triscari, Faraci, Catalisano, D'Angelo, & Urso, 2015).

A study by Triscari et al. (2015) evaluated the effectiveness of treating FOF between three different forms of therapy, one of which was VRET used in conjunction with CBT. This study was done using the randomized control-group pretest-posttest design and it randomly assigned participants to groups, used control groups, and used pre- and posttest. The pre- and posttest portion of the study was done using two questionnaires. The first was the FAS, which measured the level of anxiety produced during a specific flying situation. The second was the Flight Anxiety Modality Questionnaire (FAM), which measured the physiological responses of anxiety and the thoughts associated with the FOF. The pre- and posttest scores from these questionnaires

were evaluated to assist the researchers in understanding the efficacy of the three treatment conditions as it relates to treating the FOF.

Another study that utilized the randomized control-group pretest-posttest design was done by Rothbaum, Hodges, Smith, Lee, and Price (2000). This study compared the efficacy of VRET and standard exposure therapy (SET) when treating FOF and used a waitlist as the control group. The study included a total of 49 participants and these participants were randomly assigned to each of the three groups. The pre- and posttests used in this study were the Questionnaire on Attitudes Toward Flying (QAF) and FFI to evaluate anxiety and fear factors associated with FOF.

A study by Wiederhold et al. (2002) used the randomized control-group pretest-posttest design to evaluate if two types of virtual reality graded exposure therapy were equally, more, or less efficacious than imaginal exposure therapy (IET) when treating FOF. The two types of VRGET were with and without physiological feedback. Each of the 30 participants were randomly placed in each of the groups with the IET group serving as the control group. The pre- and posttest measures used for this study included physiological measures (skin resistance peripheral skin temperature, heart rate, and respiration rate) and the five questionnaires used to measure fear and anxiety were:

- QAF
- FFI
- Self-Survey of Stress Responses (SSR)
- State-Trait Anxiety Inventory (STAI)
- VR Scenarios Sheet

Foundation of Exposure Therapy

All ETs, whether traditional, VRET using computer simulations, or TR-VRET using real-life environments filmed in 360-degree videos, are rooted in basic foundational concepts. These foundational concepts are related to SD and various other exposure-related concepts. SD is a type of behavioral therapy that traces its roots to classical conditioning, which is used to treat phobias (Wolpe, 1958). SD treats phobias by identifying a fear response, removing it, and then replacing its various relaxation responses by way of counterconditioning (Wolpe, 1958). Counterconditioning refers to the process of replacing an unwanted behavior with a wanted behavior (Persons, 2012). Studies of SD have provided empirically tested data to show the principals behind this therapy are effective. One study showed that when SD was used on clients it was successful 93% of the time at reducing the anxiety levels associated with a fear stimulus that was directly related to a client's phobia (Rothbaum et al., 2000).

The process of SD is completed in three separate phases. These phases include the learning of relaxation and breathing exercises, ranking fears in order from least to greatest, and then finally exposure to a stimulus that has been ranked as the least unpleasant (Wolpe, 1958). When the exposure is finally done, a client is expected to make use of their newly acquired relaxation and breathing techniques. This process is repeated as clients work their way up their list of fears from the least to the greatest (Wolpe, 1958).

Another important foundational concept associated with ET is respondent conditioning, also known as classical conditioning. Studies have shown the effectiveness

(Arenson, Lannon, & Offermann, 1982; Till, Stanley, & Priluck, 2008) of the principles associated with classical conditioning. A study by Arenson et al. (1982) evaluated the effectiveness of classical conditioning by examining attitude changes of people who were determined to have a neutral position on four attitude topics. Half of the group was presented with positive stimuli associated with the attitude topics and the other half were presented with negative stimuli associated with the attitude topics. The results of this study showed the external stimuli (i.e., positive or negative) significantly affected the attitudes of the people exposed to them toward the attitude topics.

These foundational concepts are important to the overall concept of this study, which will be reviewing the efficacy of VRET using true reality 360-degree videos. This is because this form of therapy largely relies on these foundational concepts to be effective and has directly evolved from or uses them. Even though this new therapy tool for VRET relies on modern technology in the form of 360-degree videos, the therapy is still rooted directly in these foundational concepts. Foundational concepts that have been thoroughly examined and are empirically supported (Tryon, 2005; Upton, 2013).

Other forms of ET. Other forms of ET rely on these foundational concepts. These include flooding therapy, IET, in vivo ET, directed ET, and prolonged ET (Oskam, 2005). However, these other forms of ET are out of the purview of this study, thus very little attention is given to them within this literature review and the subsequent study.

Literature gap. A study conducted by Oskam (2005) examined using VRET to treat anxiety disorders. The study notes that for VRET to be effective, there are four aspects that must be present. These aspects include the virtual environments eliciting

cognitive presence, cognition, strong emotions, and the effects of VRET must be able to generalize to the real world. Further, Oskam goes on to say that the effectiveness of VRET is determined by the realism of the environment and that the realism of the environment directly affects all four of these factors.

The study by Oskam (2005) concludes by stating that the effectiveness of VRET can be improved if the realism of the virtual environment is improved. The study notes it is likely that improving realism within the virtual environments, thus cognitive presence, cognition, and emotional response, will improve the effectiveness of VRET and allow the effects to be more generalizable to the real world. However, the study further notes more research will have to be done in this area to determine exactly how this can be accomplished. This gap in the research is the gap this study looks to fill.

Use of True Reality

Little research has been done on the use of real environments with VRET. However, one study by Stupar-Rutenfrans et al. (2017) used 360-live recorded VR environments to examine the reduction (high to moderate) levels of anxiety associated with public speaking. This 360-live environment was recorded using six GoPro cameras that were fastened onto a device used to make 360-live recordings. The video was taken in three separate live environments, which included an empty classroom, a small audience, and a large audience. This recording was then used in VRET using a 360-smartphone application for a VR head-mounted device.

This first of its kind study by Stupar-Rutenfrans et al. (2017) measured over the course of 4 weeks the anxiety levels of 35 participants who suffered from a high to

moderate fear of public speaking. The study briefly discussed the concept of cognitive presence within the virtual environments. However, the researchers believed that since they used real environments and real people, cognitive presence was not an issue.

The results of the study showed people who had high levels of anxiety associated with public speaking had a greater decrease in their anxiety following the VRET. The participants who had only moderate levels of anxiety associated with public speaking experienced less reduction in anxiety following VRET. The study concluded that the study findings were in line with habituation theory and that VRET is more effective when used with people with high anxiety levels (Stupar-Rutenfrans et al., 2017). However, this study did not make any comparison between the effectiveness of using true reality environments as opposed to computer generated environments, as this was outside the scope of this study.

Current Therapeutic Use

Currently, VRET using computer-simulated environments has been in use for various therapeutic reasons over the last couple of decades, although the technology being used is also decades old (North, North, & Coble, 1997; Oskam, 2005). VRET is used to treat a myriad of issues, including PTSD, anxiety, phobias, etc. (Nezu, Nezu, Gillihan, & Foa, 2015). A study by Anderson et al. (2013) evaluated the use of traditional (i.e., use of computer-generated environments) VRET and in vivo (direct) exposure with clients suffering from a social anxiety disorder.

The results of the study showed that the participants who used VRET significantly improved their social anxiety with the improvements still present after a 12-month

follow-up. The results from the study also indicated that there were no differences at any time relating to VRET and in vivo concerning the treatment outcome or the achievement of partial and full remission. The study was able to conclude that VRET was just as effective in treating social anxiety fears as in vivo treatment (Anderson et al., 2013).

As stated previously, VRET is used to treat a myriad of psychological issues, another such area is PTSD. A study by Gonçalves, Pedrozo, Coutinho, Figueira, and Ventura (2012) evaluated the efficacy of using VRET with clients suffering from PTSD. The results of the study showed that VRET was a potentially efficacious form of treatment for PTSD relating to different types of trauma, but in general, it proved to be as efficacious as exposure therapy for PTSD. An important point made by the researchers was that VRET showed to be especially useful when treating PTSD when the client had previously been resistant to traditional exposure therapy (Gonçalves et al., 2012).

The rationale the researchers had for VRET serving as a substitute for resistant clients was that VRET allowed for the patient to be more engaged in the exposure process. Further, the researchers stated evidence from the study showed there was greater activation relating to traumatic memories, which was necessary for extinction to take place effectively (Goncalves et al., 2012). Many other studies (Beidel et al., 2017; Jiandani, Nair, & Shukla, 2014; Michael, Costanzo, Blair, & Albert, 2014; Reger et al., 2016) have drawn the same conclusion relating to VRET being suitable for treating PTSD, normalizing brain function for PTSD clients, and treating combat veterans with PTSD. However, one study (Beidel et al., 2017) suggested VRET works for PTSD, but

that it works better when used in conjunction with other therapies, such as trauma management therapy.

VRET appears to be flexible enough to meet the needs of clients suffering from a wide variety of disorders. A study by Belloch et al. (2014) evaluated the usefulness of VRET in relation to clients who had been diagnosed with an OCD. This study focused on a relatively small case study involving four clients diagnosed with OCD. The researchers specifically looked at how these clients experienced cognitive presence, emotional engagement, anxiety and disgust levels, and how real they viewed the VR environments.

The study by Belloch et al. (2014) was meant to show the feasibility of using VRET with OCD and to see if VRET would affect the factors previously listed. The study did conclude by showing that based on the findings, VRET was indeed feasible for OCD. The findings of the study showed that the clients in the study did experience the good cognitive presence and viewed the VR environment as being effectively real. The findings also showed the VR environment was able to induce increased levels of both anxiety and disgust from clients. This result was deemed by the researchers as being related to the clients' overall emotional engagement within the VR environment and the high level of cognitive presence.

Often when anxiety or related disorders are studied in relation to VRET, it is looked at as being a symptom of a disorder or problem as opposed to being isolated by itself for analysis (Meyerbröker, 2014). However, one study by Meyerbröker (2014) evaluated the use of VRET exclusively for use with anxiety and panic disorders. The researchers noted that much of the evidence and research relating to VRET has been

concerning using it with the fear of flying and acrophobia (fear of heights). The study concluded that using VRET for anxiety and panic disorders is promising, but more research is necessary before VRET can be considered empirically supported for use with anxiety and panic disorders.

As previously mentioned, one of the most highly researched areas concerning the use of VRET is with phobias, specifically the FOF and fear of heights and is seen as a common tool for use with a phobia. (Meyerbröker, 2014). This is, in fact, true as many studies (Botella et al., 2014; Gebara, Barros-Neto, Gertsenchtein, & Lotufo-Neto, 2016; Miloff et al., 2016; Ost, 1989; Peñate Castro et al., 2014; Raghav et al., 2016) have been done focusing specifically on researching the use of VRET with various phobias.

One study by Cardoş, David, and David (2017) evaluated using VRET with one specific phobia, which was the fear of flying. The study looked at the overall efficiency of VRET to be used as a therapeutic tool for the fear of flying. The results were reviewed both immediately after therapy and during follow-ups at the 3rd-month, 6th-month, 12th-month, and 36th-month mark. The study concluded that VRET was a superior tool for use with the fear of flying than other traditional exposure-based interventions. The reason VRET was deemed superior was because the treatment gains from VRET were better over time when compared to traditional exposure-based interventions.

Phobia. The phobia that was utilized for this VRET study is FOF. Hubbard and Bor (2016) explain that this type of fear affects approximately a third of the industrialized countries' population, which equates to millions of adults across the world. The *Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition* (DSM-5) by the

American Psychiatric Association (APA; 2013) designate FOF as a *specific phobia* and a situational phobia. The DSM-5s diagnostic criteria for this kind of phobia is used for this study and is as follows:

- Marked fear or anxiety that is related to a specific situation (i.e., flying)
- The fear situation that almost always leads to some form of fear or anxiety
- The phobic situation is either purposefully avoided or is endured with the presence of high levels of fear and anxiety
- The fear or anxiety of this fear situation is not proportional to the actual danger present for this specific fear situation and the sociocultural context
- The fear, anxiety, or avoidance associated with this fear situation is persistent and lasts for 6 months or more
- The fear, anxiety, or avoidance causes clinically significant distress or impairment within important areas of functioning (i.e., social, occupational, etc.)
- The problems experienced by the person are not explained in a better way by another mental disorder (i.e., PTSD, obsessive-compulsive disorder, agoraphobia, etc.; APA, 2013)

A study by Ferrand, Ruffault, Tytelman, Flahault, and Négovanska (2015) focused on the treatment of the FOF by both cognitive behavioral techniques and the use of VRET. The purpose of the study was to evaluate the effectiveness of these interventions on flight-related anxiety before and after treatment. For the study, the

researchers used 145 subjects who had been diagnosed with FOF and measured anxiety using the FAS and the FAM questionnaires.

Each of the participants was treated for FOF using both interventions (i.e., cognitive behavioral techniques and VRET). The statistical analysis of the data collected showed a decrease in flight-related anxiety as measured by the subscale from the two questionnaires. The subscales included the somatic and cognitive anxiety subscales for the FAM and the general flight anxiety, anticipatory anxiety, and in-flight anxiety subscales from the FAS. The results of the study showed that the subjects displayed lower anxiety levels after the intervention than before the intervention. The researchers concluded that the use of cognitive behavioral techniques and VRET together were effective in reducing flight-related anxiety (Ferrand et al., 2015).

A study by Botella et al. (2014) evaluated the effectiveness of two different forms of therapy for FOF. The first form was VRET by itself with the second form being VRET with the addition of cognitive restructuring (VRET+CR). Cognitive restructuring refers to a therapist working with a client to identify and dispute cognitive distortions (i.e., irrational fear) possessed by the client. The researchers came to several conclusions in this study.

First, the researchers concluded the treatment approaches were equally effective and allowed all participants to take a flight after therapy. Second, both approaches received high mean scores related to the opinion of the participants on the therapeutic approach they received, and only nonsignificant differences were noted. Third, even

though the data showed no efficacy difference between the two approaches, all participants preferred VRET+CR over VRET only, and rated VRET+CR to be:

- More effective
- An approach they would recommend to others
- Less aversive (Botella et al., 2014)

Rothbaum et al. (2000) conducted a more intensive study on FOF. It was an initial study done to evaluate the efficacy of two different treatment approaches for FOF. This initial study included results immediately after completion of the study and at the 6-month follow up. The study was then followed by a twelve-month follow up study by Rothbaum, Hodges, Anderson, Price, and Smith (2002), which aimed to evaluate the long-term efficacy of the two different treatment approaches on FOF.

The initial study by Rothbaum et al. (2000) evaluated the efficacy of VRET and SET in treating FOF, which at the time of the study the researcher's note is a phobia that was said to affect approximately 25 million people in the United States alone. This study evaluated treatment efficacy of FOF by randomly assigning participants to VRET, standard exposure therapy, or a waitlist control group. The VRET featured exposure to a virtual airplane, while SET consisted of exposure to an actual airplane at an airport.

The treatment for this study consisted of eight sessions that were administered over the course of 6 weeks, with the first four sessions focused on anxiety management training while the exposure therapy took place during the last four sessions. All the study participants were diagnosed with FOF and had pre- and posttreatment (i.e., immediately after treatment and at 6- and 12-month follow ups) measures conducted to assess for

anxiety and avoidance of an actual airplane flight. All participants completed the QAF, the Fear of Flying Interview, the Structured Clinical Interview, the Clinical Global Improvement, and the FFI. Immediately after treatment, all participants were put on a posttreatment flight to assess their willingness to fly and the anxiety experienced during flight (Rothbaum et al., 2000).

The researchers concluded that results of the study supported that VRET and SET were both superior to WL. The results also supported that there was no significant efficacy difference between VRET and SET. The researchers also concluded that both VRET and SET were equally effective at reducing FOF symptoms as measured by standardized questionnaires and the number of study participants willing to fly on an actual airplane after receiving treatment. The 6-month follow up conducted by the researchers showed that the gains made after treatment were maintained during this time, that 93% of both VRET participants and SET participants had flown in a real plane and concluded that this controlled study supported VRET and SET for treating FOF (Rothbaum et al., 2000).

The 12-month follow-up study by Rothbaum et al. (2002) aimed at evaluating the long-term efficacy of VRET and SET on FOF. The researchers evaluated whether the gains made after treatment with VRET and SET, and maintained at the 6-month follow up, continued to be maintained at the 12-month mark. Out of the participants from the original study, 80% of them were able to be evaluated during this 12-month follow-up. The results of this follow-up study showed conclusively that the symptom improvement is shown immediately after VRET and SET treatment, and maintained during the 6-

month follow-up, continued to be maintained during the 12-month follow-up. Finally, the researchers concluded that the results of the 12-month follow-up study provided support that short-term treatments could have long-term effects.

TR-VRET. Currently, little research exists related to the use of the 360-degree technique (Kallioniemi et al., 2017) and there appears to also be little research related to the use of "real-life" VR environments used for therapeutic purposes (Stupar-Rutenfrans et al., 2017). TR-VRET uses the same principles that have been empirically shown to make VRET using simulated environments to be an effective therapeutic tool. The main difference from the perspective of this study between TR-VRET and VRET is the realism of the environments. However, this and other future studies will have to compile empirical evidence to show if TR-VRET is a valid tool that can be used for therapeutic purposes.

Effectiveness

In general, several factors have been shown to make both exposure therapy and VRET effective. For exposure therapy to be effective, whether traditional or VRET, there are certain criteria that must be met. Exposure therapy seeks to disrupt what can be called a fear network and to do this exposure therapy must:

- Present fear-relevant information (i.e., fear stimulus)
- Fear stimulus presented in a way that activates fear network
- Information and stimulus presented in a way contrary to an expected outcome (Foa & Kozak, 1986).

By doing this, exposure therapy can engage the fear network with the feared stimulus and then present a new outcome instead of the expected outcome by the client (Foa & Kozak, 1986). An example of this would be if a person was afraid of large crowds and has an overwhelming sense something bad was going to happen. However, during exposure therapy when this feared stimulus was present the client was able to see that nothing bad or negative followed the experience.

The purpose of VRET is to attempt to recreate feared stimulus within a virtual environment, which is done as an alternative to IET or in vivo exposure therapy (IVET; Oskam, 2005). IVET refers to a person being exposed to a fear stimulus or scenario in real-life, while IET refers to a person imagining a fear stimulus or scenario (Norman, 2016). IVET has a large amount of empirical evidence supporting its effectiveness for use with various phobias and panic disorder (Sanderson & Woody, n.d.; Rachman, 2009). IET exposure therapy has been shown empirically to be effective in treating anxiety-related disorders (Levinson, Rapp, & Riley, 2014).

A study conducted by Anderson et al. (2013) evaluated the effectiveness of VRET for social anxiety disorder in relation to in vivo ET, group ET, and a waitlist. The social anxiety disorder evaluated was related to public speaking being identified as the primary fear of clients. Each participant in the study completed 8 sessions of VRET and standardized self-report measures were collected. The participants also received a diagnostic status reassessment at a 3-month followup.

The study concluded that the covariance showed that each participant using VRET improved significantly on all measures except for one (i.e., self-reported fear of

negative evaluation; Anderson et al., 2013). The study also concluded that there were no measurable differences in rates of partial or full remission between VRET and the other methods of ET. However, a point was made by the researchers that a large sample was necessary to better control and statistically test the differences between the various ET treatments. Concerning effectiveness, the study concluded that VRET was:

- An effective treatment tool for treating social fears
- The improvements in social fear were maintained for 1 year
- As effective at treating social fears as other methods of exposure therapy (Anderson et al., 2013).

Another study conducted by Botella et al. (2014) evaluated the effectiveness of VRET and VRET+CR (cognitive restructuring) for use on FOF. The study used an alternate treatment conditions design and a nonconcurrent multiple baseline design across individuals. The study used a small sample size of only four participants. The study concluded that both VRET and VRET+CR were equally effective, and both were equally effective tools for treating the FOF.

Many different studies have been completed (Miloff et al., 2016; Morina, Brinkman, Hartanto, Kampmann, & Emmelkamp, 2015; Peñate et al., 2014; Raghav et al., 2016) to study the effectiveness of VRET on various disorders. One study by Morina et al. (2015) evaluated the effectiveness of VRET for use with social anxiety. The study analyzed two groups of people with varying ranges of high and low levels of social anxiety. Each participant participated in two exposure settings using VRET. The study showed that participants with high levels of social anxiety reported a significant decrease

in social anxiety levels that was maintained during a follow-up 3 months later. The study concluded VRET was an effective therapeutic tool for social anxiety involving virtual social interactions.

Even though VRET is currently being used for PTSD, there is currently very little empirical evidence to support its effectiveness (Rizzo et al., 2015). Some small trials have shown promise that VRET may be a valuable tool for treatment, however, much larger trials have to be conducted before the efficacy of VRET use for PTSD can be confirmed (Rizzo et al., 2015). Another realization concerning VRET is that most of the existing empirical support for VRET is in relation to specific phobias and some anxiety disorders (Rizzo et al., 2015).

Another example of the effectiveness of VRET being used successfully for a phobia was recently completed study by Gujjar, Sharma, and Jongh, (2017) where the efficacy of VRET for dental phobia was evaluated. This study concluded there was evidence that VRET could be used effectively for this specific type of phobia. A study done by Malbos, Rapee, and Kavakli (2013) evaluated the effectiveness of VRET for agoraphobia (generally considered to be the fear of crowds). The study used a sample of 18 participants and concluded there was evidence that VRET could be used successfully for agoraphobia, although follow-up studies would be needed to confirm the effectiveness.

Variables related to effectiveness. The variables related to the effectiveness of VRET include cognitive presence, cognition, emotional response, and generalizability

(Oskam, 2005). The first three variables (the fourth is discussed later in the chapter) were defined in a study by Oskam (2005) in the following ways:

- Cognitive presence: The degree clients believe or feel they are in the virtual environment they are experiencing.
- Cognition: Clients believe that what they are seeing is real or real enough to elicit an emotional response.
- Emotional Response: Refers to what degree virtual fear stimuli elicits an emotional response (i.e., general anxiety, fear, increased heart rate, increased breathing, increased blood pressure, etc.).

Oskam (2005) argued that each of these three variables above are interdependent and are not likely to be independent of one another. Further, Oskam argue that cognitive presence is the most important factor to the success of virtual reality, while cognition and emotional response are most important to the effectiveness of the ET itself. The emotional response itself can be broken into two main components with one component being the measurable physiological response by a person and the other being the overall anxiety or fear a person feels.

Oskam (2005) described the interdependence of these variables in the following ways: First, he argues that because of the interdependence of the variables they cannot individually lead to effective VRET. Next, Oskam posited that if a VRET client believes the virtual environment is real enough, (i.e., cognition) this will lead to this environment dominating over reality and allowing the client to feel as if they are within the environment (i.e., presence). Once the client believes the virtual environment is real

enough and feels he/she is within the environment, this can allow for the client to become emotionally engaged in the virtual environment (i.e., emotional response). This emotional engagement leads to the emotional responses (i.e., fear, anxiety, increased heart rate, increased breathing, increased blood pressure, etc.). The effectiveness of VRET is often measured by the decrease in the emotional response from pretreatment to posttreatment.

A study by Silva, Donat, Rigoli, de Oliveira, and Kristensen (2016) examined cognitive presence, which the researchers described as the subjects feeling as if they were actually there in the virtual environment. Further, the researchers explained that presence was necessary for subjects to feel immersed and involved within the VR environment. The researchers discussed the most appropriate way to measure cognitive presence to be through self-report scales and questionnaires.

A study by Gujjar, van Wijk, Sharma, and de Jongh (2018) assessed the effectiveness of VRET when treating for dental phobia. This studied assessed the effectiveness by evaluating the individual components of what is supposed to make VRET effective, which was cognition, cognitive presence, and emotional response. The main purpose of the study was to determine if VRET was effective for treating the anxiety for this kind of phobia. However, the cognition, presence, and emotional response variables were secondary outcome measures. Both realism and presence were measured using an 11-point verbal rating scale while the emotional response was measured using the subjective units of distress scale (SUDS) and heart rate.

The researchers from the study concluded that when compared with the non-VRET treatment group, VRET had a greater decrease in anxiety scores. The researchers

indicated that they did not record any change in emotional response from the participants during VRET treatment. All participants reported moderate levels of cognition and cognitive presence. The researchers concluded that when comparing the two treatment groups (i.e., VRET and non-VRET) the increase in effectiveness of VRET was directly related to the increased cognition and cognitive presence experienced by the study participants. The study further noted that participants who experienced lower levels of realism and presence showed no decrease in dental anxiety (Gujjar et al., 2018)

Another study by Peperkorn, Diemer, and Mühlberger (2015) examined the correlation between presence and fear (i.e., emotional response). This study investigated the correlation between presence and fear by using 22 female participants who were fearful of spiders. These females were assigned to either a high presence or a low presence condition in which they were repeatedly exposed to a large virtual spider. The researchers used the Igroup Presence Questionnaire to measure presence and SUDS, change in heart rate and skin conductance level to measure fear. The researchers concluded in this study that initially, presence did directly influence fear. However, over time the results of the study showed that presence and fear were mutually dependent.

A proof-of-concept study by Morina, Brinkman, Hartanto, and Emmelkamp (2014) examined the levels of presence and social anxiety. This study also used two different presence conditions to compare the participants that were randomly assigned. One condition contained a high level of presence and the other condition contained a lower level of presence. The study concluded that although the condition that was supposed to elicit a sense of presence did so and the condition that was supposed to elicit

a lower sense of presence did so as well, the researchers did not find a significant difference in the level of anxiety produced in the participants between the two different conditions.

Cognitive presence has been shown to be an important component of the effectiveness of VRET. Presence has been shown to be the principle component associated with the creation of anxiety (i.e., emotional response) for clients within a virtual environment (Alsina-Jurnet, Gutiérrez-Maldonado, & Rangel-Gómez, 2011). Other attributes associated with presence have been fleshed out with continued research on this component. For example, research has shown that when the environment was not stressful presence did not play a role in anxiety. However, the same research showed that the higher or more severe the anxiety was for a given participant the stronger the relationship was between anxiety and presence environment (Alsina-Jurnet et al., 2011).

Cognition (i.e., visual realism) plays an important role in the effectiveness of VRET because of its role in the virtual environment appearing real to the person viewing the environment (Oskam, 2005). Further, previous research has shown that the realism of the virtual reality environment and the content of that environment is directly related to the sense of cognitive presence, which directly influences the emotions and behavioral reactions experienced by a person (Hendrix & Barfield, 1995; Krijin et al., 2004; Slater et al., 2009; Wiederhold & Wiederhold, 2005). A study by Slater, Khanna, Mortensen, and Yu (2009) focused specifically on realism and the effect it has on immersive virtual environments, cognitive presence, and production of anxiety. This study defined visual realism as having two distinct components which are geometric realism (i.e., object looks

real) and illumination realism (i.e., realism of lighting and shadowing). This study concluded that increased realism within a virtual environment does increase a participant's presence and the sense of anxiety experienced by the person.

A study conducted by Kwon, Powell, and Chalmers (2013) evaluated the influence realism has within a virtual environment and its effect on the production of social anxiety, emotional arousal, and valence. This study focused on the anxiety produced during a job interview and the recreation of that anxiety within virtual environments with varying levels of realism. The study evaluated the effect of realism using three virtual environments and interviewers with increasing levels of realism and one real environment (i.e., nonvirtual) and interviewer. The main question the study aimed to answer concerning realism was whether increasing the realism of a virtual human face induced a higher sense of presence, thus increasing anxiety. The study concluded that the realism of the interviewer significantly influenced the level of anxiety experienced by the participant. However, the researchers noted that the effect of realism was increased by immersion (i.e., virtual reality headset vs. looking at an LCD screen) and that further research with a larger population would be necessary to generalize the findings.

Oftentimes, when examining cognition within VRET, cognitive presence is also examined because these two variables are so interdependent to each other. A study by Hvass et al. (2017) did just this. The researchers for this study evaluated how cognitive presence was affected by the realism of a computer-generated virtual environment. This was accomplished by the researchers manipulating the virtual environment by enhancing

the resolution and clarity of the computer-generated virtual environments. The researchers measured the effects of the level of realism on presence through self-report questionnaires and physiological measures (i.e., heart rate and skin conductance). The study concluded that a higher polygon and texture resolution did influence the level of presence participants experienced during a VR game.

Gilbert (2016) analyzed realism and presence from a different perspective arguing that the authenticity of the virtual environments plays a role in a client's cognition. He said that authenticity was important because it was directly related to whether the person viewing the virtual environment was seeing what the person expected to see. Further, he said the authenticity of the virtual environment was related to the fidelity of the environment. Gilbert described fidelity as being the perceived realism of the virtual environment by the person viewing the virtual environment.

Gilbert believed the authenticity and the fidelity of the virtual environment worked together to create cognitive presence for the person viewing the environment. He believed this cognitive presence was created by the overall realism of the environment and how immersed the person felt when viewing the environment. For example, if a person engages in a virtual environment to overcome the fear of flying and the look of the plane looks how the user expected (visual fidelity) and sounds how the user expected (auditory fidelity) then the client sees the environment as authentic, thus realism (i.e., cognition has been achieved). This, in turn, allows the client to become fully immersed and develop a sense of presence within the virtual environment.

Emotional responses and their measurement during a VRET experience is another equally important variable that is related to VRET effectiveness (Oskam, 2005). However, the success of this variable hinges on the initial success of the first two variables (i.e., cognition and presence) before an emotional response can become a measurable factor within the VRET experience (Oskam, 2005). A study by Jang et al. (2002) analyzed the physiological reactions (i.e., emotional response) of participants to two virtual environments. One virtual environment was driving while the other was flying. The physiological response of these participants to the virtual environment was recorded by measuring the heart rate, skin resistance, and skin temperature. The researchers also recorded the sense of presence and simulator sickness experienced by each of the participants by administering and scoring a Presence and Simulator Sickness questionnaire given to the participants.

The study by Jang et al. (2002) came to several conclusions. First, from their data, the researchers concluded that skin resistance and heart rate variability were useful measures to record the arousal experienced by the participants when exposed to the virtual environments. They also noted that these measures usually returned to normal over time. Next, the researchers concluded that the skin resistance and heart rate could likely be used as objective measures to monitor the reactions of people being exposed to virtual environments. Lastly, the researchers noted that the variability of a participant's heart rate could be used as a tool to assess the emotional state of the participant being exposed to the virtual environment.

One reason that physiological measures (i.e., emotional response) are used to measure the effectiveness of VRET is that it allows clinicians to actively see a client's response to an external virtual stimulus. A study by Owens and Beidel (2015) examined and discussed how these physiological measures apply to social anxiety during VRET. The researchers examined the ability of virtual environments to cause physiological arousal during virtual public speaking exposures. The study used by 21 adults who had social anxiety disorder (SAD) and 24 adults who did not have the disorder.

The study aimed to achieve the following three objectives:

- To examine if speaking to a virtual audience caused a significant increase in a participant's physiological responses (i.e., heart rate, electrodermal activity, and respiratory sinus arrhythmia) over their physiological baseline at rest.
- To determine if participants with SAD exhibited a larger increase in their physiological responses and subjective distress when they spoke in front of a live audience compared with a virtual environment.
- To determine if participants with SAD had larger increases in their physiological responses and self-reported arousal during the speaking tasks compared to the controls (Owens & Beidel, 2015).

The study concluded that the virtual speaking environment did cause a significant increase in the heartrate, electrodermal activity, respirator sinus arrhythmia, and the self-reported distress of the participants over their baseline physiological measures. However, this increase was shown to be less anxiety-producing than the in vivo (i.e., real world) public speaking task (Owens & Beidel, 2015). Further, the researchers concluded that the

results indicate that virtual environments could be used as an adequate substitute for in vivo exposure when a person is hesitant to or unable to engage in an in vivo experience (Owens & Beidel, 2015). Finally, the researchers concluded that the results of the study support that with current technology, in vivo exposure is still the most effective method of treating SAD and the fear of public speaking (Owens & Beidel, 2015).

Another study by Powell, Powell, and Maron (2017) evaluated the effectiveness of using the heartrate as an indicator of the effectiveness of VRET as it related to acrophobia (fear of heights). Specifically, the researchers used five participants with acrophobia and five in a control group to determine if an increase in heart rate from a measured baseline to VR exposure was an adequate way to measure the effectiveness of the VRET stimulus. The researchers also looked to determine if there was a mediating effect exposure to a neutral VR environment that would have to be considered.

Each of the participants explored VR environments of a cityscape at the ground level and from an elevated position. During this time the participant's heart rate was recorded and compared to the baseline measure. The researchers concluded that the VR environment used during VRET was able to induce an anxiety response in the participants with acrophobia. This was measured by an increase in the heart rate from the baseline measure (Powell et al., 2017).

However, the researchers further concluded that although a heart rate measure was an effective way of measuring the anxiety response, it was not a reliable indicator of the effectiveness of VRET. The researchers stated that an adjustment must be made to consider the neutral VR exposure on the physiological response (Powell et al., 2017).

This means that even without the virtual stimulus present, VR exposure will influence physiological responses on its own and needs to be accounted for. This is important because this study shows that any study evaluating the effectiveness of VRET must use other measures than just heart rate to evaluate efficacy and account for neutral VR exposure on physiological responses (Powell et al., 2017).

Another study by Diemer, Lohkamp, Mühlberger, and Zwanzger (2016) evaluated physiological arousal as a factor of VRET efficacy by analyzing three different physiological responses, including heart rate, skin conductance level, and salivary cortisol. The study also evaluated subjective fear of the participants using fear ratings and a sense of presence using the Igroup Presence Questionnaire. The study focused on the treatment of acrophobia with VRET and used 80 participants with 40 of the participants having acrophobia while 40 of the participants were used as a healthy control group.

The study first concluded that virtual height scenarios were shown to activate subject fear and two of the physiological fear responses (i.e., heart rate and skin conductance level) in both the acrophobic and control participants. The researchers also noted that there was little distinguishable difference between the physiological reactions of the acrophobic participants and the control group. However, only the acrophobic group reported fear during the VR height environment. The largest difference between the two groups was that the acrophobic group had a higher heart rate increase than the control group (Diemer et al., 2016). Second, this study concluded that more studies are needed in future to further clarify the role of other emotional processes. The study further reported that neither one of the groups was shown to exhibit any sort of increase in salivary

cortisol and that there was a lack of parallelism of the symptoms exhibited by the acrophobic group across anxiety domains (Diemer et. al., 2016).

Generalizability. According to the study by Oskam (2005), generalizability is the fourth important factor to the effectiveness of VRET and is the degree that any fear extinction experienced during VRET generalizes to the real world and to real scenarios in a clients' life. For this generalizability to occur, the virtual environments must be perceived as being realistic enough for the fear extinction to transfer to the real world. In fact, the generalizability of VRET is directly related to the overall effectiveness of the other three factors combined (i.e., presence, cognition, and emotional response). The more effective the other three factors are the more generalizable VRET will be to the real world. Generalizability is the ultimate measure of VRET effectiveness because of it relation to the applicability to the real-world fear of the client.

Oskam (2005) discussed the importance of generalizability and the principles related to it. First, for VRET to be generalizable it also must be sustainable. This means that the effects of VRET intervention do not decrease or disappear over time, also known as relapse. When this relapse occurs, clients revert to the original state of the disorder which they have (i.e., FOF, fear-of-heights, etc.…), the effect of the VRET treatment has decreased over time. If this happens then the sustainability of the VRET intervention would be considered low and the overall generalizability would be significantly decreased as well.

Oskam (2005) further explained the importance of generalizability and how its direct relation to the effectiveness of VRET intervention in the following way. If a client

undergoes VRET for a specific fear stimulus and no longer shows any fear reaction to that fear stimulus within the virtual environment, then VRET is said to have been successful. If the client then goes into the real world and encounters the feared stimulus in this environment and still shows no fear response, then the effectiveness of VRET is said to be generalized. If the client continues with this lack of fear response into the real world, then the effectiveness of VRET is said to be sustainable.

What Oskam (2005) made clear is that for VRET to be considered effective, two criteria must be met. The first criterion is that the effectiveness of the intervention experienced in the virtual world must be transferable (i.e., generalizable) to the real world and the real-world fear stimulus. The second criterion is that this generalizability must be able to be sustained over time and not diminish in the real world. He also points out that both of these criteria come down to the differences perceived by the client between the virtual environment used during VRET and the real world.

This last point by Oskam (2005) relates to the basis of the study conducted here. This study sought to substantially decrease the differences perceived by clients between the virtual world and the real world using immersive true reality 360-degree videos created in real world environments featuring real-world fear stimuli. By following the logic put forth by Oskam, if the difference detected by the client between the virtual environment and the real world is decreased then the generalizability and sustainability, thus effectiveness, of VRET should increase. Generalizability of the results of this study were inferred from the data and the treatment outcomes measured by the FFI and FAS.

Realism. The effectiveness of VRET not only hinges on the above listed factors but also on the realism of the environment. How real a person perceives a virtual environment to be is directly related to the effectiveness of VRET (Malbos, 2015; Meyerbröker & Emmelkamp, 2014; Oskam, 2005; Triscari et al., 2015). The realism of the virtual environment has been shown to affect four important factors related to VRET effectiveness, which are cognitive presence, emotional response, cognition, and overall generalizability (Oskam, 2005).

Cognitive presence refers to the degree clients feels they are in the virtual environment. Emotional response refers to whether or to what degree the virtual fear stimulus elicits an emotional response from the client. Cognition refers to whether clients believe what they are seeing is real, or at least real enough, which is related to the emotional response they experience (Oskam, 2005). Generalizability refers to the degree that any fear extinction experienced during VRET generalizes to the real world and to real scenarios in the clients' life. To do so, the virtual environments have to be perceived as being realistic enough for the fear extinction to transfer to the real world (Oskam, 2005).

IVET. VRET cannot be discussed without also mentioning IVET. This is largely because VRET is seen as an alternative to IVET (Baus & Bouchard, 2014). The reason why VRET is seen as an alternative to IVET is mainly because of the fact people must confront a fear in real life. However, clients are often reluctant to do this for a variety of reasons, including the loss of confidentiality by doing therapy in public, in vivo can be burdensome to carry out, client feeling too threatened or scared, and safety issues (e.g.,

unsafe heights or other activities involving some risk to client, etc.; Baus & Bouchard, 2014; Wiederhold, 2002). VRET has been shown to be just as effective as IVET but alleviates the previously listed limitations of IVET (Anderson et al., 2013).

TR-VRET. At this point, it is not possible to say what the effectiveness of TR-VRET is going to be because of the lack research in this area. When looking at the effectiveness of IVET, IET, VRET, etc. a person can make an educated guess at the level of effectiveness of TR-VRET. However, this study aimed to produce empirical evidence to help start the process of discovering the effectiveness and potential of TR-VRET.

Limitations of VRET

The limitations of VRET do not necessarily directly apply to TR-VRET. At this point, there is no pointed evidence suggesting one way or the other. However, within the context of this study, the limitations of VRET were still considered an important factor to consider. For example, one major limitation of VRET, in general, is that much of the research focuses primarily on phobias, with only a few relevant studies touching on anxiety, PTSD, OCD, etc. (Rizzo et al., 2015). Another limitation related to TR-VRET is currently there is little literature focusing on using the 360-camera technique or using real life environments in therapy (Kallioniemi et al., 2017; (Stupar-Rutenfrans et al., 2017).

According to several other studies (McCann et al., 2014; Motraghi, Seim, Meyer, & Morissette, 2014; Page & Coxon, 2016;) another major limitation with VRET is that the studies done on VRET have been done relatively poorly, have small samples, conducted in less than ideal conditions, or had poor controls. A study conducted by Page and Coxon (2016) evaluated the continued lack of controls and small samples used by

VRET research. The researchers noted that despite repeated concerns about these issues researchers have not shown an inclination to use better controls and larger samples when doing VRET research. The study concluded by stating the importance of using controls and larger sample sizes to better estimate the treatment effect, confidence intervals, and would allow for practitioners to better and more effectively compare treatment options.

Side-effects. Another potential limitation to VRET are some of the side-effects associated with its use. A study done by Rosa, Morais, Gamito, Oliveira, and Saraiva (2016) evaluated the experience of people who used virtual reality. The main negative side-effect detected by the researchers was cybersickness, which was characterized as experiencing motion sickness and usually resulted in nausea and headaches. The researchers noted that 60% of the study participants experienced some level of cybersickness, which decreased the experience within the virtual environment.

Cost. One of the biggest limitations associated with VRET is the cost of the system (Limbix, n.d.; University of Southern California Institute for Creative Technologies, 2019; Waldrop, 2017; Wiederhold & Wiederhold, 2010). The cost of the system has been slowly coming down over the years but can still be cost prohibitive. During this same time as costs have come down the quality of virtual reality has gone up (David, Matu, & David, 2013). However, the cost of VRET largely depends on the quality of the VR environment and the reason it is being used. For example, just to purchase the top tier Bravemind VR system that helps to treat PTSD for soldiers can cost approximately $17,000 (Perlman, 2017). This kind of cost can be cost prohibitive for

small clinics who cannot afford the equipment's cost or afford a system that treats a narrow population (Nelson, 2013).

However, other VRET options exist that are much cheaper but are also of lower quality. One example is the VR system offered by Virtually Better. The system itself, including software and hardware (not including the PC) costs roughly $1,500, but is only able to treat a total of five phobias ("iPhone VR therapy system," n.d.). The offering made by Virtually Better also alludes to another limitation of VRET, which is the limitation of disorders these systems can treat.

Moreover, what this limitation analysis on cost does not cover, but is still somewhat relevant, is the cost associated with the actual development of the virtual environments used with VRET. These associated costs are outside of the purview of this study, but it should be noted that the virtual environments use in VRET are simulated environments that are created within a software package, such as with Bravemind and Virtually Better ("iPhone VR therapy system," n.d.; University of Southern California Institute for Creative Technologies, 2019). This means these VR environments have to be created from scratch, which takes time, money, and people with a specialized skill set.

TR-VRET impact on limitations. At this time the only known impact TR-VRET would likely have on the limitations associated with VRET is related to cost and treatment applicability. The predicted cost of a TR-VRET system would likely only cost the price of PC capable of running VR, approximately $700, a VR headset, just under $400 (BestBuy, n.d.) and potentially a 360-degree camera to record environments for therapy, which is about $400 (Insta360, n.d.). Concerning treatment applicability, TR-

VRET uses the recordings of real life environments and does not have to create them from scratch. This means that the necessary or useful environments could be recorded with relative ease and very little expense, even if these environments were recorded and distributed by a third-party.

Technology Requirements

The technology requirements for VRET varies but would likely be similar for TR-VRET as well. The actual technology requirements for both VRET systems and possible future TR-VRET is quite minimal and easily accessible in the United States, though the cost of the software appears to vary dramatically as previously noted ("iPhone VR therapy system," n.d.; Limbix, n.d.; University of Southern California Institute for Creative Technologies, 2019; Virtually Better, n.d.). Based on the information provided for Bravemind, Virtually Better, Limbix and the equipment likely needed for TR-VRET, the technology requirements are as follows:

- VR capable PC or laptop
- Smartphone with headset holder for smartphone-based systems
- PC monitor for nonlaptop set-ups
- Bluetooth controller (required for some VRET systems)
- Therapeutic software (for Bravemind and Virtually Better like systems)
- 360-degree VR videos

Clinical Competence

The clinical competence to administer VRET or TR-VRET is an important factor that cannot be overlooked. Before a clinician can engage in this type of therapy they must

be qualified to do so. This factor has been addressed in several studies (Emmelkamp, 2011; Reger, Rizzo, & Graham, 2015; Rizzo, 2016;). One such study by Reger et al. (2015) evaluated the initial development and distribution of VRET for use with PTSD and addressed the clinical competency factor. The researchers stated that for a clinician to be competent to engage in VRET they must first have strong foundational skills in exposure therapy. The only other competency factors mentioned were that the clinician must receive adequate training on how to use and administer the VRET system they were working with.

Current Trends

One major trend the literature points to is a call for better studies related to VRET that have larger samples, better controls, and are done under more ideal conditions to allow for more accurate measurements and analysis (Anderson et al., 2013; McCann et al., 2014; Motraghi, Seim, Meyer, & Morissette, 2014; Page & Coxon, 2016). One study by McCann et al. (2014) evaluated the research quality involving VRET in 27 different studies referencing eight study quality criteria. The average score for the studies, out of eight criteria, was very low at 2.85, with the maximum being met by any given study was six. The conclusion of the study was that study quality for VRET was generally low and future studies needed better RCTs. The eight study quality criteria included:

- Participants met diagnostic criteria for anxiety disorder,
- Researchers used treatment manual,
- Treatment-specific training provided to clinicians,
- Evaluation of treatment fidelity,

- Conducting of intent-to-treat analysis,
- Treatment was compared with controls included at least 50 participants,
- Randomization within study done by neutral third-party, and
- Assessors blind to condition.

In the past, VRET has predominantly been focused on treating various phobias. However, another common trend seen in the literature (Belloch et al., 2014; Gonçalves, Pedrozo, Coutinho, Figueira, & Ventura, 2012; Nezu, Nezu, Gillihan, & Foa, 2015; Wade et al., 2014) is a push to research and use VRET in other areas and to treat other disorders besides phobias, such as PTSD, OCD, anxiety, ASD, among others. One study by Rizzo, Hartholt, Grimani, Leeds, and Liewer (2014) that was evaluating the use of VRET for treating PTSD came to the same conclusion about the expanded use of VRET. The researchers concluded that not only was there a high potential for VRET to be used to treat PTSD, but there was also the potential to be used for other disorders like ADHD, stroke, and Alzheimer's.

The Need for Study

The level of realism has been shown to play an important role in the level of presence, cognition, emotional response of a client, the generalizability, and the overall efficacy of VRET (Oskam, 2005). According to Oskam (2005), the level of realism is important to VRET. This is because the level of realism affects so many important factors associated with the effectiveness of VRET, which include:

- Cognitive presence
- Cognition

- Emotional response
- Overall generalizability of the fear extinction (Oskam, 2005).

To date, no other study or research was found to have taken VRET to its logical extreme of using real life environments to measure how it affects the overall efficacy of VRET as it relates to FOF. However, one study was found to have used real life environments in VRET relating to the fear of public speaking (Stupar-Rutenfrans et al., 2017). This study was necessary to not only fill in this gap within the research but is needed to understand if TR-VRET is at least as efficacious as VRET as it relates to the FOF. Oskam (2005) noted that:

> If it is possible to let people experience more directed or more realistic stimuli, emotional effects will be greater. This can be done by representing important stimuli in such a way that cognition of these stimuli can only be done in one unified manner. With this, ambiguity can be prevented, which means that stimuli will be perceived in the way that they were meant to.

Summary

VRET is an emerging and quickly growing field in both the fields of psychology and behavior analysis. The most predominant theme within the literature revolves around the use of VRET with various phobias, specifically FOF and fear of heights. This is closely followed using VRET for treating PTSD and anxiety. Some of the recent research shows the research for using VRET in other areas (i.e., OCD, ASD, etc.) has slowly progressed and expanded. However, the other major theme within the literature is that much of the research done n VRET has been done using small samples, poor controls,

and has provided far from conclusive evidence about how effective VRET is for treatment (Anderson et al., 2013; McCann et al., 2014; Motraghi, Seim, Meyer, & Morissette, 2014; Page & Coxon, 2016). The one glaring absence within the literature is anything having to do with TR-VRET.

In general, what is most clearly known about the use of VRET is that there is an abundance of empirical evidence showing that this tool is useful for treating various phobias (Botella et al., 2014; Gebara, Barros-Neto, Gertsenchtein, & Lotufo-Neto, 2016; Meyerbröker, 2014; Miloff et al., 2016; Nezu, Nezu, Gillihan, & Foa, 2015; Ost, 1989; Peñate Castro et al., 2014; Raghav et al., 2016). Some evidence exists, although less so, that VRET can be used successfully to treat PTSD and various anxiety disorders (Anderson et al., 2013; Beidel et al., 2017; Gonçalves et al., 2012; Jiandani, Nair, & Shukla, 2014; Michael, Costanzo, Blair, & Albert, 2014; Reger et al., 2016). The research of using VRET for other disorders, such as OCD and ASD (Belloch et al., 2014; Kearney, 2015), has been minimally evaluated with initial findings showing some support for the use of VRET/VRT-like strategies.

However, much is still unknown about the effectiveness of VRET and what disorders this tool can effectively be used. For example, VRET/VRT is emerging as a tool used by behavior analyst for treating autism and the various issues associated with this disorder (Belloch et al., 2014; Kearney, 2015; Wade et al., 2014). However, still it is much unknown concerning how effective VRET could be for the use with ASD and in what way it could be applied. Not to mention the need for more research in this area. One of the other glaring unknowns about the use of VRET is understanding the exact

reliability of all the previous studies. One of the biggest complaints about the research associated with VRET is the small sample sizes, poor study designs, studies have poor controls, and the urgent need for larger studies to better (Anderson et al., 2013; McCann et al., 2014; Motraghi, Seim, Meyer, & Morissette, 2014; Page & Coxon, 2016). Until these larger and better designed VRET studies are carried out the literature and the related findings are likely to have their generalizability questioned.

This current study, in part, helped to fill in at least one of the gaps associated with the current literature. This research addressed the gap in understanding how increasing the realism of virtual reality environments using real-life environments, as opposed to simulated virtual reality environments effects the efficacy of VRET, which is referred to as TR-VRET in the study (Oskam, 2005). This, in turn, extends the knowledge of VRET in general by providing a better understanding of how using real life environments affect the efficacy of this kind of ET. The efficacy of this new tool was measured using standardized measurement instruments. These measurement instruments have been previously shown to be empirically supported and effective at measuring the effectiveness of VRET and are further explained in Chapter 3.

Chapter 3: Research Methods

Introduction

The purpose of this intervention study was to determine if TR-VRET is as effective as VRET when treating FOF, specifically at reducing the fear and anxiety associated with FOF. Historically, VRET has relied on an expensive production process to produce virtual environments; however, recent technological advancements may allow for TR-VRET environments to be produced more economically and be just as effective as VRET environments.

Chapter 3 contains four sections. In the first section, I discuss the research design and approach by focusing on the variables of the study, the research design, the research question, and a justification for the intervention chosen. The second section includes a discussion of the methodology of the study, in which the population for the study, sampling and sampling procedures, procedures for recruitment, participation criteria, data collection plans, and the instruments that were used to collect data are identified. Additional information is provided related to conducting an intervention study. In the third section, I focus on the threats to validity and ethical procedures, while in the fourth section, I provide a chapter summary and an transition to Chapter 4.

Research Design and Rationale

I chose a quantitative method for this study to determine the efficacy of the independent variables of VRET and TR-VRET on the dependent variables of anxiety and fear as experienced by people who have a diagnosed phobia of flying (i.e., FOF). The specific design chosen was the randomized control group, pretest-posttest design, also

known as a classic controlled experimental design (see Dimitrov & Rumrill, 2003; Nestor & Schutt, 2014). This design was chosen because it had the necessary components to answer the research questions, which addressed understanding the effect that TR-VRET and VRET had on anxiety and fear in patients with a FOF and the differences in efficacy between the two treatments.

The randomized control group, pretest-posttest design was necessary to use in this study because it contains a pre-/posttest component (see Dimitrov & Rumrill, 2003; Nestor & Schutt, 2014). This allowed me to measure for fear and anxiety levels with self-report questionnaires before and after using the TR-VRET and VRET treatments for FOF and compare the efficacy of both treatments. This design also allowed for the use of a concurrent active treatment control group, which is an existing therapy already know to be effective (see Dimitrov & Rumrill, 2003; Nestor & Schutt, 2014). In this case, the known effective therapy was VRET.

Defense of Intervention

In this intervention study, I focused on two interventions for FOF. The first intervention was VRET, which is a conventional and existing therapy already know to be effective for treating FOF (Botella et al., 2014; Ferrand et al., 2015; Krijn et al., 2007; Rothbaum et al., 2000). The fact that VRET was already known to be effective for treating FOF was also why it served as the active treatment control group in this study. To date, little research has been conducted on the use of real life 360-degree video in place of the computer-generated environment used in traditional VRET (Stupar-Rutenfrans et al., 2017), and none has been done related to treating FOF.

The second intervention was TR-VRET, which served as the active treatment experimental group. TR-VRET provided the same treatment experience for FOF except for real-life environments instead of the computer-generated environments used by VRET. This was the only difference between the two interventions. This is important for several different reasons relevant to this study. First, no research currently exists showing whether using real-life environments is equal, more, or less effective than using computer-generated environments to treat FOF. Second, some research literature has suggested that increased realism within virtual environments may make VRET more effective (Costa, Carvalho, & Nardi, 2010; Dunser & Grasset, 2011; Kwon et al., 2013; Oskam, 2005). Last, if TR-VRET was shown to be *at least* as effective as VRET for treating FOF, this may present huge cost-savings opportunities for psychologists in adopting alternative treatment options. This will be discussed in more detail in Chapter 5.

Methodology

Population

The participants for this research study were community-dwelling adults, 18 years of age or older, living in Central Wisconsin. In the study, I recruited men and women from diverse ethnic backgrounds (e.g., White, Hmong, Asian, Hispanic, Native American, and others) through the identified participating organization for this study and the local community. Before any flyers were distributed or individuals contacted through the abovementioned organization, the leadership and other senior administrators were contacted via e-mail with an attached formal letter. This letter introduced the study, the purpose of the study, and requested the organization to consider distributing flyers for the

study through their facilities. This letter also requested for this organization to provide the clinical oversight and therapeutic portion of the study. I obtained written consent (e.g., a signed letter of cooperation) from the leadership of this organization who agreed to allow recruitment through their facilities and provide clinical oversight and therapeutic services for the study. The leadership and administrators from this organization also had the initial screening process of the study explained to them. Thereafter, approval from the Walden Institutional Review Board (IRB) was sought.

The leadership and administrators from the organization who agreed to participate in the study were asked to distribute recruitment flyers in areas of their choosing and at their discretion. The flyer provided information relating to the purpose and details of the study and contact information to sign up for the study or to learn further information about the study. The target population for this study was comprised of 217,806 adults 18 years of age or older (Data USA, 2016). All the individuals who responded to the flyers were invited to participate in the initial screening for inclusion in the study. The organization that agreed to distribute flyers at their locations agreed to announce to their populations when the flyers were distributed.

Sampling and Sampling Procedures

The target population in Central Wisconsin consisted of 217,806 adults who were 18 years of age or older (Data USA, 2016). The sample for this study was drawn directly from people who responded to the flyers about the study, which were located throughout Central Wisconsin. The respondents were screened and then randomly selected for inclusion in the study via simple random sampling. This simple random sampling ensured

all respondents would have the same probability of being selected for the study and was carried out by the participating organization through selecting participant names out of a bucket (see Clark & Creswell, 2008).

To participate in the study, all respondents met current *DSM-5* (APA, 2013) criteria for either specific phobia, situational type, panic disorder with agoraphobia in which flying was the feared stimulus, or agoraphobia without a history of panic disorder with flying as the feared stimulus (Rothbaum et al., 2006). Participants were diagnosed by a specific doctor at the participating organization. Potential subjects who had never flown before were ineligible to participate. Eligible participants who were taking psychoactive medication for a minimum of 3 months agreed to remain on the medication and not to change the dose amount during the entirety of the study. Participants were excluded from the study if they had a history of mania, schizophrenia or other psychoses, suicidal ideations, or current drug or alcohol abuse or dependence (see Rothbaum et al., 2006) or were currently undergoing therapy for FOF. Participants' mental health screenings were also conducted by the same doctor from the participating organization for this study.

Power Analysis

Three factors must be considered when determining a sample size through a power analysis: power of the test, effect size, and level of significance (Creswell, 2013). The power of the test refers to the probability of rejecting the null hypothesis when it is false and should be rejected (Creswell, 2013). If too weak of a power is used, then the chances are reduced that a significant effect will be detected (Cohen, 2013). If too strong

of a power is used, then this can lead to an unrealistic sample size requirement (Cohen, 2013). Therefore, Cohen (2013) recommended using a statistical power of 0.8. I followed this recommendation and used a power of 0.8 in this study.

The effect size refers to the magnitude of the difference between groups (Browner, 2012). In this case, the effect size is the difference in magnitude between the variables in the study. If the effect size is too small, then the strength of the relationship between the variables is also going to be small resulting in the need for a larger sample size (Browner, 2012). Cohen (2013) recommended using a medium effect size, which is different depending on the test used. Since I used the repeated measures ANOVA in this study, the recommended effect size was .25 (Cohen, 2013). I followed this recommendation and used an effect size of .25.

The level of significance (i.e., alpha level) refers to the probability of rejecting the null hypothesis when it is true and is usually set at 5% or .05 (Rethorst, Landers, Nagoshi, & Ross, 2012). I made use of this commonly accepted level of significance in this study. G-Power was used to conduct a power analysis on the repeated measures ANOVA with two measurements that were used in the study. This was completed using the recommended statistical power of 0.8, effect size of .25, and alpha level of .05 with the results showing that a sample size of 34 was required for the study (see Faul, Erdfelder, Lang, & Buchner, 2007).

Procedures for Recruitment, Participation, and Data Collection

After receiving permission from the IRB at Walden University, I sent flyers to the participating organization for this study and they were posted within the local

community. This was done to inform prospective participants of who to contact if they were interested in participating in the study. The flyer included information about the objectives of the study and the process to follow to participate. Informed consent was attained from every person who was interested in participating in the study.

This informed consent provided information to the prospective participant about many aspects of the study, including the purpose of the study, the procedures involved with the study, that the study was voluntary, potential benefits or risks of the study, and the procedures that were taken to protect the participants' privacy and confidentiality. Once the potential study participant agreed and signed the informed consent, they were moved forward to the screening process with the doctor from the participating organization. Each potential study participant was screened by this doctor to determine if they met the current *DSM-5* (APA, 2013) criteria for either specific phobia, situational type, panic disorder with agoraphobia in which FOF was the feared stimulus, or agoraphobia without a history of panic disorder with flying as the feared stimulus. Once this screening process was completed, eligible participants were asked to complete a demographic questionnaire developed specifically for this study that collected information on age, years of education, annual income, gender, ethnicity, and marital status.

Once the demographic information was collected each participant's name was placed into a medium-sized, two-gallon plastic bucket and 34 names were randomly drawn from the bucket by the participating organization. These 34 names were then placed back into the bucket and 17 names were randomly drawn from the bucket by the

participating organization. and placed in the active treatment experimental group, which were those who received TR-VRET for FOF. The remaining 17 participants were placed in the active treatment control group, which were those who received the VRET treatment, which is already known to be effective for treating FOF (Rothbaum et al., 2006).

Data for this study was collected by having the participants in the experimental group and the control group complete two questionnaires before treatment began and after treatment ended (i.e., pre-/posttests). These two questionnaires are the FFI and the FAS. The FFI will record data relating to the intensity of fear associated with flying and the FAS will record the level of anxiety associated with flying and flying related situations (Scott, 1987; Van Gerwen et al., 1999).

Participants were free to leave the study at any time and were not compensated. However, at the end of the study the participants who stayed for the entirety were given a chance to ask any questions about the study. Any treatment related questions were referred to the licensed psychologist from the participating organization for this study, who was overseeing all clinical and therapeutic aspects of the study. This study ded not have any follow-up requirements. Any treatment follow-ups were exclusively between the participant and psychologist from the participating organization and outside the scope of this study.

Additional Information for Conducting of an Intervention

This study focused on the treatment of FOF using VRET and an experimental therapy called TR-VRET. VRET makes use of computer-generated environments that a

person can view and be immersed in by wearing a head-mounted display (HMD). This HMD provides a person a 360-degree view of the virtual environment and includes visual, auditory, and kinesthetic cues (Rothbaum et al., 2006). In this study the control group used the HMD during VRET to view the computer-generated environment related to flying and flying-related stimuli. VRET was used as the active treatment control group since it is already established as an effective method for treating FOF (Botella et al., 2014; Ferrand et al., 2015; Krijn et al., 2007; Rothbaum et al., 2006).

TR-VRET made use of real-life environments by recording these environments with a 360-degree camera. A person can then view and be immersed in these real life recorded environments by wearing a HMD. This HMD provides a person a 360-degree view of the real life virtual environment. This environment also provided visual, auditory, and kinesthetic cues.

In this study the active treatment experimental group used the HMD during TR-VRET to view the real life virtual environment related to flying and flying related stimuli. TR-VRET was used as the active treatment experimental group since there is no current literature supporting its effectiveness for treating FOF. However, literature does support that an increase in realism may make VRET more effective (Costa et al., 2010; Dunser & Grasset, 2011; Kwon et al., 2013; Oskam, 2005).

The active treatment control group using VRET used a product called Virtually Better that has been designed, in part, to treat FOF by Dr. Rothbaum who has extensively studied and produced literature on this topic (Virtually Better, n.d.). This VRET treatment by Virtually Better uses HMD and computer-generated environments and stimuli

relating to flying or flying environments to treat FOF. The environments include the concourse, gate, passenger areas, boarding, taking off, stable flying, and landing, as well as the sights, sound, and kinesthetic cues commonly related to these environments (Virtually Better, n.d.). All these virtual environments relate to commercial flying and flying on a commercial jetliner.

This Virtually Better system includes the *Therapist Treatment Manual: Virtual Reality Exposure Therapy of Fear of Flying* that walks the clinician through step-by-step how to treat a client for fear-of-flying using virtual reality (Virtually Better, n.d.). The treatment manual was used as the treatment protocol for this intervention study and the VRET treatment was carried out by the licensed psychologist through the partnering organization for this study. All VRET treatment was conducted by a licensed psychologist and not by me.

The TR-VRET environments using real life environments were recorded using the Insta360 ONE 360-degree 4K camera to produce the realistic flying and flying-related environments (Insta360, n.d.). This 360-degree camera was used to record similar environments used by the Virtually Better product, which include the concourse, gate, passenger areas, boarding, taking off, stable flying, and landing, including the sights, sound, and kinesthetic cues commonly related to these environments. This clinical process, including obtaining the necessary written permission to record in airports and on commercial airliners, was overseen by a licensed psychologist from the participating organization for this study.

The active treatment experimental group using TR-VRET used the real life 360-degree recordings for treatment that was viewed through the same HMD as the VRET group. This group viewed similar environments as the VRET group, but only the real life version of the environments. The only difference between VRET and TR-VRET treatments were the environments being viewed (i.e., computer-generated vs. real life recordings). All other aspects of the treatment were the same. This included the TR-VRET group using the same FOF treatment manual as the VRET group for step-by-step instructions on how to treat a client for FOF using virtual reality. The treatment manual used as the treatment protocol for this intervention study and the TR-VRET treatment were carried out by a licensed psychologist through the partnering organization for this study. All TR-VRET treatment was conducted by a licensed psychologist through the partnering for this study and not by me.

Instrumentation and Operationalization of Constructs

Demographic Items

Before the participants began the study and given the FFI and FAS, they were be asked to complete a demographic questionnaire. This demographic questionnaire was used to collect information from the participant about their age, gender, ethnicity, marital status, years of education, and annual income. This demographic information was used to describe the demographic characteristics of each of the active treatment group samples.

FFI

The FFI (Scott, 1987) is a Likert-type 33-item self-report measure used for assessing the intensity of the fear associated with FOF. The FFI allows participants to

rate the level of distress they experienced during the different aspects of flying. Some examples of the different aspects of flying a participant rates includes traveling to the airport, looking out of the window while on the ground, take-off, experiencing turbulence, and feeling of touchdown on landing strip. Each item is rated on a 9-point scale. The scale ranges from 0 (*not at all*) to 8 (*very severely disturbing*). Scott (1987) has reported the test-retest reliability for 15 waitlisted patients as .92 and that the FFI has shown sensitivity to detecting change after a client has completed treatment. The FFI is appropriate for this study because it is meant to be used as a pre-/posttest measure for the FOF and has been successfully used in other studies treating FOF with VRET (Rothbaum et al., 2000, Rothbaum et al, 2006; Wiederhold & Wiederhold, 2003).

FAS

The FAS (Van Gerwen et al., 1999) is a Likert-type 32-item self-report measure used for assessing the level of anxiety associated with flying and flying related situations. The FAS allows participants to rate the level of anxiety they experience related to flying and flying-related situations. Some examples of the different situations a participant rates includes seeing an airplane, hearing about a flight, going through the gate, hearing noises during flight, and the descent of the plane. Each item is rated on a 5-point scale. The scale ranges from 1 (*no anxiety*) to 5 (*overwhelming anxiety*).

The FAS according to Van Gerwen et al. (1999) consists of three subscales. These three subscales are the anticipatory flight anxiety (ASA) scale, in-flight anxiety scale (IFA), and generalized flight anxiety (GFA) scale. The ASA is a 14-item scale that relates to the anxiety experienced when anticipating a flight. The IFA is an 11-item scale that

relates to the anxiety experienced during flight. The GFA is a 7-item scale that relates to the anxiety associated with airplanes in general.

Van Gerwen et al. (1999) has reported the internal consistency for 746 patients of the FAS for the three subscales were .97 for the GFA, .95 for the IFA, .88 for the AFA. The test-retest reliability for 746 patients of the FAS for the three subscales were .90 for the GFA, .92 for the IFA, and .90 for the AFA. The FAS is appropriate for this study because it is meant to be used as a pre-/posttest measure anxiety related to FOF and has been successfully used in other studies treating FOF with VRET (Czerniak et al., 2016; Hubbard & Bor, 2016; Shiban et al., 2017; Triscari et al., 2015).

Summary of Measures and Permission to Use

The FFI and FAS are available online, easily accessible, and able to be used for research. Written permission was obtained for both the FFI and FAS. Written permission to use the FFI was obtained from the publisher. Written permission to use the FAS was obtained from the author.

The FFI and FAS questionnaires are relevant to use for this study because they were necessary to examine the stated population related to the variables in the study. The fear variable was measured by the FFI, which assesses the level of the intensity of fear a person experiences during various aspects of flying. The anxiety variable was measured by the FAS, which assess the level of anxiety associated with flying and flying related situations. The FFI questionnaire is reliable to measure the intensity of the fear associated with flying (Scott, 1987). The FAS questionnaire is reliable to measure the anxiety associated with flying and flying situations (Van Gerwen et al., 1999).

Data Analysis Plan

Descriptive Statistics

IBM SPSS Statistics 24 was used to produce descriptive statistics. These statistics were used to evaluate and graphically display data collected from the two questionnaires relating to the active treatment experimental and control groups, and the demographic questionnaire. This included data related to participant demographics, the intensity of fear associated with FOF and situational anxiety associated with FOF, including the three anxiety subscales (i.e., ASA, IFA, and GFA) associated with FOF. The descriptive statistics used include the mean, percentages, and standard deviation.

Inferential Statistics

IBM SPSS Statistics 24 was used to perform a repeated measures ANOVA in this study. The repeated measures ANOVA was utilized to compare the means across one or more variables that are based on repeated observations (Christopher, 2016). The repeated measures ANOVA was used to answer the following research questions and hypothesis:

Research Question 1: Does TR-VRET equal VRET in the reduction of anxiety when treating fear-of-flying?

$H1_0$: The reduction in anxiety after TR-VRET is not equal to the reduction in anxiety after VRET following treatment for fear-of-flying as measured by the FAS.

$H1_1$: The reduction in anxiety after TR-VRET is equal to the reduction in anxiety after VRET following treatment for fear-of-flying as measured by the FAS

Research Question 2: Does TR-VRET equal VRET in the reduction of fear when treating fear-of-flying?

$H2_0$: The reduction in fear after TR-VRET is not equal to the reduction in fear after VRET following treatment for fear-of-flying as measured by the FFI.

$H2_1$: The reduction in fear after TR-VRET is equal to the reduction in fear after VRET following treatment for fear-of-flying as measured by the FFI.

Analysis. The repeated measures ANOVA was used first to analyze Research Question 1 by comparing the means between the pre-/posttest of the FAS to determine the reduction, if any, of the anxiety associated with FOF. This analysis of the reduction of anxiety was done for TR-VRET and VRET separately. The repeated measures ANOVA was then used to compare the means between TR-VRET and VRET to each other. This was done to determine if any reduction in anxiety from TR-VRET was equal to the reduction in anxiety from VRET. If the reduction in anxiety from TR-VRET was at least equal to that of VRET, then the null hypothesis is rejected.

The repeated measures ANOVA was used next to analyze Research Question 2 by comparing the means between the pre-/posttest of the FFI to determine the reduction, if any, of the fear associated with FOF. This analysis of the reduction of fear was done for TR-VRET and VRET separately. The repeated measures ANOVA was then used to compare the means between TR-VRET and VRET to each other. This was done to determine if any reduction in fear from TR-VRET was equal to the reduction in fear from

VRET. If the reduction in fear from TR-VRET was at least equal to that of VRET, then the null hypothesis is rejected.

Ethical Procedures

Initially, the priority for this study was to obtain Walden University IRB approval before moving forward. Once permission from the IRB to conduct the study was granted (IRB Approval #12-28-18-0318927), the distribution of the study flyers to the community and participating organization began. As noted earlier, informed consent was obtained from all potential participants recruited for this study. The informed consent provided each potential study participant with information relating to the purpose of the study, study procedures, any possible benefits or risks related to study participation, the voluntary nature of the study, that no compensation was provided for participation in the study, and the process to ensure their privacy and confidentiality were protected.

Several measures were taken to protect the privacy and confidentiality of the participants, which are outlined in the informed consent. All participant information and raw data from the demographic, FAS, and FFI questionnaires were saved on a password-protected laptop that was used only by me. A backup of the study data was created, updated regularly, and stored on a password protected and encrypted external hard drive, where it will be stored for 5 years until it is deleted. Participants were eached assigned a unique identification number that was used to identify them for each of the questionnaires. Data from the three questionnaires were stored in a locked filing cabinet during the study. The three questionnaires were shredded and discarded once the data

were recorded digitally and into SPSS and no longer needed. Also, the site this study was being conducted will not be published.

Further, the informed consent provided other information to participants. This included an explanation that the study does not report individual results. An explanation was provided within the informed consent that makes clear the participants were free to quit the study at any time, even after they have given consent to participate. Each participant was also provided with contact information in case they have any questions about the study. Each participant receives a copy of the informed consent.

Since this study was an intervention study, steps were taken to ensure I was only involved in processing the data collected and not the actual therapy (i.e., TR-VRET and VRET) or collection of data. I was only provided the archival data produced from the screening and therapy. This was done by referring each participant who agreed to and signed the informed consent to the participating licensed psychologist for initial screening. The licensed psychologist was from the participating organization for this study and was the one who determined if potential participants meet the diagnostic criteria to participate in the study. The licensed psychologist was also the person who conducted the therapy (i.e., TR-VRET and VRET) from which the data for the study was collected. A signed letter of cooperation, which has been provided by to the IRB, was obtained from the licensed psychologist and the partnering organization concerning the distribution of flyers and providing clinical oversight and therapy for the study, which was provided to the IRB during the application process.

Threats to Validity

Any researcher conducting a study must be aware of the potential for external and internal threats to the validity of the study. Two potential concerns related to internal validity of this study was maturation and history. Maturation refers to the biological factors that can occur in a participant during the study that can create differences between a pretest and posttest (Nestor & Schutt, 2014). History refers to the external factors that participants may experience outside of treatment, but during the study, that can affect test scores (Nestor & Schutt, 2014).

The researcher incorporated measures within the study to manage these potential threats to internal validity. The impact of maturation and history on the internal validity of the study may be reduced because the length of the intervention study was anticipated to be short. However, this does not completely rule that maturation and history have a potential impact on the internal validity. The measure taken to manage these threats to internal validity is to screen each participant for changes that occurred in their lives during the study related to maturation and history. Any significant changes found were noted in the study findings.

One potential concern associated with external validity was the interaction between the pretest questions and treatments used in the study. This concern was related to the participant potentially being influenced by one of the pretest questions (Nestor & Schutt, 2014). To safeguard against this threat to external validity only empirically supported scientific instruments (i.e., valid and reliable) that had been used in similar studies was used to measure the dependent variables. These instruments included the

FAS to measure situational anxiety related to flying (Van Gerwen et al., 1999) and the FFI to measure the intensity of fear related flying (Scott, 1987).

Summary

The purpose of this chapter was to introduce and discuss the research design, methodology, and threats to the validity of this intervention study. The first section discussed the research design and approach used for the study. This included information on the study variables, research design, research question, and a defense of the choice of intervention used in the study. The second section discussed the methodology of the study. This included the study population, sampling and sampling procedures, procedures for recruitment, participation criteria, data collection, additional intervention information, and study instruments. The third section discussed the threats to validity and ethical procedures. The fourth section provided a chapter summary and a Chapter 4 introduction.

Chapter 4 provides information related to three main sections of the study. The first section discusses details of the data collection and the overall process of the data collection. The second section discusses the treatment and intervention fidelity of the study. The final section of Chapter 4 reports and evaluates the results of the study and presents relevant tables and figures.

Chapter 4: Results

Introduction

The purpose of this study was to demonstrate if TR-VRET, displaying real environments for use in treatment is at least as efficacious as traditional VRET using simulated environments for treating anxiety and fear associated with the FOF. I collected data for this study from a cooperating organization that carried out the therapeutic portion of this study and provided the data from the 37 adults who participated in the data collection process. In this chapter, I provide a summary of the data and the results of the study used to evaluate the hypotheses of my study.

Data Collection

The data for this study were collected between January 2019 and March 2019 by a collaborating organization. This organization recruited 73 participants by placing flyers throughout the community that was to be screened for this study. Sixty-nine of these participants were deemed to be eligible for participation in this study by the organization. Out of these 69 participants, 40 were randomly selected by the organization for inclusion in the therapeutic and data collection portion of this study. Thirty-seven of these participants completed all requirements necessary for data collection, and three participants dropped out before completion. Nineteen participants in the active treatment experimental group completed all requirements for data collection, and 18 participants in the active treatment control group completed all requirements for data collection. No discrepancies in the data collection plan existed or were noted from the plan presented in Chapter 3.

Characteristics of the Sample

In this quantitative study, I used a randomized control group, pretest-posttest design. This design makes use of active treatment concurrent control that allows for the participants to be randomly assigned to an active treatment control group and an active treatment experimental group (Nestor & Schutt, 2014). The sample was taken from a population of adults diagnosed with FOF. The data used for this study were provided by a cooperating organization and were collected over the months of January, February, and March 2019. The population for this study was composed of only adults (i.e., 18 years old or older) who were, or able to be, diagnosed with FOF, who were not currently undergoing therapy for FOF, and living in Central Wisconsin.

The data were collected from adults between the ages of 18 and 64 years at the time of their admission to the study. The duration of study participation was the same for each participant. Participation included a therapy session with the cooperating organization twice a week for 4 weeks, for a total of eight therapy sessions. All participants who completed the study completed all eight sessions over the course of 4 weeks. The population consisted of both adult males and females diagnosed with FOF, with diverse ages, marital statuses, income, and ethnicities that were reflective of the general population.

Treatment and Intervention Fidelity

The treatment, which consisted of TR-VRET and VRET, was administered as planned. Each participant who completed the study participated in two therapy sessions each week for 4 weeks for a total of eight sessions. The study needed a minimum of 34

participants, 17 participants in each group, based on the power analysis. The study had a total of 37 participants, 19 in the experimental group and 18 in the control, which met the minimum participant requirement. No challenges were reported by the cooperating organization related to the planned implementation of the treatment, other than the three participants who dropped out of the study before completion. No adverse events with serious consequences related to the intervention were reported by the cooperating organization.

Results

Descriptive Statistics

The sample consisted of 37 participants, out of whom 19 were in the experimental group, and 18 in the control group. The distribution of demographic variables (i.e., gender, age, marital status, income, education, and ethnicity) for each group is presented in Table 1. The significance of chi-square tests of independence for the dichotomous variable group with each of the categorical demographic variables is presented in the table as well. Experimental and control groups were equal regarding gender, age, marital status, education, and ethnicity; however, they differed significantly in income. Specifically, those in the experimental group had higher relative percentages of higher income levels and lower relative percentages of lower income levels compared to the control group, indicating a higher overall income for the experimental group.

Table 1

Frequencies and Percentages Within Group of Various Demographic Categories in Experimental and Control Groups, With Significance of Chi-Square Statistics

Variable	*Group*		*p* value
	Experimental (*n* = 19)	Control (*n* = 18)	
Gender			.56
Male	9 (47.4)	8 (44.4)	
Female	10 (52.6)	10 (55.6)	
Age			.74
18–24	1 (5.3)	3 (16.7)	
25–34	5 (26.3)	4 (22.2)	
35–49	8 (42.1)	7 (38.9)	
50-64	5 (26.3)	4 (22.2)	
Marital status			.44
Never married	4 (21.1)	2 (11.1)	
Married	8 (42.1)	9 (50.0)	
Widowed	1 (5.3)	/	
Divorced	6 (31.6)	5 (27.8)	
Engaged	/	2 (11.1)	
Income			.01
Under $29,999	1 (5.3)	7 (38.9)	
$30,000–$49,000	14 (73.7)	11 (61.1)	
$50,000–$74,999	4 (21.1)	/	
Education			.41
Did not complete high school	/	1 (5.6)	
Graduated from high school or GED	3 (15.8)	5 (27.8)	
Some college	9 (47.4)	9 (50.0)	
Bachelor's degree	5 (26.3)	3 (16.7)	
Graduate or professional degree	2 (10.5)	/	
Ethnicity			.17
Asian	1 (5.3)	2 (11.1)	
Black/African	/	3 (16.7)	
White	15 (78.9)	13 (72.2)	
Native American	1 (10.5)	/	
Did not disclose	1 (5.3)	/	

Note. Percentages are shown in parentheses

Treatment Effect Comparison

In order to compare the effects of the treatment in the experimental and control group, I performed two repeated measures ANOVAs on the total FFI and total FAS scores. A between-subjects factor was the group (i.e., experimental and control), while a within-subjects factor was the treatment (i.e., pretest and posttest). Outcome measures were the continuous total pretest and posttest scores on the FFI and FAS score for each analysis. The analyses of these data did not reveal any violation of normality assumption for any of the pretest or posttest scores on the FFI and the FAS, neither for experimental, nor for the control groups (Shapiro-Wilk, $p > .05$), as shown in Tables 2–5. No outliers were detected either when observing boxplot visualizations.

Table 2

Tests of Normality

	Kolmogorov-Smirnov[b]			Shapiro-Wilk		
	Statistic	*df*	Sig.	Statistic	*df*	Sig.
FFI_pre_score	.155	19	.200*	.949	19	.375
FFI_post_score	.114	19	.200*	.985	19	.983

*. This is a lower bound of the true significance.

[a.] group = Experimental group

[b.] Lilliefors Significance Correction

Table 3

Tests of Normality

	Kolmogorov-Smirnov[b]			Shapiro-Wilk		
	Statistic	*df*	Sig.	Statistic	*df*	Sig.
FFI_pre_score	.151	18	.200*	.946	18	.365
FFI_post_score	.110	18	.200*	.956	18	.535

*. This is a lower bound of the true significance.

[a.] group = Control group

[b.] Lilliefors Significance Correction

Table 4

Tests of Normality

	Kolmogorov-Smirnov[b]			Shapiro-Wilk		
	Statistic	*df*	Sig.	Statistic	*df*	Sig.
FAS_pre_score	.115	19	.200*	.968	19	.735
FAS_post_score	.137	19	.200*	.932	19	.189

*. This is a lower bound of the true significance.

[a.] group = Experimental group

[b.] Lilliefors Significance Correction

Table 5

Tests of Normality

	Kolmogorov-Smirnov[b]			Shapiro-Wilk		
	Statistic	*df*	Sig.	Statistic	*df*	Sig.
FAS_pre_score	.136	18	.200*	.942	18	.309
FAS_post_score	.137	18	.200*	.947	18	.375

*. This is a lower bound of the true significance.

[a.] group = Control group

[b.] Lilliefors Significance Correction

Research Question 1

To answer Research Question 1 (i.e., Does TR-VRET equal VRET in the reduction of anxiety when treating FOF?), the following null hypothesis was evaluated: The reduction in anxiety after TR-VRET is not equal to the reduction in anxiety after VRET following treatment for FOF as measured by the FAS. Table 6 presents the main descriptive statistics measures of the FAS pretest and posttest scores in the experimental and control group as well as in both groups together.

Table 6

Main Descriptive Measures of the FAS Pretest and Posttest Scores for the Experimental and Control Groups

FAS score	Group	*M*	*SD*	*N*
Pretest	Experimental group	2.22	.35	19
	Control group	2.19	.38	18
	Total	2.21	.36	37
Posttest	Experimental group	1.43	.28	19
	Control group	1.50	.19	18
	Total	1.46	.24	37

The equality of error variances (see Table 7) assumption was not violated for either the pretest (F (1, 35) = .61, p = .44) or for the posttest FAS score (F (1, 35) = 1.49, p = .23). The equality of covariance matrices (see Table 8) assumption was also met with a Box's M = 5.46, F (3, 245669.39) = 1.71, p = .16. According to the tests of within-subjects effects (see Table 9), there was a statistically significant effect of treatment on the FAS scores, F (1, 35) = 163.38, p < .001, partial η^2 = .82. There was, however, no

effect of interaction between group and treatment, F (1, 35) = .67, p = .42, partial η^2 = .02. Tests of between-subjects effects (see Table 10) revealed no significant main effect of group on the FAS score, F (1, 35) = .06, p = .81, partial η^2 = .002. In conclusion, both treatments were effective decreasing the FAS score. There were no differences between the experimental and control groups related to the effect of the treatments, as shown in Figure 1. Therefore, the null hypothesis was rejected because data shows the reduction in anxiety after TR-VRET is equal to the reduction in anxiety after VRET following treatment for FOF, as measured by the FAS.

Table 7

Levene's Test of Equality of Error Variances.

	F	*df*1	*df*2	Sig.
FAS_pre_score	.613	1	35	.439
FAS_post_score	1.494	1	35	.230

Note. Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

Table 8

Box's Test of Equality of Covariance Matrices

Box's *M*	*F*	*df*1	*df*2	Sig.
5.455	1.706	3	245669.391	.163

Note. Tests the null hypothesis that the observed covariance matrices of the dependent variables are equal across groups.

Table 9

Tests of Within Subjects Effects

Measure: FAS Source		Type III sum of squares	*df*	Mean square	*F*	Sig.	Partial eta squared
treatment	Sphericity assumed	10.177	1	10.177	163.384	.000	.824
	Greenhouse-Geisser	10.177	1.000	10.177	163.384	.000	.824
	Huynh-Feldt	10.177	1.000	10.177	163.384	.000	.824
	Lower-bound	10.177	1.000	10.177	163.384	.000	.824
treatment * group	Sphericity assumed	.042	1	.042	.670	.419	.019
	Greenhouse-Geisser	.042	1.000	.042	.670	.419	.019
	Huynh-Feldt	.042	1.000	.042	.670	.419	.019
	Lower-bound	.042	1.000	.042	.670	.419	.019
Error (treatment)	Sphericity assumed	2.180	35	.062			
	Greenhouse-Geisser	2.180	35.000	.062			
	Huynh-Feldt	2.180	35.000	.062			
	Lower-bound	2.180	35.000	.062			

Table 10

Tests of Between Subjects Effects

Measure: FAS

Source	Type III sum of squares	*df*	Mean square	*F*	Sig.	Partial eta squared
Intercept	248.689	1	248.689	1945.717	.000	.982
group	.007	1	.007	.056	.814	.002
Error	4.473	35	.128			

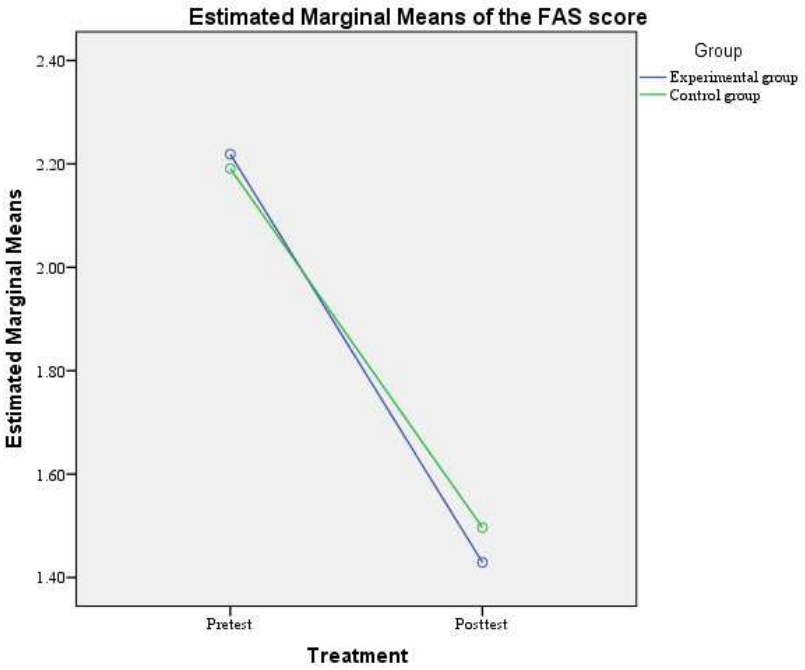

Figure 1. Change in the FAS score after the treatment in experimental and control group.

Research Question 2

To answer Research Question 2 (i.e., Does TR-VRET equal VRET in the reduction of fear when treating FOF?), the following null hypothesis was evaluated: The reduction in fear after TR-VRET is not equal to the reduction in fear after VRET following treatment for FOF, as measured by the FFI. Table 11 presents the results of

descriptive statistics on the FFI pretest and posttest scores in the experimental and control groups as well as for both groups together.

Table 11

Main Descriptive Measures of the FFI Pretest and Posttest Scores for Experimental and Control Group

FFI score	*Group*	*Mean*	*SD*	*N*
Pretest	Experimental group	2.30	.75	19
	Control group	2.51	.76	18
	Total	2.40	.75	37
Posttest	Experimental group	1.20	.45	19
	Control group	1.55	.47	18
	Total	1.37	.49	37

The assumption of equality of error variances (Table 12) was met both for the pretest (F (1, 35) = .16, p = .69) and for the posttest score (F (1, 35) = .04, p = .84). The equality of covariance matrices (Table 13) assumption was met as well, Box's M = 3.39, F (3, 245669.39) = 1.06, p = .36. The sphericity assumption was not violated, as there were only two within-subjects levels. According to the tests of within-subjects effects (Table 14), there was a statistically significant effect of treatment on the FFI scores, F (1, 35) = 124.17, p < .001, partial η^2 = .78. There was, however, no effect of interaction between group and treatment, F (1, 35) = .63, p = .43, partial η^2 = .02. Tests of between-subjects effects (Table 15) revealed no significant main effect of group on the FFI score, F (1, 35) = 2.29, p = .14, partial η^2 = .06. In conclusion, the FFI score is affected by both treatments, as the posttest scores were lower than the pretest scores. However, there were no differences between the experimental and control groups, neither in overall FFI score, nor in the effect of treatment on the FFI score, as displayed in Figure 1. Therefore, the

null hypothesis was rejected because data shows the reduction in fear after TR-VRET is equal to the reduction in fear after VRET following treatment for FOF, as measured by the FFI.

Table 12

Levene's Test of Equality of Error Variances

	F	*df*1	*df*2	Sig.
FFI_pre_score	.160	1	35	.692
FFI_post_score	.039	1	35	.844

Notes. Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

a. Design: Intercept + group
Within Subjects Design: treatment

Table 13

Box's Test of Equality of Covariance Matrices

Box's *M*	*F*	*df*1	*df*2	Sig.
3.390	1.060	3	245669.391	.365

Notes. Tests the null hypothesis that the observed covariance matrices of the dependent variables are equal across groups.

a. Design: Intercept + group
Within Subjects Design: treatment

Table 14

Tests of Within Subjects Effects

Measure: FFI Source		Type III sum of squares	*df*	Mean square	*F*	Sig.	Partial Eta squared
treatment	Sphericity assumed	19.455	1	19.455	124.169	.000	.780
	Greenhouse-Geisser	19.455	1.000	19.455	124.169	.000	.780
	Huynh-Feldt	19.455	1.000	19.455	124.169	.000	.780
	Lower-bound	19.455	1.000	19.455	124.169	.000	.780
treatment * group	Sphericity assumed	.099	1	.099	.629	.433	.018
	Greenhouse-Geisser	.099	1.000	.099	.629	.433	.018
	Huynh-Feldt	.099	1.000	.099	.629	.433	.018
	Lower-bound	.099	1.000	.099	.629	.433	.018
Error (treatment)	Sphericity assumed	5.484	35	.157			
	Greenhouse-Geisser	5.484	35.000	.157			
	Huynh-Feldt	5.484	35.000	.157			
	Lower-bound	5.484	35.000	.157			

Table 15

Tests of Between Subjects Effects

Measure: FFI Source	Type III sum of squares	*df*	Mean square	*F*	Sig.	Partial Eta squared
Intercept	264.005	1	264.005	422.774	.000	.924
group	1.431	1	1.431	2.292	.139	.061
Error	21.856	35	.624			

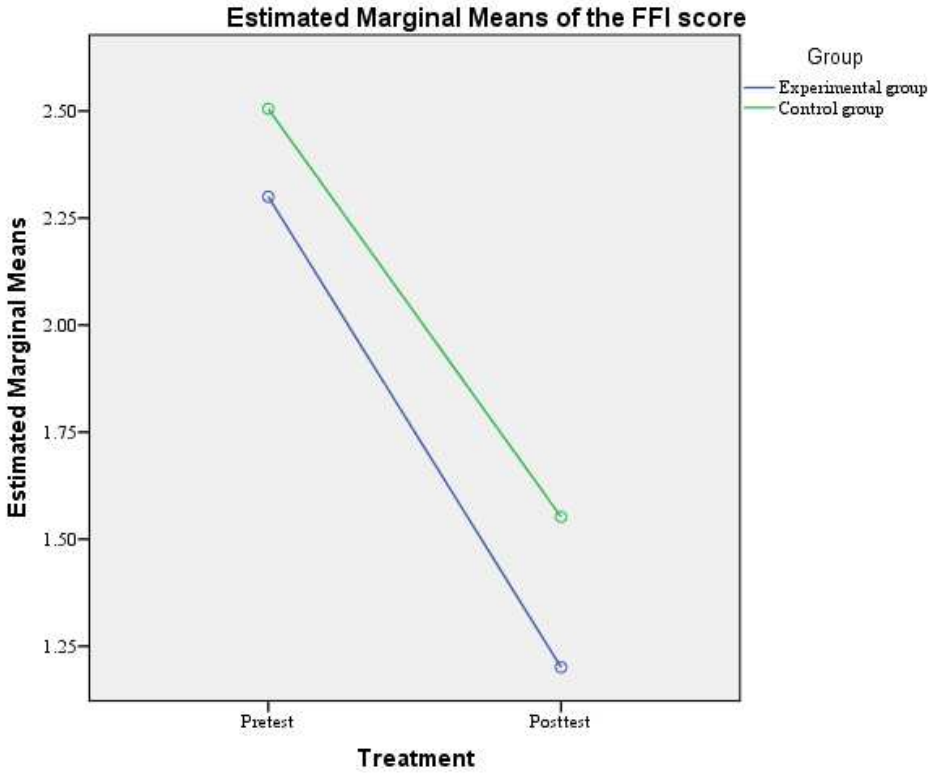

Figure 2. Change in the FFI score after the treatment in experimental and control groups.

Summary

This study was designed to investigate if TR-VRET, displaying real environments for use in treatment, is at least as efficacious as traditional VRET using simulated environments for treating anxiety and fear associated with the FOF. The results of the study allowed for three conclusions to be drawn. First, both the active treatment experimental group (TR-VRET) and the active treatment control group (VRET) were shown to have a significant effect on reducing anxiety related to flying, through the pre-/posttest data provided by the FAS. Second, both the active treatment experimental group (TR-VRET) and the active treatment control group (VRET) were shown to have a significant effect on reducing fear related to flying, through the pre-/posttest data provided by the FFI. Third, there was no significant effect found between the efficacy of

the active treatment experimental group (TR-VRET) and the active treatment control group (VRET), meaning that the null hypothesis was rejected for both research questions. This means that TR-VRET is equal to VRET in the reduction of both anxiety and fear when treating the FOF.

Chapter 5 provides information related to the last four main sections of the study. The first section discusses the overall interpretation of the findings. The second section discusses any limitations of the study. The third section discusses the recommendations for further research. The fourth section discusses the implications of the findings of this study, as it relates to positive social change, and any recommendations for practice.

Chapter 5: Discussion, Conclusions and Recommendations

Introduction

The purpose of this study was to demonstrate if the new technique called TR-VRET, displaying real environments for use in treatment, was at least as efficacious as traditional VRET using simulated environments. With this study, I aimed to increase the realism of VRET through the creation and use of real-life VR environments in a technique called TR-VRET as opposed to a simulated VR environment, which should result in effective phobia treatment. I employed a quantitative approach using an experimental design to test the treatment efficacy of using the TR-VRET technique with patients who had been referred for FOF. The design used in this study was a randomized control group, pretest-posttest design, known as a classic controlled experimental design (see Nestor & Schutt, 2014). This design was used because it allowed a direct comparison of the efficacies of the two treatment modalities. In this study, the control group consisted of participants who had received VRET, and the experimental treatment group were the participants who had received TR-VRET (i.e., active treatment concurrent control; see Chow & Liu, 2008). This design allowed for all participants to be randomly assigned to the control group or experimental treatment group (see Nestor & Schutt, 2014). This design also allowed for a new treatment method and an established treatment method to be tested and the outcomes to be analyzed and compared to one another using a pretest and posttest (see Chow & Liu, 2008). In this study, the pretest and posttest evaluated both anxiety and fear before and after treatment for FOF. The core analytical strategies used for this study were means, standard deviations, and repeated measures ANOVA.

Interpretation of the Findings

I developed two research questions for this study to analyze the treatment efficacy between groups (i.e., experimental and control) and within each group (i.e., pretest and posttest) related to the reduction of anxiety and fear related to FOF. The first question focused on whether TR-VRET would equal VRET in the reduction of anxiety when treating FOF. Previous studies indicated that VRET was effective in reducing FOF anxiety, and that the efficacy of VRET would likely increase as the realism of the virtual environment increased (Meyerbröker & Emmelkamp, 2014; Oskam, 2005; Rothbaum et al., 2000). Therefore, I assumed, as outlined in the Assumptions section of this study, that TR-VRET would likely be more efficacious for treating FOF anxiety because of its use of real-life virtual environments.

The second question focused on whether TR-VRET would equal VRET in the reduction of fear when treating FOF. Previous studies indicated that VRET was effective in reducing fear related to FOF, and that the efficacy of VRET would likely increase as the realism of the virtual environment increased (Meyerbröker & Emmelkamp, 2014; Oskam, 2005; Ost, 1989; Rothbaum et al., 2000). Therefore, I made the assumption that, as outlined in the Assumptions section of this study, that TR-VRET would likely be more efficacious for treating FOF because of its use of real-life virtual environments.

The level of fear and anxiety that participants had prior to treatment was identified by having them complete a pretest (i.e., FAS and FFI) indicating their level of fear and anxiety associated with flying. Higher ratings on the FAS and FFI indicated higher levels of anxiety and fear associated with flying and various events associated

with flying. Lower ratings on the FAS and FFI indicated lower levels of anxiety and fear associated with flying and various events associated with flying. The level of fear and anxiety that participants had after treatment were identified by having them complete a posttest (i.e., FAS and FFI) indicating their fear and anxiety associated with flying.

As expected, the results indicated that both TR-VRET and VRET were effective at reducing both fear and anxiety related to FOF. The results of the study showed a significant treatment effect on both fear and anxiety for both the TR-VRET and VRET treatments. All participants showed some reduction in both their fear and anxiety related to FOF after treatment using either TR-VRET and VRET. In this way, the results seem to be consistent with existing literature in showing that VRET is effective in reducing anxiety and fear associated with FOF (see Meyerbröker & Emmelkamp, 2014; Oskam, 2005; Ost, 1989; Rothbaum et al., 2000).

The results of this study also indicated that TR-VRET was equal in efficacy to VRET in reducing fear and anxiety for FOF; however, the findings did not confirm that TR-VRET was more effective than VRET. The results of this study did not show any significant effect between groups (i.e., experimental and control) relating to treatment effect. This means there were no differences between the experimental and control groups, neither in the overall FAS and FFI scores, nor in the effect of treatment on the FAS and FFI scores. Existing literature indicated that an increase in realism in the virtual environment was likely to show an increase in the efficacy of the treatment (Meyerbröker & Emmelkamp, 2014; Oskam, 2005). However, the findings of this study did not support this conclusion. The results of this study were partially supported by similar findings by

Rothbaum et al. (2006), showing a difference in realism between VRET and IVET had no significant effect on the efficacy of the treatment.

Theoretical Framework Context

I also evaluated the results of this study in the context of the theoretical frameworks used. The findings of this study show that TR-VRET and VRET are equally efficacious at treating the fear and anxiety associated with FOF. The three theories that served as the conceptual framework for this study were cognitive theory (Abramowitz, 2013), EPT (Kaczkurkin & Foa, 2015), and behaviorism (Mason, 2013).

Cognitive theory states that a person's perceptions and thoughts about a situation, event, or stimuli will directly influence their emotions and behaviors (Abramowitz, 2013). This applies to a person's irrational thinking or cognitive distortions as it relates to a phobia (Abramowitz, 2013). VRET exposes a person to this situation, event, or stimuli, then works to transform the person's perception or thoughts about it, which in turn helps in positively changing the person's emotions and behaviors (Oskam, 2005).

Evidence of cognitive theory can be seen in the results of the data from this study. The data and results of the study indicate that the participants experienced reduced fear- and anxiety-related symptoms after treatment with TR-VRET and VRET. Cognitive theory would explain the decrease in fear and anxiety symptoms by positing that these participants, through the courses of treatment, were able to change their cognitive distortions and irrational thinking as it applies to FOF, resulting in their symptoms decreasing.

The next theory used to evaluate the results was EPT. This theory states that fear is represented by cognitive fear structures that contain information about a feared stimulus, the type of fear response, and the meaning behind the fear structures (Kaczkurkin & Foa, 2015). This can, in turn, lead to pathological behaviors when the fear response does not match reality (Kaczkurkin & Foa, 2015). VRET activates the pathological fear structure and provides new information that works to disconfirm the pathological and unrealistic associations within these structures (Kaczkurkin & Foa, 2015). Furthermore, through habituation, the fear structures are systematically broken down, which can be done using VRET. This process of systematically breaking down fear structures consists of exposing a person to their fear- or anxiety-inducing stimulus until the fear or anxiety starts to decrease on its own (Kaczkurkin & Foa, 2015).

The results of the study can be explained from the perspective of EPT. First, the participants' fear structures were activated through the fear and anxiety they experienced during the TR-VRET and VRET treatments. Then, through the treatments, participants were provided with new information to disconfirm their pathological and unrealistic associations with these structures. The participants were then repeatedly exposed to these fear- and anxiety-producing stimuli and, through habituation, these fear structures were systematically broken down. This breakdown in the fear structures then led to a decrease in fear and anxiety related to FOF. This decrease in fear and anxiety is evident from the results of the study, which showed that participants experienced a decrease in their fear- and anxiety-related symptoms at the end of both the TR-VRET and VRET treatments.

The last theory used to evaluate the results was the theory of behaviorism. Behaviorism is a learning theory that specifically concentrates on objectively observable behaviors (Watson, 2017). The theory of behaviorism posits that learning relates to the acquisition of behaviors and is the result of environmental conditions (Watson, 2017). Behaviorism focuses on conditioning as a universal learning process (Skinner, 2011; Watson, 2017). The two types of conditioning are classic conditioning and behavioral (operant) conditioning (Skinner, 2011; Watson, 2017).

The results of this study can also be explained from the perspective of the theory of behaviorism. First, TR-VRET and VRET were used to expose participants to a new and controlled set of environmental conditions through SD, which in turn, altered the individuals' objectively observable behaviors (see Boundless, 2016). During treatment, these participants displayed behaviors (i.e., fear and anxiety), in response to the FOF stimuli in their environment. These behaviors were then shaped through positive reinforcement during treatment. This positive reinforcement consisted of kind and encouraging words and a show of approval from the therapist to the participant after the desired behavior was demonstrated. This, in turn, helped to facilitate a change in behavior (i.e., decrease in fear and anxiety). These changes in behavior are evident in the results of the study, which shows a decrease in fear and anxiety.

Limitations of the Study

Several limitations were associated with this study. One limitation was related to the randomized control group, pretest-posttest design used for this study. The two main issues associated with this design relate to both internal validity issues and external

validity issues. Internal validity issues included maturation and history (Nestor & Schutt, 2014). The single external validity issue noted is the interaction of pretest questions and treatment because a participant can be influenced by one of the questions within the pretest (Nestor & Schutt, 2014).

The limitations associated with threats to internal and external validity were addressed by taking appropriate measures during the study. Maturation and history were not likely to have been a factor during this study because of its short length; however, they could not be ruled out completely, which is why I took steps to address them. To guard against these threats, each of the participants were screened for any changes that occurred in their lives relating to maturation and history effects. Any significant changes would have been noted in the study, but none were found.

The only noted threat to external validity was related to the randomized controlgroup, pretest-posttest design because of the interaction of pretest questions and treatment in the event a participant is influenced by one of the questions within the pretest (see Nestor & Schutt, 2014). I minimized this threat during the study by using empirically supported scientific instruments to measure the dependent variables. The FAS was the scientific instrument used to measure anxiety associated with FOF, and the FFI was the scientific instrument used to measure the fear associated with the FOF.

Another potential limitation during this study was response bias. This occurs when participants consciously or subconsciously provide a response on a self-report questionnaire that they believe the researcher wants (Monette et al., 2013). This can also happen if participants believe they know the intent of the study or what the study expects

to find (Monette et al., 2013). To minimize and guard against response bias in this study, I took several measures, including restricting information to participants about the purpose of the study and potential outcomes and by using empirically supported scientific instruments within the study, such as the FAS and FFI.

The generalizability of the study results is potentially limited from a cultural perspective. Although I recruited participants from a geographic region with a large population pool, the final study participants were not a diverse group. Most of the participants were White, with only a few participants who were not. This lack of diversity means the study results would likely need to be validated from a cultural perspective before they could be confidently applied to other cultures.

Recommendations

Several recommendations can be made from the results of this study. First, further research evaluating the use and effectiveness of TR-VRET should be conducted. This is especially important because this study is the first known study that evaluated the use of TR-VRET for treating FOF or any other phobia. Further research evaluating the efficacy of TR-VRET being applied in other ways would help to expand the understanding of the overall efficacy of TR-VRET. Second, another recommendation would be to expand the size of the study population to include participants with a larger variety of demographic characteristics and from different demographic areas. A third recommendation is to replicate this study using participants with more diverse cultural backgrounds to increase the potential generalizability of the results to other cultures. By expanding the population to include a larger geographic area, a larger variety of demographics, and to be more

culturally inclusive, would help to increase the generalizability of the study results beyond just a mostly Midwest White population. Fourth, future studies could include qualitative methods to better understand the experience of the participants who are treated with TR-VRET.

Implications

The main aim of this study was to determine if TR-VRET was at least as efficacious as VRET for treating FOF. The study results indicated that TR-VRET was at least as efficacious as VRET for treating FOF. As previously noted, VRET treatments can be expensive, have limited variability in environments, are not personalized, and the equipment and software can be very expensive. By showing that TR-VRET is just as efficacious as VRET allows practitioners to access a cheaper and more adaptive tool to treat their clients who suffer with FOF.

What this all means is that practitioners can potentially purchase their own 360-degree camera, and create their own realistic virtual environments associated with flying. These environments and the stimuli can then be tailored to best fit the needs of clients. These self-created environments are a low-cost approach that can then be effectively used to treat clients who suffer with FOF. Finally, the practitioner would have the tools to create other environments if future research shows TR-VRET is efficacious in being used in other ways.

Positive Social Change

The use of technology and its integration into all aspects of peoples lives has been a driving force for social change in general for many years (Servaes, 2014). The results of

this study could potentially help to integrate technology into psychology and psychological practices in a way never done before. This is because current VRET treatments use technology that is decades old (North et al., 1997) and does not currently take wide advantage of modern-day technological advances, as prescribed by this study.

This study could contribute to social change by more effectively allowing people to overcome their fears to become better and more productive versions of themselves. This would be done, in part, by decreasing anxiety, improving functionality, and mitigating or eliminating the symptoms of the various phobias. This, in turn, would increase a person's overall quality of life.

Conclusion

To conclude, the results of the study allowed for three conclusions to be drawn. First, both the active treatment experimental group (TR-VRET) and the active treatment control group (VRET) were shown to have a significantly reduced anxiety related to flying, through the pretest/posttest data provided by the FAS. Second, both the active treatment experimental group (TR-VRET) and the active treatment control group (VRET) were shown to have a significantly reduced fear related to flying, through the pretest/posttest data provided by the FFI. Third, there was no significant effect found between the efficacy of the active treatment experimental group (TR-VRET) and the active treatment control group (VRET). This indicates that TR-VRET and VRET are equally effective in reducing both anxiety and fear when treating FOF. More importantly, the results of the study highlight the potential for practitioners to have access to an equally effective and more cost-effective tool for treating FOF.

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