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The feasibility and acceptability of virtual environments in the treatment of childhood social anxiety disorder

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Abstract

Objective—Two significant challenges for the dissemination of social skills training programs are the need to assure generalizability and provide sufficient practice opportunities. In the case of social anxiety disorder, virtual environments may provide one strategy to address these issues. This study evaluated the utility of an interactive virtual school environment for the treatment of social anxiety disorder in preadolescent children.

Method—Eleven children with a primary diagnosis of social anxiety disorder between 8 to 12 years old participated in this initial feasibility trial. All children were treated with Social Effectiveness Therapy for Children, an empirically supported treatment for children with social anxiety disorder. However, the in vivo peer generalization sessions and standard parent-assisted homework assignments were substituted by practice in a virtual environment.

Results—Overall, the virtual environment programs were acceptable, feasible, and credible treatment components. Both children and clinicians were satisfied with using the virtual environment technology, and children believed it was a high quality program overall. Additionally, parents were satisfied with the virtual environment augmented treatment and indicated that they would recommend the program to family and friends.

Conclusion—Virtual environments are viewed as acceptable and credible by potential recipients. Furthermore, they are easy to implement by even novice users and appear to be useful adjunctive elements for the treatment of childhood social anxiety disorder.

Keywords

childhood social anxiety disorder; behavioral treatment; virtual environment; virtual reality augmented treatment

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Exposure therapy remains the empirically-supported treatment of choice for anxiety disorders (Barlow, 2002; Chambless & Ollendick, 2001; Deacon & Abramowitz, 2004). To enhance the efficacy of exposure, virtual environments allow the presentation of situational cues not easily reproduced either through imagination (imaginal exposure) or in real life (in vivo exposure). 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 concluded promising clinical outcomes based on case, comparative, and randomized controlled studies. Although a large majority of studies

on the application of virtual environments for the treatment of anxiety disorders focused 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), virtual environments have also provided a particularly promising alternative to in vivo exposure sessions for individuals with social anxiety disorder (SAD).

People with 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), yet a significant barrier to the optimal treatment of SAD lies in the difficulty of re-creating an audience for 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. All elements of the core fear must be addressed in the exposure scenario in order to maximize the efficacy of exposure. As such, existing audience-based virtual environments are a promising alternative to in vivo exposure because therapists can control the behavior of virtual audience members in a way that allow maximum control over elements of the exposure scenario (Klinger et al., 2003; Klinger et al., 2005; Roy et al., 2003),

For adults with SAD, existing unidirectional classroom and audience-based virtual environments appear to elicit physiological and subjective distress (Harris, Kemmerling, & North, 2002; Lister, Piercey, & Joordens, 2010; Wallach, Safir, & Bar-Zvi, 2009; Pertaub, Slater, & Barker, 2002; Slater, Pertaub, Barker, & Clark, 2006; Kotlyar et al., 2008) and successfully target exposures for public speaking fears alone (Anderson, Rothbaum, & Hodge, 2003; Anderson, Zimand, Hodges, & Rothbaum, 2005; North, North, & Coble, 1998). However, existing environments generally depict adult audiences, and there is currently no data on the application of virtual environments to augment behavioral treatments for youth with SAD. Thus, although promising, the potential application of this technology to youth is unknown.

In addition, there are accumulating data that exposure therapy alone does not produce the optimal outcome for youth with SAD. Although still controversial, existing data suggest that youth with SAD 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). Thus, the use of bi-directional interactive virtual environments to augment skills-based behavioral treatments for youth with SAD extends beyond the existing unidirectional exposure paradigms, and represents an even more innovative approach to treatment.

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 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). Social Effectiveness Therapy for Children 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 have typically faced two challenges. First, skill consolidation depends on practice between treatment sessions and typically, emphasizes the need to use the acquired skills outside of the clinical setting (what is known as skill generalization). Although Social Effectiveness Therapy for Children has addressed the issue of generalization by including formal peer-generalization sessions as part of the overall treatment program, few traditional outpatient clinics have sufficient personnel and financial resources to conduct peer generalization sessions. These sessions, which are a core element of Social Effectiveness Therapy for Children are estimated to cost 152 "person hours" and $2000 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. The second challenge is that homework assignments, designed to enhance skill generalization, also 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).

In summary, there are two challenges to the dissemination of social skills training treatments such as Social Effectiveness Therapy for Children: (a) peer generalization strategies that incur extensive time and financial expense, and (b) 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 for youth in particular. Virtual environments, with their ability to (a) present an unlimited number of virtual characters to enhance generalization beyond the typical clinic setting and (b) reside on a standard PC to allow practice by the child without the need for parental support, could be an optimal solution.

This manuscript describes the initial feasibility, acceptability and credibility study of a new virtual environment program developed as a tool to optimize the dissemination of a skills-based behavioral treatment for youth with SAD. We partnered with Virtually Better, Inc. (VBI), and received funding for this project from a National Institutes of Health Small Business Technology Transfer (NIH STTR) grant, to develop this interactive school-based virtual environment. Specifically, the environment was integrated into the peer generalization and homework components of standard Social Effectiveness Therapy for Children. We substituted the in-clinic virtual environment for the peer generalization sessions and used the at-home virtual environment for traditional homework assignments. We predicted that children, parents and clinicians would be satisfied using the virtual environment and endorse it as a high quality program. 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.

Method

Development of the Environment

Developing complex virtual environments is typically outside the scope of expertise of most clinical psychologists. Thus, partnering with experts is technology is typically necessary to produce a product of this type. Additionally, the financial investment in producing these environments is quite substantial. Funding mechanisms such as the National Institute of Health or the Department of Defense Small Business Innovation Research (SBIR)/Small Business Technology Transfer (STTR) allow small businesses to team with academicians to produce products that then can be marketed to the general public. Whereas small businesses are eligible to submit grants through the SBIR mechanism, the STTR mechanism require a formal partnership between a small business and a research university. In the case of this project, through a partnership between UCF and VBI funded by an NIH STTR, individuals from various disciplines (psychology, engineering, computer programming, gaming, and art) collaborated on the product development. Clinical psychologists (the first and second authors) provided the vision of the software's capabilities for research and clinical purposes. This included the content such as specifying the different skills modules and levels, providing a description of the visual environment and characters, and creating the verbal dialogue and nonverbal responses for each character. VBI provided the technical design and development team to create a prototype with computer programmers and software engineers responsible for writing the software, and artists/graphic designers building the visual layout and characters that populate the environment. This was what is known as a Phase I project, designed to produce a product prototype.

A school was selected as the initial environment to be developed because it is a setting familiar to children and children with SAD report that 60% of distressful social events occur at school (Beidel, Neal, & Lederer, 1991). This virtual 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.

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 were taught and practiced across different virtual characters (e.g., principal, classroom teacher, gym teacher, popular classmate, smart classmate, school bully; see images of virtual avatar characters in Figure 1). For each character 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 allowed for virtually unlimited dialogue. Thus, the environment allowed 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 the clinic (known as the in-clinic version), the therapist sat behind a two way mirror and uses a Wizard of Oz interface to control the interactions. The child was seated in the adjacent room and responded to the virtual characters displayed on a computer monitor. In

the clinic, the interactions were driven by the therapist and can be as brief or extended as necessary or desired (see sample interactions in Figure 2). The therapist had the flexibility to individually tailor 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 challenged 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 provided practice with a variety of interpersonal partners, used a dose-controlled strategy to control the pace of the practice, and assured acquisition of basic skills before proceeding to more advanced and challenging interactions.

The at-home software was an abridged version of the in-clinic component that allowed for brief but repeated interactions with the characters. The program allowed the therapist to use the different difficulty levels to design practice sessions that were 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.

Procedure

Recruitment—This project was approved by the University of Central Florida (UCF) Institutional Review Board prior to the onset of data collection. 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 (3 children with probable Autism and 2 children with probable Attention-Deficit/Hyperactivity Disorder) and 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 after the telephone screening process because they were not ready to engage in treatment due to family time commitments, and two additional children were excluded because of primary Attention-Deficit/Hyperactivity Disorder, thus resulting in 17 families who received 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 Attention-Deficit/Hyperactivity (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—Seventeen children with a primary diagnosis of SAD and their parents provided informed consent/assent, completed the pre-treatment assessment, and were allocated to the intervention. Of those children, eleven began the virtual environment assisted treatment protocol. Thus, the final sample 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 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 was based on all eleven children unless otherwise indicated for treatment completers (*n* = 8).

Treatment Description

Social Effectiveness Therapy for Children—Traditional Social Effectiveness Therapy for Children therapy lasted 12 weeks and consisted of group social skills training, peer generalization, individual exposure therapy, and homework practice. In this feasibility study, we focused specifically on the social skills component. The social skills training included basic conversation skills, empathic listening skills, friendship and conflict resolution skills, and assertiveness training. Immediately following social skills training were therapist supervised peer generalization sessions designed to promote skill generalization. Children apply their newly acquired social skills by practicing with friendly peers recruited specifically for this program at typical and developmentally appropriate social activities (i.e., bowling, miniature golf, picnics, or games at pizza parlors).

Modified Treatment with Virtual Environments—For this feasibility study, live peer generalization sessions were replaced with in clinic practice sessions using the virtual environment (See Table 1). Each weekly session consisted of approximately thirty to forty minutes of group social skills training using traditional social skills procedures (instruction, modeling, behavior rehearsal, and feedback techniques). Both verbal and non-verbal skills were trained, followed by thirty to forty minutes of therapist-directed generalization practice using the virtual environment in clinic. All sessions were videotaped and reviewed by the 1st author 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 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

Feasibility—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 the software development team developer regarding technical issues).

Treatment Acceptability—For the in-clinic version, children specifically 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. In addition, 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—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.

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. Additional self-report user feedback and suggestions were provided to the development team to be incorporated into future software revisions throughout the development phase.

Feasibility

Regarding the therapist driven in-clinic virtual environment, there were six telephone calls by the first author to VBI for technical support during initial equipment set-up prior to launching the treatment study. The first 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 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). By 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 by children ages 7 – 12. 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 was 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, and created significant waiting on the part of the children 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 treatment and 12.5% of parents would "probably recommend" this treatment 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 study investigated the feasibility, acceptability and credibility of a computer-based virtual environment program as a viable component for the treatment of social anxiety disorder in children. 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, prior to examining treatment efficacy, it was first necessary to demonstrate that this novel virtual environment is feasible, acceptable, and credible to the clinicians, children and parents who are potential program users.

The results suggested that incorporating virtual environments as part of social skills training was 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. The virtual environment was built to run on a standard PC with an advanced graphics card and lack of appropriate hardware should be less of a problem in the future as newer computer models have increasingly powerful processing speed and graphics capability. Other measures of feasibility 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 needed 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 summary, learning how to use the intervention required minimal time and computer skills on the part of children, parents and clinicians.

A second important element of treatment development was acceptability. The 17.6% dropout rate for this investigation 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.

Third, assessment of treatment credibility indicated that the use of virtual environments is considered appropriate for the treatment of childhood social anxiety disorder. Children reported that the in-clinic virtual environment was a high quality program that they believed would be useful for the acquisition of social skills. Among 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, although there was substantial homework compliance, there is still room for improvement. Feedback from the children indicated that the first rendition of the homework was "boring" and several limitations to the initial homework modules required technical revision. The webcam audio/video capture initially proposed to monitor homework compliance and social skills acquisition was eliminated because it was difficult to implement and it was not practical for clinicians to review all audio/video recordings. Furthermore, as with most technological advances, the development process followed an iterative process and program improvement and alteration was expected.

Based on data from these participants, revisions have been made to the virtual environment program based on feedback since its initial launching. For example, the homework module was revised to add a game-like quality to the assignment, including a narrated storyline, additional narrator instructions to increase ease of use, an additional character to increase the number of possible interactions, and a "badges" reinforcement system to increase homework compliance. Children may now earn virtual badges after completing their homework, which they can turn in at the next clinic appointment for real foil badges, and collect in a booklet. We are currently replicating this feasibility study to evaluate the revised homework program for acceptability and enhanced homework compliance, and extending our work by adding

initial treatment efficacy measures. Six children are currently participating in treatment receiving version two of this software program and data collection is currently ongoing.

Overall, the virtual school environment was developed as a two-part solution to replace the community-based peer generalization component of Social Effectiveness Therapy for Children, and provide additional skills practice at home without the need for intensive parental involvement. With the introduction of the virtual environment, however, new challenges emerge. For example, the technology works on an individual basis (one therapist driving the interactions for one child at a time). Consequently, concentrated generalization practice requires that therapists have separate in-clinic practice sessions for each child instead of one group peer generalization session. However, benefits include eliminating the logistics and time involved in coordinating a mutually agreeable day/time for generalization session with 8–12 children, and 60–90 minute sessions that resemble more closely to traditional outpatient format. Reliance on parental involvement is also minimized as the need to transport children to different community locations for peer generalization sessions and homework assignments is eliminated.

Despite the preliminary nature of this feasibility trial, 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 was feasible, acceptable and credible, this research represents an iterative development 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, thus increasing the possibility of treatment dissemination. The flexible and customizable nature of this interactive virtual environment allows the clinician to have full control over with whom the child interacts with, where the interaction takes place, what skills to isolate, and how difficult the interaction should be. 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. Should the revised homework element prove more engaging, eliminating the reliance on busy parents may increase adherence to treatment as recommended (Nock & Kazdin, 2005).

Future Directions

This NIMH STTR Phase 1 trial suggests good feasibility, acceptability, and credibility by children, parents, and clinicians alike, a foundation of preliminary work that will inform future research in this area. Future work will strengthen the homework elements in addition to preliminary treatment efficacy measures. This replication and extension study is currently underway with six additional children. Should the replication study demonstrate feasibility and initial efficacy, future larger randomized controlled trials will examine whether children and parents perceive the virtual environment modules as satisfying relative to the standard treatment components, and investigate whether the social skills practiced in the virtual environment generalize to real life situations.

As technology becomes more sophisticated, many clinicians are considering how to use tools such as the web and virtual reality to augment their clinical armamentarium. As exciting as the opportunities may be, these technologies also have some limitations. Generally, prices for initial outlay systems typically used in research settings range from $15,000–$25,000 for hardware and software programs, although the system used in this

investigation was specifically designed to run on a standard desktop computer. Even for sophisticated systems, once past this initial investment, there are few additional costs (e.g., repair/replacement of broken equipment, maintenance contracts, software upgrades) and may be more cost effective in the long-term. For example, VE appears to be a cost effective treatment strategy (Wood et al., 2009) where the cost of VRET for 12 participants was estimated to be $114,490 less than the cost of treatment as usual ($439,000). In contrast, constructing new virtual environments can be more costly. In this initial study, the design of one setting (various areas within an elementary school), the related background, and 8 interactive avatars cost approximately $250,000 and took over one year to develop (funded by NIH STTR). This development process included the conceptual storyboard design and conversational content for each avatar characters as well as the actual visual design and engineering. We predict that as the efficacy data for the applications of virtual environments increase, additional research and treatment demand for the intervention will also increase, thereby making the purchase of the equipment a better investment for researchers, therapists and patients.

Given that this program is used by several different types of users (i.e., clinicians, children, and their parents), the definition, measurement, and assessment of program usability varies by users. Currently, there are no psychometrically sound measures that can be used across groups. 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. Initially, therapists will need to invest time and effort to learn to use 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.

Conclusion

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 attention-deficit/hyperactivity disorder). 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.

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References

Albano A, Marten PA, Holt CS, Heimberg RG, Barlow DH. Cognitive-behavioral group treatment for social phobia in adolescents: A preliminary study. The Journal of nervous and mental disease. 1995; 183:649–645. [PubMed: 7561811]

American Psychiatric Association. Diagnostic and statistical manual of mental disorders. 4th ed.. Washington, DC: 2000. text rev.

Anderson P, Jacobs C, Rothbaum BO. Computer-supported cognitive behavioral treatment of anxiety disorders. Journal of Clinical Psychology. 2004; 60:253–267. [PubMed: 14981790]

Anderson P, Rothbaum BO, Hodges LF. Virtual reality exposure in the treatment of social anxiety. Cognitive & Behavioral Practice. 2003; 10:240–247.

Anderson P, Zimand E, Hodges LF, Rothbaum BO. Cognitive behavioral therapy for public-speaking anxiety using virtual reality for exposure [Brief Report]. Depression & Anxiety. 2005; 22:156–158. [PubMed: 16231290]

Baer S, Garland J. Pilot study of community-based cognitive behavioral group therapy for adolescents with social phobia. Journal of the American Academy of Child and Adolescent Psychiatry. 2005; 44:258–264. [PubMed: 15725970]

Barlow, DH. Anxiety and its disorders: The nature and treatment of anxiety and panic. 2nd ed.. New York: Guilford Press; 2002.

Beidel DC, Neal AM, Lederer AS. The feasibility and validity of a daily diary for the assessment of anxiety in children. Behavior Therapy. 1991; 22:505–517.

Beidel DC, Turner SM, Ammerman RT, Sallee FR, Crosby LA, Pathak S. SET-C versus Fluoxetine in the treatment of childhood social phobia. Journal of the American Academy of Child and Adolescent Psychiatry. 2007; 46:1622–1632. [PubMed: 18030084]

Beidel DC, Turner SM, Morris TL. Psychopathology of childhood social phobia. Journal of the American Academy of Child and Adolescent Psychiatry. 1999; 38:643–650. [PubMed: 10361781]

Beidel DC, Turner SM, Morris TL. Behavioral treatment of childhood social phobia. Journal of Consulting and Clinical Psychology. 2000; 68:1072–1080. [PubMed: 11142541]

Beidel DC, Turner SM, Young BJ. Social Effectiveness Therapy for Children: Five years later. Behavior Therapy. 2006; 37:416–425. [PubMed: 17071218]

Borkovec TD, Nau SD. Credibility of analogue therapy rationales. Journal of Behavior Therapy & Experimental Psychiatry. 1972; 3:257–260.

Bush J. Viability of virtual reality exposure therapy as a treatment alternative. Computers in Human Behavior. 2008; 24:1032–1040.

Chambless DL, Ollendick TH. Empirically supported psychological interventions: Controversies and evidence. Annual Review of Psychology. 2001; 52:685–716.

Coelho CM, Waters AM, Hine TJ, Wallis G. The use of virtual reality in acrophobia research and treatment. Journal of Anxiety Disorders. 2009; 23:563–574. [PubMed: 19282142]

Crawley SA, Beidas RS, Benjamin CL, Martin E, Kendall PC. Treating socially phobic youth with CBT: Differential outcomes and treatment considerations. Behavioural & Cognitive Psychotherapy. 2008; 36:379–389.

Deacon BJ, Abramowitz JS. Cognitive and behavioral treatments for anxiety disorders: A review of meta-analytic findings. Journal of Clinical Psychology. 2004; 60:429–441. [PubMed: 15022272]

Fedoroff IC, Taylor S. Psychological and pharmacological treatments of social phobia: a meta-analysis. Journal of Clinical Psychopharmacology. 2001; 21:311–324. [PubMed: 11386495]

Gerardi M, Cukor J, Difede J, Rizzo A, Rothbaum B. Virtual reality exposure therapy for post-traumatic stress disorder and other anxiety disorders. Current Psychiatry Reports. 2010; 12:298–305. [PubMed: 20535592]

Harris SR, Kemmerling RL, North MM. Brief virtual reality therapy for public speaking anxiety. CyberPsychology & Behavior. 2002; 5:543–550. [PubMed: 12556117]

Herbert JD, Gaudiano BA, Rheingold AA, Myers VH, Dalrymple K, Nolan EM. Social skills training augments the effectiveness of cognitive behavioral group therapy for social anxiety disorder. Behavior Therapy. 2005; 36:125–138.

Kazdin, AE.; Weisz, JR. Evidence-based psychotherapies for children and adolescents. New York: Guilford Press; 2003.

Kendall PC, Robin JA, Hedtke KA, Suveg C, Flannery-Schroeder E, Gosch E. Considering CBT with anxious youth? Think exposures. Cognitive & Behavioral Practice. 2005; 12:136–148.

Klinger E, Bouchard SS, Légeron PP, Roy SS, Lauer FF, Chemin II, Nugues PP. Virtual reality therapy versus cognitive behavior therapy for social phobia: A preliminary controlled study. CyberPsychology & Behavior. 2005; 8:76–88. [PubMed: 15738695]

Klinger, E.; Chemin, I.; Légeron, P.; Roy, S.; Lauer, F.; Nugues, P. Designing virtual worlds to treat social phobia. In: Wiederhold, B.; Riva, G.; Wiederhold, MD., editors. Cybertherapy. San Diego, CA: Interactive Media Institute; 2003. p. 113-121.

Kotlyar M, Donahue C, Thuras P, Kushner MG, O'Gorman N, Smith EA, Adson DE. Physiological response to a speech stressor presented in a virtual reality environment. Psychophysiology. 2008; 45:1034–1037. [PubMed: 18778321]

Krijn MM, Emmelkamp PG, Ólafsson RP, Biemond RR. Virtual reality exposure therapy of anxiety disorders: A review. Clinical Psychology Review. 2004; 24:259–281. [PubMed: 15245832]

Lister HA, Piercey C, Joordens C. The effectiveness of 3-D video virtual reality for the treatment of fear of public speaking. Journal of CyberTherapy and Rehabilitation. 2010; 3:375–381.

Masia-Warner C, Klein RG, Dent HC, Fisher PH, Alvir J, Albano AM, Guardino M. School-based intervention for adolescents with social anxiety disorder: Results of a controlled study. Journal of Abnormal Child Psychology. 2005; 33:707–722. [PubMed: 16328746]

Meyerbröker K, Emmelkamp PG. Virtual reality exposure therapy in anxiety disorders: A systematic review of process-and-outcome studies. Depression and Anxiety. 2010; 27:933–944. [PubMed: 20734361]

Nock MK, Ferriter C. Parent management of attendance and adherence in child and adolescent therapy: A conceptual and empirical review. Clinical Child & Family Psychology Review. 2005; 8:149–166. [PubMed: 15984084]

Nock MK, Kazdin AE. Randomized controlled trial of a brief intervention for increasing participation in parent management training. Journal of Consulting and Clinical Psychology. 2005; 73:872–879. [PubMed: 16287387]

North M, North S, Coble JR. Virtual reality therapy: An effective treatment for the fear of public speaking. International Journal of Virtual Reality. 1998; 3:2–6.

Olfson M, Guardino M, Struening E, Schneier FR, Hellman F, Klein DF. Barriers to the treatment of social anxiety. The American Journal of Psychiatry. 2000; 157:521–527. [PubMed: 10739410]

Parsons TD, Rizzo AA. Affective outcomes of virtual reality exposure therapy for anxiety and specific phobias: A meta-analysis. Journal of Behavior Therapy and Experimental Psychiatry. 2008; 39:250–261. [PubMed: 17720136]

Pellegrin KL, Stuart GW, Maree B, Frueh BC, Ballenger JC. A brief scale for assessing patients' satisfaction with care in outpatient psychiatric services. Psychiatric Services. 2001; 52:816–819. [PubMed: 11376232]

Pertaub DP, Slater M, Barker C. An experiment on public speaking anxiety in response to three different types of virtual audience. Presence: Teleoperators and Virtual Environments. 2002; 11:68–78.

Powers MB, Emmelkamp PG. Virtual reality exposure therapy for anxiety disorders: A meta-analysis. Journal of Anxiety Disorders. 2008; 22:561–569. [PubMed: 17544252]

Pull CB. Current status of virtual reality exposure therapy in anxiety disorders. Current Opinion in Psychiatry. 2005; 18:7–14. [PubMed: 16639177]

Rothbaum B, Hodges LF. The use of virtual reality exposure in the treatment of anxiety disorders. Behavior Modification. 1999; 23:507. [PubMed: 10533438]

Rao PA, Beidel DC, Turner SM, Ammerman RT, Crosby LE, Sallee FR. Social anxiety disorder in childhood and adolescence: Descriptive psychopathology. Behaviour Research and Therapy. 2007; 45:1181–1191. [PubMed: 17007813]

Roy SS, Klinger EE, Légeron PP, Lauer FF, Chemin II, Nugues PP. Definition of a VR-based protocol to treat social phobia. CyberPsychology & Behavior. 2003; 6:411–420. [PubMed: 14511454]

Ruscio AM, Brown TA, Chiu WT, Sareen JJ, Stein MB, Kessler RC. Social fears and social phobia in the USA: Results from the National Comorbidity Survey Replication. Psychological Medicine. 2008; 38:15–28. [PubMed: 17976249]

Segal R, Bhatia M, Drapeau M. Therapists' perception of benefits and costs of using virtual reality treatments. CyberPsychology, Behavior & Social Networking. 2011; 14:29–34.

Silverman, W.; Albano, AM. The Anxiety Disorders Interview Schedule for Children DSM-IV Child and Parent Version (ADIS-C/P). San Antonio, TX: Psychological Corporation; 1996.

Silverman WK, Pina AA, Viswesvaran C. Evidence-based psychosocial treatments for phobic and anxiety disorders in children and adolescents. Journal of Clinical Child & Adolescent Psychology. 2008; 37:105–130. [PubMed: 18444055]

Slater M, Pertaub D, Barker C, Clark DM. An experimental study on fear of public speaking using a virtual environment. CyberPsychology & Behavior. 2006; 9:627–633. [PubMed: 17034333]

Spence SH, Donovan C, Brechman-Toussaint M. Social skills, social outcomes, and cognitive features of childhood social phobia. Journal of Abnormal Psychology. 1999; 108:211–221. [PubMed: 10369031]

Spence SH, Donovan C, Brechman-Toussaint M. The treatment of childhood social phobia: The effectiveness of a social skills training-based, cognitive-behavioral intervention, with and without parental involvement. Journal of Child Psychology & Psychiatry. 2000; 41:713–726. [PubMed: 11039684]

Turner SM, Beidel DC, Townsley RM. Social phobia: A comparison of specific and generalized subtypes and avoidant personality disorder. Journal of Abnormal Psychology. 1992; 101:326–331. [PubMed: 1583227]

Wallach HS, Safir MP, Bar-Zvi M. Virtual reality cognitive behavior therapy for public speaking anxiety: A randomized clinical trial. Behavior Modification. 2009; 33:314–338. [PubMed: 19321811]

Wood D, Murphy J, McLay R, Koffman R, Spira J, Obrecht RE, Pyne J, Wiederhold BK. Cost effectiveness of virtual reality graded exposure therapy with physiological monitoring for the treatment of combat related post-traumatic stress disorder. Annual Review of CyberTherapy and Telemedicine. 2009; 7:223–229.

Figure 1.
Screen capture of avatar characters in the virtual environment
Top Row (Left to Right) School Bully, Popular Classmate, Smart Classmate; Bottom Row (Left to Right) School Principal, Classroom Teacher, Gym Teacher

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!

Figure 2.
Sample interactions in the virtual environment during in-clinic social skills practice

Table 1

Modification of Social Effectiveness Therapy for Children with Virtual Environment

Treatment Components	**Standard Social Effectiveness Therapy for Children Treatment**	**Modified Treatment With Virtual Environment**
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

Table 2

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

Item	*Mean (SD)*	*Range*
Quality of the sounds	3.68 (0.41)	3.00–4.00
Quality of the images	3.23 (0.94)	1.00–4.00
How real the school locations feel	2.80 (0.77)	1.80–4.00
How real it felt when you were talking to the virtual characters	2.69 (0.99)	0.80–3.80
How easy it was to move through the program	3.53 (0.39)	3.00–4.00
Enjoyment in using the program	2.90 (1.07)	1.10–4.00
How sure are you that you understood the program's instructions correctly	3.52 (0.76)	1.50–4.00
How comfortable was it for you to ask for help if you did not understand something	3.69 (0.39)	3.00–4.00
How comfortable was it for you to share information with the virtual characters	3.22 (0.99)	1.00–4.00
How comfortable was it when you were talking to the virtual characters	3.18 (0.97)	1.00–4.00
How comfortable was it when you were talking to the child characters	3.34 (0.96)	1.00–4.00
How comfortable was it when you were talking to the adult characters	3.13 (0.87)	1.80–4.00
How sure are you that the program understood your answers	3.00 (0.97)	1.00–4.00
How helpful was the information given by the program	3.27 (0.89)	1.50–4.00
Overall quality of the program	3.36 (0.57)	2.50–4.00
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
How likely do you think you will use this program again	2.92 (0.94)	1.40–3.90

Note: $n = 10$ because one child did not complete any in-clinic treatment sessions.