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Evaluating The Utility Of A Virtual Environment For Childhood Social Anxiety Disorder

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EVALUATING THE UTILITY OF A VIRTUAL ENVIRONMENT FOR CHILDHOOD SOCIAL ANXIETY DISORDER

by

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ABSTRACT

Objective: Two significant challenges for the dissemination of social skills training programs are (a) the need to provide sufficient practice opportunities to assure skill consolidation and (b) the need to assure skill generalization (i.e., use of the skills outside the clinic setting). In the case of social anxiety disorder, virtual environments may provide one strategy to address these issues. This investigation describes the development of an interactive skills-oriented virtual school environment and evaluated its utility for the treatment of social anxiety disorder in preadolescent children (Study 1). This environment included both in-clinic and at-home solutions. In addition, a pilot replication/extension study further examined preliminary treatment efficacy between children who received a standard multi-component treatment and children who received the modified treatment with social skills practice in a virtual environment (Study 2).

Method: Eleven children with a primary diagnosis of social anxiety disorder between 7 to 12 years old participated in the initial feasibility trial (Study 1). Five additional children participated in the replication/extension study (Study 2). To investigate preliminary treatment efficacy, clinical outcome measures for the Study 2 sample were compared to a comparison sample who received the standard treatment.

Results: Overall, the virtual environment program was viewed as acceptable, feasible, and credible treatment components to children, parents, and clinicians alike but modifications would likely improve the current version. Additionally, although preliminary, children who received the modified treatment with virtual environment practice demonstrated significant improvement at post-treatment on clinician ratings but not parent or self-reported measures.

Conclusion: Virtual environments are feasible, acceptable, and credible treatment components for clinical use. Future investigations will determine if the addition of this dose-controlled and

intensive social skills practice results in treatment outcome equivalent to traditional cognitive-behavioral programs.

This manuscript is dedicated to my mentor and my family and friends.

"So I say to you, keep asking, and it will be given to you. Keep searching and you will find. Keep knocking, and the door will be opened to you. For everyone who asks receives, and the one who searches finds, and to the one who knocks, the door will be opened."

Luke 11: 9-10

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LIST OF ACRONYMS/ABBREVIATIONS

ADIS-C/P	Anxiety Disorders Interview Schedule for Children/Parents
ADHD	Attention-Deficit/Hyperactivity
APA	American Psychological Association
CBT	Cognitive Behavior Therapy
C-GAS	Children's Global Assessment Scale
CGI	Clinical Global Impressions Scale
DSM-IV	Diagnostic and Statistical Manual of Mental Disorders – 4th edition
IRB	Institutional Review Board
SAD	Social Anxiety Disorder
SET-C	Social Effectiveness Therapy for Children
SPAI-C/PV	Social Phobia and Anxiety Inventory for Children/Parent version
UCF	University of Central Florida
VBI	Virtually Better Inc.

CHAPTER ONE: INTRODUCTION

The development and application of virtual environments has flourished since the introduction of computer-generated graphics in the early 1960s. Although clinical psychology has only recently taken advantage of such technology (Glantz, Rizzo, & Graap, 2003; Wiederhold & Wiederhold, 2005), the utilization of virtual reality and computer-based therapies has rapidly increased over the past decade and are increasingly more popular (Norcross, Hedges, & Prochaska, 2002). Several qualitative literature reviews (i.e., Anderson, Jacobs, & Rothbaum, 2004; Bush, 2008; Coelho, Waters, Hine, & Wallis, 2009; Gerardi, Cukor, Difede, Rizzo, & Rothbaum, 2010; Krijn, Emmelkamp, Ólafsson, & Biemond, 2004; Meyerbröker & Emmelkamp, 2010; Pull, 2005; Rothbaum & Hodges, 1999) and recent meta-analytic studies (Parsons & Rizzo, 2008; Powers & Emmelkamp, 2008) on the application of virtual environments to treat anxiety disorders conclude promising clinical outcomes based on case, comparative, and randomized controlled studies.

CHAPTER TWO: LITERATURE REVIEW

Exposure therapy remains the empirically-supported treatment of choice for anxiety disorders (Barlow, 2002; Chambless & Ollendick, 2001; Deacon & Abramowitz, 2004). An ongoing challenge for behavior therapists is the need to accurately reproduce the feared environment, situation or event in order to access the underlying fear network (Lang, 1968). Virtual environments provide clinicians with an important tool by allowing the presentation of situational cues not easily reproduced either through imagination (imaginal exposure) or in real life (in vivo exposure). In particular, a large majority of studies on the application of virtual environments for the treatment of anxiety disorders focus on the treatment of specific phobias using powerful physical cues (e.g., distance cues for people with acrophobia, or strong vibrations and loud noises for people with aviophobia). For therapists treating individuals with social anxiety disorder, virtual environments provide a promising alternative to in vivo exposure.

Unlike real humans, the behavior of virtual humans can be completely controlled by a therapist, thus allowing maximum control over the elements of the exposure scenarios. Specifically, people with social anxiety disorder (SAD) are characterized by a pattern of excessive fear of social situations or performances in which an individual may be scrutinized by others (APA, 2000), with the fear that others will find their behavior or performance to be sub-standard in some manner. Common distressful situations include formal public speaking, informal speaking during meetings or class, and meeting new people (Ruscio et al., 2008; Turner, Beidel, & Townsley, 1992). A significant barrier to the optimal treatment of SAD lies in the difficulty of re-creating in vivo exposure sessions that uniquely match the fear of the individual (Olfson et al., 2000). For example, someone with SAD is not simply afraid that she will forget her speech. She may fear that she will forget her speech and the audience will laugh at

her, get up and walk away or fall asleep, which becomes a humiliating situation. For exposure to be effective, all elements of the fear must be addressed in the exposure scenario. Exposure sessions that only partially re-create the patient's fear may result in partial improvement. Thus, virtual environments, with their ability to control and better re-create the environment represent a promising strategy for exposure therapy for SAD (Klinger et al., 2003; Klinger et al., 2005; Roy et al., 2003).

Indeed, existing virtual environments for SAD primarily target exposure to specific situations such as public speaking. Virtual environments appear capable of eliciting physiological and subjective distress among clinical (Anderson et al., 2003; Anderson et al., 2005; North et al., 1998) and nonclinical samples (Harris, Kemmerling, & North, 2002; Kotlyar et al., 2008; Lister, Piercey, & Joordens, 2010; Pertaub, Slater, & Barker, 2002; Slater, Pertaub, Barker, & Clark, 2006; Wallach, Safir, & Bar-Zvi, 2009) with high levels of public speaking fears. A number of small studies further suggest treatment efficacy in decreasing anxiety and public speaking fears among individuals with non-generalized social phobia (Anderson, Rothbaum, & Hodge, 2003; Anderson, Zimand, Hodges, & Rothbaum, 2005; North, North, & Coble, 1998). Thus, the potential of virtual environments as a tool to enhance exposure therapy for the treatment of SAD has been established.

Although still controversial, there are accumulating data that exposure therapy alone does not produce the optimal outcome for youth with SAD. Existing data suggest that children and adolescents exhibit social skills deficits (Beidel et al., 1999; Spence, Donovan, & Brechman-Toussaint, 1999; Rao et al., 2007) and extant treatment outcome studies indicate that social skills training added to exposure therapy produces the optimal treatment outcome (Albano, Marten, Holt, Heimberg, & Barlow, 1995; Beidel et al., 2007; Beidel, Turner, & Morris, 2000; Beidel,

Turner, & Young, 2006; Herbert et al., 2005; Masia-Warner et al., 2005; Spence, Donovan, & Brechman-Toussaint, 2000). Indeed, although various forms of cognitive behavioral therapy (CBT) exist (e.g., Kendall et al., 2005), treatments that do not include social skills training appear to be less effective for children with SAD than for children with other anxiety disorders (Crawley, Beidas, Benjamin, Martin, & Kendall, 2008).

One empirically supported multicomponent treatment for youth with SAD, Social Effectiveness Therapy for Children (Beidel et al., 2007; Beidel et al., 2000; Beidel et al., 2006), combines exposure therapy, social skills training, peer generalization strategies, and homework practice as a unique evidence-based psychosocial treatment (Silverman, Pina, Viswesvaran, 2008). Social Effectiveness Therapy for Children (SET-C) has been demonstrated to be more efficacious than a psychological placebo, a pill placebo, or fluoxetine (Baer & Garland, 2005; Beidel et al., 2007; Beidel et al., 2000; Beidel et al., 2006; Masia-Warner et al., 2005), and effects are maintained even five years after treatment (Beidel et al., 2006). SET-C is considered a "probably efficacious treatment" (Silverman et al., 2008) and no intervention for childhood SAD has a higher ranking to date.

Unfortunately, despite overall efficacy, social skills training paradigms typically face two challenges. First, skill consolidation depends on practice between treatment sessions. Typically known as homework, these assignments are designed to enhance skill generalization, and often require parents to actively organize and supervise the activity. Homework is considered crucial to successful treatment outcome for many child interventions (Nock & Kazdin, 2005), and nearly every CBT intervention for children, including Social Effectiveness Therapy for Children, requires parental compliance with the treatment plan. However, it is a challenge because parents often do not expect to be active participants in their child's treatment (Nock & Ferriter, 2005).

Homework non-compliance is detrimental to treatment– resulting in poor outcome, sampling bias, reduced statistical power, and limited generalizability (Kazdin & Weisz, 2003; Nock & Kazdin, 2005).

The second challenge is skill generalization. Most social skills training programs fail because there are few attempts to specifically ensure that children use their skills outside of the clinic setting. Although SET-C has addressed the issue by including formal peer-generalization sessions as part of the overall treatment program, few traditional outpatient clinics have sufficient personnel and financial resources to implement this important treatment element. Specifically, the SET-C peer generalization sessions are estimated to cost 152 "person hours" and $2000 in expenses per 12 week program. Time and cost intensive efforts include identifying age-appropriate activities, recruiting/screening and coordinating friendly peers to assist in the skills generalization, paying for the group activity, and coordinating/paying clinical personnel to supervise the event. In addition, parent involvement (e.g., transportation) is required as parents must transport their child to/from the community-based peer generalization activities.

In summary, there are two challenges that limit the dissemination of social skills training treatments such as SET-C: (1) peer generalization strategies that incur extensive time and financial expense, and (2) homework non-compliance because of dependency upon parental involvement. The challenge lies in modifying these two efficacious behavioral elements to optimize the dissemination of skills based treatments. Virtual environments, with their ability to present an unlimited number of virtual characters to enhance generalization beyond the typical clinic setting and reside on a standard PC to allow practice by the child without the need for parental support could be an optimal solution. We partnered with Virtually Better, Inc. (VBI) to develop an interactive school-based virtual environment to optimize the dissemination of Social

Effectiveness Therapy for Children. If the virtual environment is feasible, credible and acceptable, the program may provide clinical researchers with a tool to offer children daily social skills practice without formal peer group activities or intensive parental involvement.

CHAPTER THREE: RESEARCH OVERVIEW

The successful application of any technology as a tool to enhance evidence-based treatments is directly related to the ability of families and clinicians to use the tool easily and effectively. Therefore, in addition to the actual development of the virtual environment, we evaluated the feasibility, acceptability and credibility of a new virtual environment program when integrated into SET-C for childhood social anxiety disorder. The goal of Study 1 was to develop an appropriate environment for use by clinicians and families and evaluate it for the purpose of integration into an ongoing behavioral treatment program (i.e., program development and technical improvement). In addition, we evaluated the initial utility of the virtual environment as a tool for social skills generalization and homework practice. We predicted that children, parents and clinicians will be satisfied using the virtual environment and endorse it as a high quality program. We also expected users to provide feedback on usability and technical improvements to the virtual environment. The specific findings and feedback from Study 1were incorporated into technical and/or program revisions for Study 2. In addition to replication after technological revisions, Study 2 examined preliminary treatment efficacy by comparing treatment outcome measures between children who received social skills practice using the virtual environment and a comparison sample of children who received traditional Social Effectiveness Therapy for Children.

CHAPTER FOUR: STUDY 1

Study 1: Development and Initial Feasibility Trial

Development of the Environment

A school setting was selected for initial development because it is an environment familiar to children and one where children with SAD report that 60% of distressful social events occur (Beidel, Neal, & Lederer, 1991). This virtual environment was built on a Windows-based platform by graphic artists and computer programmers at VBI. The environment was designed to provide practice interactions with people who differed in age, sex, race/ethnicity (i.e., teacher, principal, classmate, or bully) and in several typical school settings (i.e., classroom, hallway, and gymnasium) while minimizing the need for formal peer group activities in the clinic or intensive parental involvement at home. Each of the characters and settings were modeled after descriptions and visual images selected to reflect the diversity found in real-life people and represent typical school locations. VBI recruited non-anxious children and adults to volunteer as models during the development phase to act out each of the characters' nonverbal behaviors and to audio-record their voices for each of the characters' verbal responses.

The program targeted four areas of social skill: greetings and initiating conversations, maintaining conversations through asking questions, giving and receiving compliments, and assertiveness. Each area had three skill levels (beginner, intermediate, advanced), such that the therapist could vary the level of interactional difficulty to allow further skill generalization. These four skills are taught and practiced across different virtual characters (e.g., principal, classroom teacher, gym teacher, popular classmate, smart classmate, school bully). For each character (See Appendix B: Screen capture of avatar characters in the virtual environment), we constructed 31 different responses for each of the four skills at each of the three skill difficulty

levels (totaling 744 unique dialogue responses). These responses may be used in any combination, during any given interaction, for any given period of time, and allow for virtually unlimited dialogue. Thus, the environment allows for children to engage in social situations with multiple characters, across multiple contexts (i.e., classroom, gymnasium, and hallway), while the digital images varied in a controlled environment with preprogrammed verbal and non-verbal responses selected by the therapist.

In-clinic skills practice.

In the clinic (known as the in-clinic component), the therapist sits behind a two way mirror and uses a Wizard of Oz interface to control the interactions. The child is seated in the adjacent room and responds to the virtual characters displayed on a computer monitor. In the clinic, the interactions are driven by the therapist and can be as brief or extended as necessary/desired (See Appendix C: Sample interactions in the virtual environment during in-clinic social skills practice). The therapist has the flexibility to individually tailor the interactions to the child's current skill level by controlling the length, pace, and level of difficulty. With three levels of increasing social demands, the in-clinic practice challenges the child with increasingly difficult social scenarios using a hierarchal schema similar to the mastery of different levels in video games. In this paradigm, the therapist provides practice with a variety of interpersonal partners, uses a dose-controlled strategy to control the pace of the practice, and assures acquisition of basic skills before proceeding to more advanced and challenging interactions.

At-home skills practice.

At home, the child practices on an abridged version of the in-clinic skills practice that allows the child to engage in brief but repeated interactions with the characters (known as the at-home component). The program allows the therapist to use the different difficulty levels to

design practice sessions that are unique to the needs of each child participating in the program. Homework was downloaded onto a USB drive and children were instructed to practice the homework assignment three times per week.

Study 1 Method

Procedure.

Recruitment.

This project was approved by the Institutional Review Board prior to the onset of data collection (See Appendix A: IRB Approval). Participants were recruited from a university-based psychology clinic. Twenty-seven parents expressed interest by phone and completed a brief telephone screen to determine if their child met eligibility criteria. Five children were screened out for other primary Axis I diagnoses (3 children with probable Autism and 2 children with probable Attention-Deficit/Hyperactivity Disorder) and were provided with a community clinic referral. Twenty-two children between the ages of 8 and 12 screened positive for SAD and were invited to participate in the full assessment. Three parents declined to participate in the full assessment because they were not ready to engage in treatment due to family time commitments, and three additional children were excluded because of other primary Axis I disorders, thus resulting in 16 families who were allocated to receive the treatment intervention.

Inclusion criteria.

All participants were administered the Anxiety Disorders Interview Schedule for Children/Parents (ADIS-C/P; Silverman & Albano, 1996) by an advanced doctoral student in clinical psychology. The ADIS-C/P is a semi-structured diagnostic interview that assesses anxiety disorders and other DSM-IV diagnoses. Diagnoses were based on information gathered

from both parental and child interviews. All interviews were videotaped and rated by a second clinician to determine inter-rater reliability.

Exclusion criteria.

Youth with primary diagnosis of ADHD, autism, bipolar disorder, conduct disorder, severe depression, psychotic disorders, or presented with suicidal ideation were excluded from the study. After the full assessment, two children were excluded from the study due to other primary Axis I diagnoses and provided with referrals to a community clinic.

Participant characteristics.

Sixteen children with a primary diagnosis of SAD and their parents provided informed consent/assent, completed the pre-treatment assessment, and were given treatment appointments (See Figure 1). Of those children, eleven began the virtual environment assisted treatment protocol in Study 1. Thus, the final sample in Study 1 consisted of 11 children (five males and six females) ranging from 8 to 12 years of age *(M* = 9.18, *SD* = 1.25*).* Four children also met diagnostic criteria for other Axis I disorders including Asperger's Disorder (*n* = 2), Separation Anxiety Disorder (*n* = 1), and Dysthymic Disorder with oppositional defiant features (*n* = 1). Parents identified their child's ethnicity as Caucasian (*n* = 6) or Hispanic (*n* = 5). Parents were married (*n* = 9), single *(n* = 1), or widowed (*n* = 1). Parents reported annual incomes between $13,200 and $100,000 *(M* = $59,150, *SD* = $26, 279.98). Although three children discontinued treatment within the first two weeks because of family illness (*n* = 1) and parent schedule conflicts (*n* = 2), the feasibility data presented in Study 1 will be based on all eleven children unless otherwise indicated for treatment completers (*n* = 8). The remaining 5 children were allocated to the intervention in Study 2. Allocation to Study 2 was based on chronological order of recruitment (Study 2 participant characteristics detailed below).

Treatment Description.

Social Effectiveness Therapy for Children (SET-C).

SET-C is a 12 week treatment program and consists of group social skills training, peer generalization, individual exposure therapy, and homework practice. The social skills training includes basic conversation skills, empathic listening skills, friendship and conflict resolution skills, and assertiveness training. Immediately following social skills training are therapist supervised peer generalization sessions designed to promote skill generalization. Children apply their newly acquired social skills by practicing at typical and developmentally appropriate social activities (i.e., bowling, miniature golf, picnics, or games at pizza parlors) with friendly peers recruited specifically for this program.

Modified Treatment with the Virtual Environment.

In this initial feasibility study, we evaluated whether the virtual environment would be a feasible, acceptable, and credible tool when integrated into the social skills peer generalization and homework practice components of Social Effectiveness Therapy. Specifically, we replaced the live peer generalization sessions with in-clinic skills practice on the virtual environment (See Table 1). Thus, after each weekly group social skills training (thirty to forty minutes) using traditional social skills procedures (e.g., instruction, modeling, behavior rehearsal, and feedback techniques), the child engaged in therapist-directed skills generalization practice in the clinic using the virtual environment (thirty to forty minutes). The individual exposure therapy component was not provided in Study 1. All sessions were videotaped and reviewed to monitor treatment fidelity and to identify potential problems with treatment implementation.

In addition, each child was instructed to practice the skill using the at-home virtual environment component three times per week for 30 minutes. The child installed the homework assignment software from a low-cost HIPAA compliant thumb drive and practiced independently

at home. Although parental support was not necessary, both children and their parents were provided with a ten minute training session in how to use the at-home software during the first generalization session. Webcam technology recordings and homework tracking sheets were used to monitor homework compliance and assess any user or software problems during skills practice at home. The children's verbal and non-verbal reactions to the virtual interactions were saved and encrypted to a secure HIPAA-compliant USB thumb drive provided by the project. Children returned the drive to the clinician weekly so that homework completion and software problems could be reviewed.

Measures.

Treatment feasibility was defined as the ability to access and use the program successfully, assessed by frequency counts of access to technology (e.g., the number of families accepted into the study without internet, computers, or webcams) and the frequency of technical difficulties (e.g., number of patient calls made to our clinic requesting help to operate the at-home version, and number of clinician phone calls made to Virtually Better, Inc. regarding technical issues).

Children rated the usability and quality of the virtual environment software at the end of every clinic session using a rating scale with specific anchors: 0 = *poor*, 1 = *fair*, 2 = *good*, 3 = *very good*, and 4 = *excellent*. At the last session, children also rated how likely they were to recommend the in-clinic virtual environment program to other children.

Treatment adherence to the at-home component was defined as compliance with homework assignments, and measured by the percentage of homework assignments completed using the at-home software. Descriptive statistics for the frequency of homework practice and time spent engaging in virtual homework practice were calculated.

Treatment credibility was measured at week three by children using standardized Likert rating scales (Borkovec & Nau, 1972) to rate whether the overall treatment program appears logical, whether they were confident in the treatment, and their confidence in recommending the treatment to others.

Parental satisfaction with the overall treatment program was rated with the Charleston Outpatient Satisfaction Questionnaire (Pellegrin, Stuart, Maree, Frueh, & Ballenger, 2001). This questionnaire was developed originally for VA outpatient clinics and thus, a number of items were not relevant for this study. Therefore, we selected a subset of relevant items (item 6 = matching of treatment plan to your individual needs, and item 8 = overall quality of care provided) rated on a Likert scale with specific anchors: 1 = *poor*, 2 = *fair*, 3 = *good*, 4 = *very good*, and 5 = *excellent*. Parents were also asked whether or not they would recommend this clinic to a friend or family member (item 16).

In addition, all clinicians rated their overall satisfaction with the clinic based virtual environment after each session on a scale from 1 = *not at all satisfied* to 10 = *very satisfied*, and the mean/standard deviations for clinician satisfaction rating scores were calculated. Finally, additional qualitative user feedback and suggestions were provided to the development team to be incorporated into future software revisions throughout the development phase.

Results

Given the nature of this investigation, data regarding treatment feasibility, acceptability, credibility, and quality of the virtual environments consisted of frequency counts, percentages, and mean ratings of study measures.

Feasibility of virtual environment use by non-technical specialists.

Regarding the therapist driven in-clinic virtual environment, there were six telephone calls by the author to VBI for technical support during initial equipment set-up prior to launching

the treatment study. The author trained two additional clinicians on program use. Both clinicians were trained to criterion in 10 hours each. No additional phone calls to VBI for technical support occurred once the project was underway.

Of the 11 children admitted to the feasibility study, ten (90.9%) had access to either desktop computers or laptops for homework practice. In the case of one child who did not have computer access, the program loaned a laptop to that family. Four parents (36%) called the clinic to request technical support regarding the homework program installation. In two of the cases, the family's personal computer specifications did not have an advanced graphics card to meet the hardware requirements and problems were resolved after the children borrowed project laptops. Thus, 27.2% of the participants borrowed laptops in order to participate in the program. The two other parental requests for technical support were resolved by the therapist over the telephone in less than 10 minutes (e.g., assisted parents in program installation and changing security settings).

Acceptability of the virtual environment (in-clinic).

Eight children completed the treatment program (73%). These children evaluated the quality of the in-clinic virtual practice at the end of each treatment session. On average, across all weeks of treatment, children rated the overall quality of the virtual environment program as *very good* to *excellent* ($M = 3.36$, $SD = 0.57$). Children generally rated talking to the virtual characters as *very good* ($M = 3.18$, $SD = 0.97$). All other aspects of the in-clinic virtual practice were rated as *good* to *excellent* (See Table 2). At the final treatment session, 75% of the children indicated they would definitely recommend the in-clinic virtual environment program to others.

Acceptability/Compliance (at-home).

Among the treatment completers, there were a total of 288 homework sessions. Only one child requested parental help with homework on one occasion (0.3% of all sessions), indicating

that the program was easily used. Homework compliance was less than optimal. Although children were instructed to complete homework 3 days per week, the mean number of completed homework was 2.01 days per week (*SD* = 0.73; *range* = 0.89 to 2.75). The average amount of time spent completing weekly homework was 35.42 minutes per week (*SD* = 18.56, *range* = 11.53 to 65.75). One child skipped one entire week of homework practice, and one child skipped two entire weeks of virtual homework practice (3.12% of all sessions).

Although the webcamera was initially proposed to monitor homework compliance and social skills acquisition, several technical difficulties emerged regarding its implementation (i.e., the audio/video data captured on the USB exceeded the USB drive capacity, some of the audio/visual data captured were not audible/viewable, the audio sounds and visual images were not synced during review of recordings, and the use of external webcams crashed/lagged some personal computers). In addition, clinician review of the homework practice required 30 minutes, which created significant wait time on the part of the family prior to session initiation.

Treatment credibility.

Ratings of treatment credibility were high. All children (100%) rated the virtual environment augmented treatment as logical in decreasing anxious distress, and 88% believed that the treatment would specifically help them become less anxious. The majority of children (75%) also reported this treatment as helping them improve other areas of their functioning such as getting along with parents, and 75% reported they would recommend this treatment to a friend who is anxious. Furthermore, parents rated the quality of care as *very good* to *excellent* (*M* = 4.75, *SD* = 0.46) and endorsed the treatment as *very good* to *excellent* with respect to matching the treatment plan to their child's needs (*M* = 4.75, *SD* = 0.46). Finally, 87.5% of parents rated that they would "definitely recommend" this clinic and 12.5% of parents would "probably

recommend" this clinic to a friend or family member. Overall, clinicians were also highly satisfied with using the in-clinic virtual practice (M = 7.09, SD = 2.39).

Discussion

This first study investigated the initial feasibility, acceptability and creditability of a computer-based virtual environment program as a viable component for the treatment of social anxiety disorder in children. Results suggest that incorporating virtual environments as part of social skills training is feasible for young children and their parents as well as clinicians. Although only one child did not have access to a computer at intake, we discovered that two other children did not have advanced graphics cards to run the program. This does suggest some challenges to accessibility, in that a certain percentage of the population might not have computers with the capability to run the virtual environment and many traditional clinics might not have the resources to loan laptops to patients.

A second important element of treatment development is acceptability. The 17.6% dropout rate for this initial study was similar to other social skills based treatment outcome studies that did not use virtual environments (Beidel et al., 2000; Beidel, et al. 2007; Fedoroff & Taylor, 2001). In each case, parents indicated that their decision to leave the program was due to inability to adhere to time constraints regarding weekly treatment, not to any concerns about the virtual environment components specifically. Thus, it appears that VE treatment is accepted by children and their parents.

Third, initial assessment of treatment credibility indicated that the use of virtual environments is considered appropriate for the treatment of childhood social anxiety disorder. Children evaluated the in-clinic virtual environment to be of high quality and useful for the acquisition of social skills. Of all the children who completed the treatment, most believed that the treatment would help them become less anxious. In fact, both children and parents were

satisfied with the overall treatment and indicated that they would recommend it to family and friends. Clinicians were also highly satisfied with using this technology to help children practice their social skills in the clinic.

Finally, homework compliance measures indicated that approximately 66% of assigned tasks were completed. Thus, homework compliance was substantial and comparable to previous literature on homework compliance rates for children with anxiety disorders (Hughes & Kendall, 2007), although there is still room for improvement. Several limitations to the initial homework modules were identified that required technical revision. Additionally, informal feedback from the children indicated that the homework was "boring." These suggestions for technical improvement were provided to the development team and incorporated into software revisions for Study 2.

CHAPTER FIVE: STUDY 2

Study 2: Replication and Extension Trial

Study 2 replicated the initial trial and evaluated the revised virtual environment. In addition to replication, Study 2 extended the scope by examining preliminary treatment efficacy. We predicted that children who received social skills practice using the virtual environment would improve on clinical measures from pre-to post-treatment. In addition, the means and standard deviations on several clinical measures were presented for initial comparison between Study 2 children (those who received social skills practice using the virtual environment) and a comparison sample from Beidel et al., 2007 (those who received SET-C). Given the low sample size, nonparametric tests were used to compare group means.

Revisions to the Virtual Environment

As with most technological advances, the development process follows an iterative process and program improvement and alteration is expected. Thus, revisions were made to the virtual environment program based on technical findings and user feedback. In particular, the homework module was revised to add a game-like quality to the assignment, including a narrated storyline and a "badges" reinforcement system to increase homework compliance. Children earn virtual badges after completing their homework, which they turn in at the next clinic appointment for real foil badges, which they could collect in a booklet. An additional character (female teacher) was added to increase the number of possible interactions, and additional narrator instructions were added to increase ease of use. The length of homework practice was reduced by removing redundant interactions. Finally, the webcam audio/video capture initially proposed to monitor homework compliance and social skills acquisition was eliminated in Study

2 because it was difficult to implement and not practical for clinicians to review all audio/video recordings.

Study 2 Method

Procedure.

The procedure including recruitment, inclusion, and exclusion criteria was identical to Study 1.

Participant characteristics.

Description of Sample.

Five children with a primary diagnosis of SAD and their parents provided informed consent/assent, completed the pre-treatment assessment, and completed the intervention using version two of the virtual environment (See Figure 1). The sample consisted of 1 female and 4 males ranging from 7 to 10 years of age (M = 8.6, SD = 1.14). Three children also met diagnostic criteria for other Axis I disorders including ADHD (n =1), Separation Anxiety Disorder (n = 1), Obsessive Compulsive Disorder and Dysthymic Disorder (n = 1). Parents identified their child's ethnicity as Hispanic (n = 2) or Caucasian (n = 3). Parents were married (n = 2) or divorced (n = 3). Parents reported annual incomes between $18,000 and $200,000 ($M$ = 69,000, SD = 75,921). One child discontinued treatment after week 5 because the parent wanted treatment for ODD and aggressive behaviors. Thus, the feasibility data presented will be based on all five children unless otherwise indicated for treatment completers (n = 4).

Description of Comparison Sample.

To examine initial treatment efficacy, five children with a primary diagnosis of SAD who received traditional SET-C were selected from a previous study (Beidel et al., 2007) and matched by age (± 1 year) and gender. The comparison sample consisted of 1 female and 4 males ranging from 8 to 10 years of age (M = 8.80, SD = 0.84). One child also met diagnostic criteria for other

Axis I disorders including Separation Anxiety Disorder and Generalized Anxiety Disorder (*n* = 1). Parents either identified their child's ethnicity as Caucasian (*n* = 4) or other (*n* = 1*)*.

Treatment Description and Revision.

The treatment provided in Study 2 was nearly identical to Study 1 whereby the virtual environment social skills practice replaced live peer generalization sessions. Each child was asked to practice the skill using the revised at-home virtual environment component, and homework tracking sheets were used to monitor homework compliance. Because the individual in vivo exposure component continues to be a crucial element to the traditional SET-C, children in Study 2 received 30 to 45 minutes each week of individual exposure therapy. This change also makes it possible to compare preliminary treatment efficacy between children who received Study 2 intervention and children who received standard SET-C.

Primary Measures.

All participants in Study 2 received the same ADIS-C/P clinical interview and treatment feasibility, acceptability, and credibility measures administered at Study 1. Additionally, preliminary efficacy measures were administered pre- and post-treatment.

Clinical Assessment Measures.

Self-Report Measure.

Each child completed the *Social Phobia and Anxiety Inventory for Children* (SPAI-C; Beidel, Turner, & Morris, 1995). The SPAI-C is a 26 item self-report questionnaire that assesses severity and range of social fears and avoidance. Each item is rated on a 3-point Likert scale: 0 = *never/hardly ever*, 1 = *sometimes*, 2 = *almost always/always*. The SPAI-C is well established with excellent reliability and validity (Beidel, Turner, & Fink, 1996; Beidel, Turner, & Hamlin, 2000; Beidel et al., 1995) and differentiates children with SP from normal controls (Beidel et al., 1995), externalizing disorders (Beidel, Turner, & Fink, 1996) and other anxiety disorders

(Beidel, Turner, & Hamlin, 2000). Parents completed the corresponding parent version of the SPAI-C.

Clinician Administered Measures.

Doctoral level therapists completed the *Children's Global Assessment Scale* (C-GAS; Shaffer et al., 1983) assessing overall functioning and the *Clinical Global Impressions Scale* (CGI; Guy, 1976) severity, avoidance, and global improvement scales. Treatment responders were youth who no longer met diagnostic criteria at post-treatment based on the ADIS-C/P clinical interview.

Results

Feasibility.

Regarding the in-clinic virtual environment, there were no additional telephone calls to VBI for technical support during Study 2. Of the 5 children admitted to the feasibility study, all (100%) had access to either desktop computers or laptops for homework practice. However, two families had Apple Macintosh computers and were unable to run the Windows based software. Thus, 40% of the participants borrowed laptops in order to participate in the program. One parent (20%) called the clinic to request technical support running the homework program because there were problems that were due to a computer virus. The request for technical support was resolved after the computer virus was removed.

Acceptability of the virtual environment (in-clinic).

Four children completed the treatment program (80%). These children evaluated the quality of the in-clinic virtual practice at the end of each treatment session. On average, across all weeks of treatment, children rated the overall quality of the virtual environment program as *very good* to *excellent* (M = 3.53, SD = 1.47). Children generally rated talking to the virtual characters as *very good* (M = 3.83, SD = 1.00). All other aspects of the in-clinic virtual practice

were rated as *good* to *excellent* (See Table 2). At the final treatment session, 50% of the children indicated they would recommend the in-clinic virtual environment program to others.

Acceptability/Compliance (at-home).

Among the treatment completers, there were a total of 108 homework sessions. No children requested parental help with homework on any session, indicating that the program was easily used. Homework compliance was poor. Although children were instructed to complete homework 3 days per week, the mean number of completed homework was 1.36 days per week (*SD* = 0.79; *range* = 0.56 to 2.44). The average amount of time spent completing weekly homework was 9.57 minutes per week (*SD* = 3.13, *range* = 6.22 to 13.33). Children skipped between one to four entire weeks of homework practice (*M* = 3.00, *SD* = 1.41).

Treatment credibility.

Ratings of treatment credibility were high. The majority of children (75%) rated the virtual environment augmented treatment as logical in decreasing anxious distress, and believed that the treatment would specifically help them become less anxious. The majority of children (75%) also reported this treatment as helping them improve other areas of their functioning such as getting along with parents, and reported they would recommend this treatment to a friend who is anxious. Furthermore, parents rated the quality of care as *excellent* (*M* = 5.00, *SD* = 0.00) and endorsed the treatment as *excellent* with respect to matching the treatment plan to their child's needs (*M* = 5.00, *SD* = 0.00). Finally, 100% of parents rated that they would "definitely recommend" this clinic to a friend or family member. Overall, clinicians were also highly satisfied with using the in-clinic virtual practice (*M* = 8.42, *SD* = 0.25).

Preliminary treatment efficacy.

Pre- to post-treatment outcome.

Wilcoxon Signed Rank tests were used to examine pre- and post-treatment outcome differences among children who practiced social skills in the virtual environment. Significance values were based on one-tailed tests ($p < .10$) to conserve power and because scores were expected to improve after treatment. Results indicate that children who practiced social skills in the virtual environment improved on clinician administered measures. CGI severity scores decreased significantly ($Z = -1.84$, $p = .07$) from pre-treatment ($M = 4.00$, $SD = 0.82$) to post-treatment ($M = 2.00$, $SD = 0.82$). CGI avoidance scores decreased significantly ($Z = -1.84$, $p = .07$) from pre-treatment ($M = 3.75$, $SD = 0.96$) to post-treatment ($M = 1.50$, $SD = 0.58$). CGAS scores increased significantly ($Z = -1.89$, p = .06) from pre-treatment ($M = 6.00$, $SD = 0.00$) to post-treatment ($M = 7.25$, $SD = 0.50$). However, no significant improvement ($Z = -1.34$, $p = ns$) was detected on parent-reported SPAI-C/PV scores ($Z = -.73$, $p = .07$) from pre-treatment ($M = 35.25$, $SD = 11.81$) to post-treatment ($M = 26.22$, $SD = 12.04$), or self-reported SPAI-C scores from pre-treatment ($M = 11.33$, $SD = 17.10$) to post-treatment ($M = 6.22$, $SD = 8.19$). SPAI-C pre-treatment scores were low because two children denied any items and one child did not complete the measure. The two children who did not endorse any pre-treatment SPAI-C items also did not endorse SPAI-C items at post-treatment.

Between group comparison.

Mann-Whitney U tests were used to examine differences on post-treatment clinical measures between groups. Results did not detect any significant between group differences on any post-treatment clinical measures. The means and standard deviations on post-treatment clinical measures were presented for initial comparison between Study 2 children and the

comparison sample (Table 3). Lastly, regarding treatment response rates, 75% of children in Study 2 versus 80% of comparison children no longer met diagnostic criteria at post-treatment.

Discussion

Study 2 replicated the initial feasibility, acceptability, and credibility findings. The in-clinic virtual environment continued to function without additional technical support and children generally rated the environment as very good to excellent. The majority of children in this replication study also believed that the treatment would help them become less anxious. Children and parents similarly endorsed satisfaction with the overall treatment and indicated that they would recommend it to family and friends. Clinicians also continued to be highly satisfied with using this technology.

Regarding the at-home practice, there were no additional technical problems reported related to the virtual environment. However, findings indicated that the technical revisions did not enhance homework compliance. In fact, the changes appeared to decrease homework compliance. Despite revisions designed to decrease redundancy in homework practice and make it less "boring," the result was a decrease in average homework time from approximately 35 minutes to 10 minutes. Additionally, although the homework reinforcement system was changed to potentially enhance homework compliance, children in Study 2 completed fewer assignments overall per week (approximately once a week) and completed fewer weeks of homework relative to children in the initial study. Informal feedback from the children continued to indicate that the homework was boring. One explanation may be that, unlike the interactions driven by the therapist in-clinic, the at-home practice is limited to very brief preprogrammed interactions (e.g., the child initiates the conversation and the avatar responds, or the avatar initiates and the child responds), which may be less reflective of day to day conversations that entail multiple back and forth exchanges. Significant changes in the homework elements (e.g., the use of artificial

intelligence or live therapists responding on the other end) may help enhance the at-home component and increase compliance with homework practice.

Regarding preliminary treatment efficacy, results from nonparametric tests suggest that children who received the modified treatment with virtual environment practice demonstrated significant improvement on clinician-reported clinical measures, but not parent or self-reported measures. These findings should be interpreted with caution given the extremely low sample size, missing data, and low self-reported SPAI-C scores at pre-treatment. In addition, these findings may be limited because clinicians were not blind to the child's treatment condition. On the other hand, the primary purpose of these studies was to evaluate the feasibility of a newly developed virtual environment and use the findings to directly influence its technological development. By being informed about the purpose of the study, clinicians were able to provide invaluable user feedback during the development process on the broad clinical utility of the virtual environment for their patients, as well as suggestions on the finer technical improvements for usability. Thus, it would not be practical for the clinicians to be blinded during these initial feasibility studies. Similarly, parents and children were informed that this was initial feasibility study and they were not randomized or blinded to the modified intervention with virtual environment practice. It is possible that the self-reported data from these families were influenced by the fact that they were aware they did not receive the standard empirically-tested treatment. However, given that their feedback was critical to the development and improvement of the virtual environment, it should be expected that they report problems with the virtual environment.

CHAPTER SIX: CONCLUDING DISCUSSION

This project represents an NIMH STTR Phase 1 trial with specific aims to demonstrate the feasibility, acceptability, and credibility of a new virtual environment protocol. The virtual school environment was developed as a two-part solution to replace the community-based peer generalizations, and provide additional skills practice at home without the need for intensive parental involvement. The initial data indicate good feasibility, acceptability, and credibility by children, parents, and clinicians alike. In addition, although preliminary and for clinician-reported measures only, findings suggest that children who practice social skills in the virtual environment improve from pre- to post-treatment.

Other findings were also quite positive. Initially, 8 hours of face-to-face training and 4 hours of follow-up telephone consultation with the program designer was all that was necessary for the clinician to become proficient at installation and program use. As is the case for any new interventions, clinicians need to spend time becoming proficient with the intervention components. Specifically, clinician's comfort with the user interface and familiarity with potential avatar responses increases conversational fluency between the child and the avatar. Our assessment of the training process indicated a total of 8-12 training hours for clinicians to become proficient at using the program, manipulating the characters, selecting the appropriate dialogue, and extracting homework assignments. Parents and children were proficient at installing and using the homework program after one ten-minute training session. In short, learning how to use the intervention required minimal time and computer skills on the part of children, parents and clinicians.

With the application of any virtual environment as a modality to enhance treatment, however, new challenges emerge. First, the technology works on an individual basis (one

therapist driving the interactions for one child at a time), which impacts the standard treatment structure. For example, in addition to individual in vivo exposures, concentrated generalization practice consequently requires that therapists have separate in-clinic practice sessions for each child instead of one group peer generalization session. On the other hand, benefits include eliminating the need to recruit typically developing peers, eliminating the logistics and time involved in coordinating a mutually agreeable day/time for generalization session with 8-12 children, as well as eliminating the need for appropriate adult supervision. Furthermore, 60-90 minute treatment sessions more closely resemble traditional outpatient format. Reliance on parental involvement was also reduced as they no longer had to transport children to different community locations for peer generalization sessions and homework assignments.

Another issue that became apparent during this study was that in order for patients to maximally benefit from the generalization homework assignments, a reliable laptop or computer is necessary. Although most families have access to some type of computer, the virtual environment currently runs best on a Windows-based PC with an advanced graphics card for rapid processing speed and good graphics capability. Fortunately, lack of appropriate hardware should be less problematic in the future as newer computer models have increasingly powerful processing speed and graphics capability. In addition, as this virtual environment software continues to evolve, it is possible to develop it on other compatible platforms for increased software compatibility.

Study Limitations

Despite that the initial data indicated good feasibility, acceptability, and credibility by children, parents, and clinicians, this study is not without limitations. First, given the nature of this study as a feasibility trial, one limitation is the small sample size. Given the promising preliminary results, future larger randomized controlled trials should examine whether children

and parents perceive the virtual environment modules as satisfying relative to the standard treatment components. In addition, although the dropout rate for these feasibility studies were not different from previous SET-C studies, future studies should consider obtaining as much feasibility data as possible from treatment dropouts. Although we tried to carefully survey the patient's reason for discontinuing treatment, parents only gave broad reasons for discontinuing and thus it was not possible to rule out whether specific aspects of the virtual environment played a role in their dropout. Future studies should also investigate the effectiveness of this treatment in alternative (e.g., community-based) settings and examine whether the social skills practiced in the virtual environment generalize to real life situations.

Another limitation is that the definition, measurement, and assessment of program usability tend to vary by users. Currently, there are no psychometrically sound measures that can be used across several different types of users (i.e., clinicians, children, and their parents). Furthermore, even though sophisticated virtual environment technology exists, it is difficult to predict how likely researchers and clinicians will accept and adapt to this technology. Therapists will need to invest time and effort upfront to learn to use the equipment properly. Some comfort with basic electronics may be beneficial since technical difficulties are possible and may require the ability to troubleshoot the problem (Segal, Bhatia, & Drapeau, 2011). However, this virtual environment may be more practical because of its ability to run on a standard desktop or laptop computer without the need for expensive head-mounted displays or supplementary equipment typically required by older virtual reality technology.

Despite these study limitations, several distinct strengths are clear. First, this is the first study to examine whether an interactive virtual environment may be a viable tool to increase the dissemination of an existing empirically supported skills-based treatment for youth with SAD. In

addition, beyond just investigating whether the virtual environment works and how well it works, our research is part of an iterative process where we provide informal quantitative and qualitative feedback to the development team so that the technology can continue to be tested and improved. With this innovative virtual environment program, clinicians no longer have to struggle with the cost, time, and human resources required to establish a social skills group and peer generalization sessions. The flexible and customizable nature of this interactive virtual environment allows the clinician to have full control over with whom the child interacts, where the interaction takes place, what skills to isolate, and the difficulty of the interaction. The at-home component further provides children with intensive practice of social skills and potentially eliminates the need for formal peer group activities or substantial parental involvement. Children's ability to practice newly acquired social skills are no longer contingent on parents accompanying them on community assignments. It may be possible to increase homework compliance by having more immediate reinforcers (e.g., fun mini-games as a reward after their homework assignment) or publically visible reinforcers (e.g., either clinic or web-based "sticker" charts). Should the revised homework element continue to be more engaging, eliminating the reliance on busy parents may increase adherence to treatment (Hudson & Kendall, 2002; Nock & Kazdin, 2005).

Future Directions

As modern technology becomes increasingly available, tools such as virtual environments may enhance existing evidence-based care for youth. Findings from this study suggest that a virtual school environment designed to provide dose-controlled and intensive social skills practice is acceptable, feasible, and credible to preadolescent children. These preliminary but promising results align with broader NIMH initiatives to utilize technological advances in clinical psychology to help children and their families. Clinicians and researchers

may use these tools to disseminate skills-based treatments to children with social skills deficits (e.g., social anxiety disorder, Asperger's disorder, or ADHD). Ultimately, with the eventual ubiquity of personal computers and related devices, a web-based program may be developed to reach to a wider population segment regardless of income or geography.

APPENDIX A: IRB APPROVAL

University of Central Florida Institutional Review Board
Office of Research & Commercialization
12201 Research Parkway, Suite 501
Orlando, Florida 32826-3246
Telephone: 407-823-2901 or 407-882-2276
www.research.ucf.edu/compliance/irb.html

Approval of Human Research

From: **UCF Institutional Review Board #1**
FWA00000351, IRB00001138

To: **Deborah Casamassa Beidel** and Co-PI: **Nina Wong**

Date: **March 07, 2011**

Dear Researcher:

On 3/7/2011, the IRB approved the following human participant research until 3/6/2012 inclusive:

Type of Review:	UCF Initial Review Submission Form
Project Title:	Virtual Environments for Childhood Social Phobia
Investigator:	Deborah Casamassa Beidel
IRB Number:	SBE-11-07430
Funding Agency:	National Institutes of Health
Grant Title:	Virtual Environments for Childhood Social Phobia
Research ID:	1031576

The Continuing Review Application must be submitted 30days prior to the expiration date for studies that were previously expedited, and 60 days prior to the expiration date for research that was previously reviewed at a convened meeting. Do not make changes to the study (i.e., protocol, methodology, consent form, personnel, site, etc.) before obtaining IRB approval. A Modification Form **cannot** be used to extend the approval period of a study. All forms may be completed and submitted online at https://iris.research.ucf.edu .

If continuing review approval is not granted before the expiration date of 3/6/2012, approval of this research expires on that date. When you have completed your research, please submit a Study Closure request in iRIS so that IRB records will be accurate.

Use of the approved, stamped consent document(s) is required. The new form supersedes all previous versions, which are now invalid for further use. Only approved investigators (or other approved key study personnel) may solicit consent for research participation. Participants or their representatives must receive a copy of the consent form(s).

In the conduct of this research, you are responsible to follow the requirements of the Investigator Manual.

On behalf of Joseph Bielitzki, DVM, UCF IRB Chair, this letter is signed by:

Signature applied by Joanne Muratori on 03/07/2011 03:35:15 PM EST

IRB Coordinator

APPENDIX B: SCREEN CAPTURE OF AVATAR CHARACTERS IN THE VIRTUAL ENVIORNMENT

Note: Top Row (Left to Right) School Bully, Popular Classmate, Smart Classmate; Bottom Row (Left to Right) School Principal, Classroom Teacher, Gym Teacher

APPENDIX C: SAMPLE INTERACTIONS IN THE VIRTUAL ENVIRONMENT DURING IN-CLINIC SOCIAL SKILLS PRACTICE

Greetings Module (Beginners Level)

Narrator Prompts: In just a moment, someone will speak to you. Be ready to respond.
Principal Avatar: Hello there!
Child: Good morning, Principal!
Principal Avatar: So good to see you.
Child: Good to see you too.
Principal Avatar: Have a great day.
Child: Thanks.

Questions Module (Advanced Level)

Narrator Prompts: In just a moment, you will see someone. Start by greeting that person.
Child: Hi Ginnie!
Girl Avatar: Hey, what's up?
Child: Not much, it's a boring Monday.
Girl Avatar: What are you doing after school?
Child: Hmm, I have soccer practice.
Narrator Prompts: Now ask a question.
Child: Do you want to come see my game this weekend?
Girl Avatar: Well, maybe. Let me think about it.
Child: Come on, we've been winning 3-0. It's going to be fun!
Girl Avatar: Cool. That sounds good!
Child: Okay, we're playing at the soccer field on Saturday at 5 o'clock.
Narrator Prompts: Now end the conversation.
Child: Well, time for class. I'll find you at lunch.
Girl Avatar: Uh huh, see you later.
Child: Later!

APPENDIX D: TABLES

Table 1. Modification of Social Effectiveness Therapy for Children with Virtual Environment Practice

Treatment Components	Standard Social Effectiveness Therapy for Children	Modified Treatment With Virtual Environment Practice
Social Skills Training	Group Format	Individual Format
Peer Generalization Sessions	Community Based Group practice With 5 friendly peers Therapist Supervised	Virtual Environment in Clinic Individual practice With peer avatars and adult avatars Therapist Driven Interactions
Homework Skills Practice	Community Based Parental support required 3 times per week	Virtual Environment at Home Computer Based 3 times per week
Exposure Therapy	Individualized in-vivo	Individualized in-vivo ǂ

ǂ Note: Only children who completed Study 2 received individualized in-vivo exposure sessions.

Table 2. Descriptive statistics for average weekly post-session evaluation of in-clinic program quality

Item	Study 1 (n = 10)		Study 2 (n = 4)	
	Mean (SD)	*Range*	*Mean (SD)*	*Range*
Quality of the sounds	3.68 (0.41)	3.00-4.00	3.53 (1.47)	1.33-4.33
Quality of the images	3.23 (0.94)	1.00-4.00	3.39 (1.74)	0.78-4.33
How real the school locations feel	2.80 (0.77)	1.80-4.00	3.31 (1.44)	1.22-4.44
How real it felt when you were talking to the virtual characters	2.69 (0.99)	0.80-3.80	3.25 (1.69)	0.78-4.44
How easy it was to move through the program	3.53 (0.39)	3.00-4.00	3.94 (0.64)	3.00-4.33
Enjoyment in using the program	2.90 (1.07)	1.10-4.00	3.26 (2.11)	0.11-4.44
How sure are you that you understood the program's instructions correctly	3.52 (0.76)	1.50-4.00	3.97 (0.56)	3.33-4.44
How comfortable was it for you to ask for help if you did not understand something	3.69 (0.39)	3.00-4.00	3.83 (0.76)	2.78-4.44
How comfortable was it for you to share information with the virtual characters	3.22 (0.99)	1.00-4.00	3.81 (0.79)	2.67-4.33
How comfortable was it when you were talking to the virtual characters	3.18 (0.97)	1.00-4.00	3.83 (1.00)	2.33-4.44
How comfortable was it when you were talking to the child characters	3.34 (0.96)	1.00-4.00	3.89 (0.97)	2.44-4.44
How comfortable was it when you were talking to the adult characters	3.13 (0.87)	1.80-4.00	3.83 (1.00)	2.33-4.33
How sure are you that the program understood your answers	3.00 (0.97)	1.00-4.00	3.70 (1.28)	2.22-4.44
How helpful was the information given by the program	3.27 (0.89)	1.50-4.00	3.44 (1.49)	1.22-4.44
Overall quality of the program	3.36 (0.57)	2.50-4.00	3.42 (1.84)	0.67-4.44
How likely do you think this program will help you learn to make new friends or be less nervous talking to other people	3.40 (0.57)	2.50-4.00	3.31 (1.64)	0.89-4.33
How likely do you think you will use this program again	2.92 (0.94)	1.40-3.90	3.17 (1.65)	0.89-4.44

Note: Data presented for treatment completers only.

Table 3. Descriptive statistics on post-treatment clinical measures between Study 2 sample and a comparison sample

Clinical Measure	Study 2 Sample (n = 4)	Comparison Sample (n = 5)
	Mean (SD)	*Mean (SD)*
SPAI-C	6.22 (8.19) ǂ	11.25 (8.71)
SPAI-C/PV	26.22 (12.04)	16.93 (12.84)
CGI Severity	2.00 (0.82)	2.20 (1.30)
CGI Avoidance	1.50 (0.58)	1.80 (1.30)
CGI Global Improvement	2.00 (0.00)	1.60 (0.89)
CGI Change in Condition	3.00 (0.00)	1.80 (1.48)
CGAS	7.25 (0.50)	7.80 (1.10)

ǂ Note: Two children in Study 2 did not endorse any items on the SPAI-C measure at post-treatment.

APPENDIX E: FIGURES

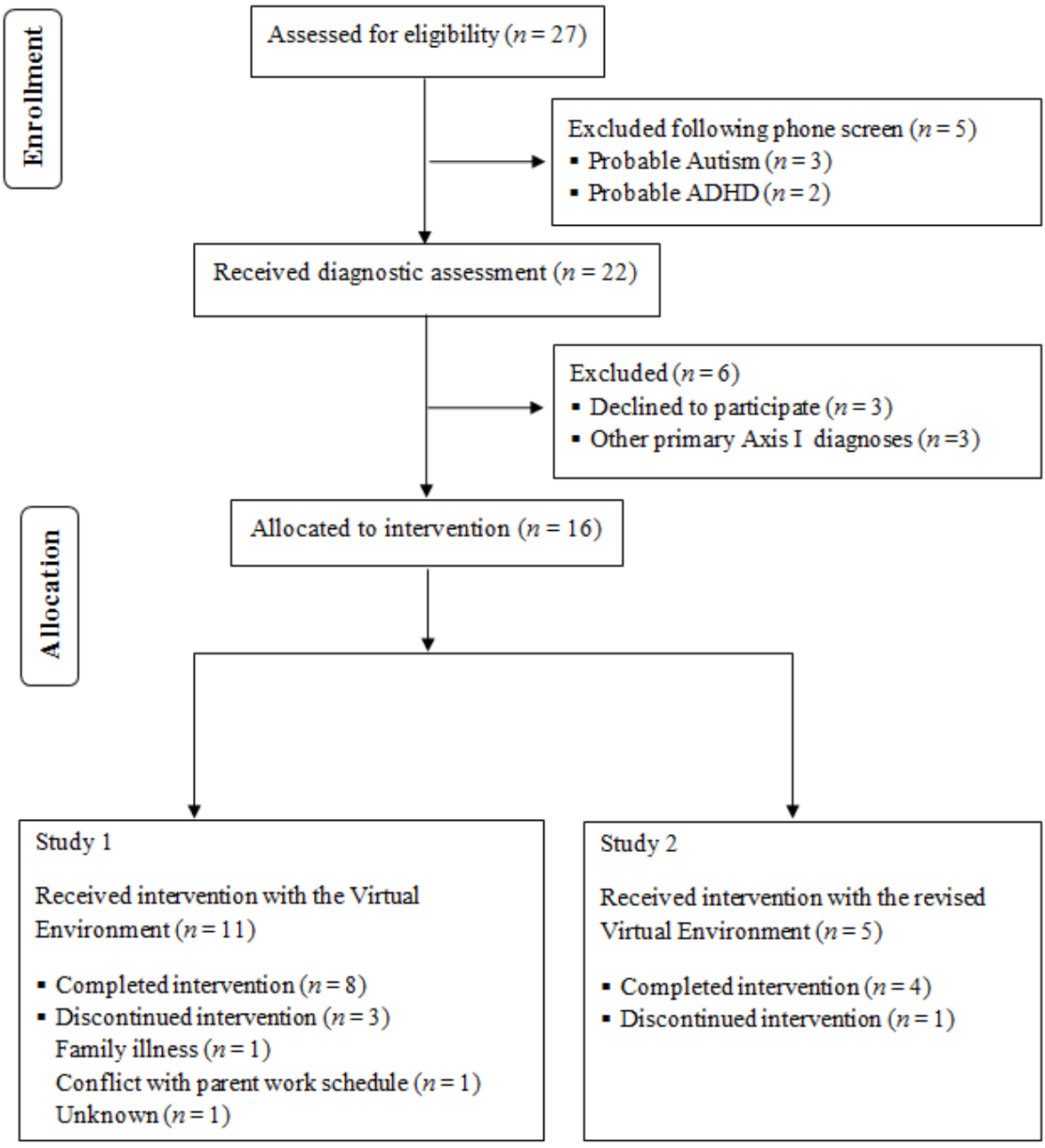

Figure 1. Participant Flow Diagram

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