Increasing Resilience and Preventing Suicide: Training and Interventions with a Distressed Virtual Human in Virtual Reality[1]

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ABSTRACT

Virtual agents have been used as virtual patients for medical training, as well as for mental health training. When the training takes place inside VR the experience is more immersive, which allows for illusions of presence: the illusion that you are co-present with the virtual agent in the same space, and the illusion that the virtual agent is a real human. We have developed 'Daniel', a VR framework, based on a semi-automated virtual agent, which can be used for training for increasing resilience and for suicide prevention, and has the potential of being used as an intervention. Here we report on two different studies aimed at evaluating the framework and the psychological protocols involved. In the first study we trained participants from the general population to develop a resilience plan intervention (RPI) with a distressed virtual agent, and in the second study we trained therapists to use the safety plan intervention (SPI) with a suicidal virtual agent. In both cases we compare the VR sessions with role-playing by human actors. We report that all interventions resulted in an increase in participant self-efficacy in helping others, and we also report results on the possible importance of presence and social presence.

CCS CONCEPTS

Human Centered Computing, Human Computer Interaction (HCI) • Applied Computing, Law, Social and Behavioral Sciences

KEYWORDS

Virtual patient, virtual reality, psychological counseling, suicide, resilience, presence, social presence

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1 Introduction

Virtual patients are being increasingly utilized for training medical students [9,16] and there has also been research on using them for mental health training [38]. However, within virtual reality (VR) psychotherapy there are relatively few studies or applications that involve interpersonal and social interactions; one reason is the challenge of developing convincing interactive virtual agents [22,23]. Mental health is an especially challenging domain for virtual patients; the symptoms of mental illness are subtler than physical illness and pose a high bar for both verbal and non-verbal behavior. Previous research indicates that virtual training can be as effective as in-person peer-to-peer role play in increasing clinical interviewing skills and for practice new emotion regulation skills. These skills are important for treating and preventing mental health

[1] Companion video: https://youtu.be/SuI3AswXeGY

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issues [2,13]. Thus, using VR for these purposes has enormous positive potential. The current research is focused on building resilience and suicide prevention. Most such studies adopt approaches like ours, i.e., a semi-automated dialogue, controlled by a human operator.

Suicide is a major social challenge, claiming 800,000 lives annually worldwide [28]. The COVID-19 pandemic and its implications on everyday life have caused an increase in rates of stress, depression, and anxiety in the general population [8,25]. The full effect of the pandemic on suicidal behavior is yet unknown, but there has been an increase in suicidal ideation and thoughts [8].

Some individuals can develop post-traumatic stress disorder (PTSD), depression, anxiety, or even suicidal behavior, while others will not develop psychological symptoms at all, and some might even thrive from traumatic experiences [31]. Resilience is considered a major protective factor against suicide and other mental illnesses [14,28]; it includes multiple dimensions such as genetic, developmental, psychosocial, and psychological factors [28,31]. Hamill argued that the more self-efficacy one has, the more able he or she will be in coping with emotional crisis [26]. Thus, enhancing self-efficacy is expected in turn enhance resilience [26,30]. Self-efficacy is defined as beliefs in one's capabilities to mobilize the motivation, cognitive resources, and courses of action needed to meet given situational demands [40]. Thus, the method of adapting common and specific suicide prevention interventions to increase self-efficacy has a strong potential for success in both domains: support coping of the general population and training mental health practitioners [24].

Crisis intervention with a suicidal patient is challenging, even for trained mental health professionals [1]. Many will suffer from higher anxiety while intervening with a suicidal patient [19], and these intense emotions can lead to subsided self-efficacy to treat a suicidal patient and can lead to lower willingness to treat a suicidal patient, especially when the suicide risk is high [1, 13]. There is convincing evidence that training mental health professionals in evidence-based interventions for suicide preventions (EBI-SP) enhance self-efficacy and that it should be measured and targeted in training programs to improve treatment for suicidal patients [21]. Nevertheless, there is not enough adequate training for dealing with suicidal patients [15].

The safety-plan intervention (SPI) is an example of an evidenced-based brief intervention designed to help manage suicidal crises as a risk management tool [32]; it shows effectiveness in preventing the recurrence of suicidal behavior for adults and adolescents [35] and it is considered by the American Foundation for Suicide Prevention as best practice [28]. SPI was found to be feasible and facilitated enhanced self-efficacy when used by counselors on hotlines [17] or as a smartphone application [18]. The SPI consists of a prioritized list of coping strategies and sources of support that patients can use to alleviate a suicidal crisis. It helps clients identify personal warning signs of an emerging suicidal crisis, utilizing internal coping strategies, social contacts, and adaptive social settings to distract from suicidal thoughts. It enumerates existing external strategies, seeking help from family members or close friends, contacting mental health professionals or emergency services, and restricting access to lethal means [33]. The SPI can be administered as a stand-alone intervention delivered in a single session taking 20-45 minutes by either a trained professional or a paraprofessional [37], which made it appropriate for our study.

When training for high expertise-complex skills, such as psychological interventions, it is very important to incorporate real-life practice to acquire sufficient self-efficacy [7,11,21,27]. Still, real-life practice is often unavailable due to ethical issues of a student practicing on real patients and the need for systematic guidance [15]. Role-plays are a great resource for improving competence and self-efficacy in suicide prevention interventions [10]. The disadvantages of using role-play are the need for an experienced actor; it is extremely difficult for actors to perform consistently and to mimic the suicidal patient's answers and gestures fully [37]. Hence, VR role play is a promising solution.

In addition to the SPI, which is intended for potentially suicidal patients, we have designed the Resilience Plan Intervention (RPI) to be appropriate for use by the general population for coping with emotional distress, by omitting the suicide-related SPI components. Some advantages of this adaptation include psychoeducation for the general population, developing discourse, and increasing awareness of emotional distress signals. Also, using the conceptualization of RPI can be a quasi-vaccine against unexpected emotional crisis or stress [24].

In order to develop an accessible and highly effective training program, we designed a full standardized role play with a virtual patient in VR. In the first study, a distressed virtual patient was used to train participants from the general population in RPI, and in the second study a suicidal virtual patient was used to train therapists in SPI.

Our research goes beyond the state of the art in two major directions. First, we present novel specific training and interventions protocols in VR – safety plan intervention (SPI) and resilience plan intervention (RPI) [32]. This domain is particularly challenging because of the high sensitivity and emotional intensity that may be triggered by suicidal ideation, and our work indicates that it can nevertheless be simplified and made accessible using immersive VR with interactive dialogue. The VR SPI protocol presented here is already being utilized by a defense agency for training commanders to identify and deal with suicidal ideas among their subordinates, outside the laboratory. Additionally, we provide some results about the reported sense of presence in the virtual space (i.e., place illusion [29]) and social presence, i.e., the illusion that the virtual agent is a real patient [20,39]. We show that in both studies both presence and social presence are positively correlated with reported self-efficacy post intervention.

2 Study 1: Resilience Plan Intervention (RPI)

The goal of study 1 is twofold: i) increase participants self-efficacy for supporting individuals in distress, and ii) increase their own ability to cope with emotional distress.

2.1 Method

2.1.1 Participants The study included 116 adults aged 18-60 (M= 29.12, sd= 10.69, 85 females: 73.3%). Participants selected from the general population and without severe existing mental health problems were randomly assigned to one of two experimental

conditions, with 58 participants in VR group and 58 participants in RP (Role-Play) group. The study received ethical approval from the Institutional Review Board (IRB) at the (Removed for anonymity).

2.1.2 Procedure The participants completed a set of online questionnaires before the study (Time 0), and then watched a 15-minute tutorial video explaining the theoretical basis for RPI, how one can construct it with another person. and how to implement it with another person. In VR condition, participants put on the VR device and met "Daniel", a 27-year-old student (virtual agent) who is in distress, and they had to construct a resilience plan catered to his needs (Fig. 1). Participants in the role play (RP) group constructed a resilience plan with “Daniel” role-played by a research assistant. After the simulation, participants in both conditions received a summary of the four steps for constructing a RPI, were asked to write their own RPI, and were instructed to keep it in an easily accessible place for the next 30 days. At the end of the meeting, participants completed another set of questionnaires (Time 1- post-intervention).

2.1.3 The Virtual Agent is based on our lab-based platform, implemented in Unity, including a wide range of assets and scripts. At its core is a simple automated mechanism that includes three states: talking, listening, and idle. For each utterance, there is a set of predefined animations (facial expressions and body gestures) played in a loop with motion blending, with lip sync automatically detected from speech. In these studies, the voice of the agent was pre-recorded. In order to portray the character as depressed we have used pre-recorded animations from public libraries in which the characters are lowering the head or leaning forward.

Spoken dialogue is an open challenge. In this case we opted for a manual operator, who decides about each appropriate agent utterance from a set of six menus – one menu for each RPI stage (70 items in total), and an additional menu of general-purpose responses referred to as “fillers” (27 items) (Fig. 2). The menus and utterances were determined using an iterative design process, including several stages of low fidelity prototype evaluation, i.e., before implementing the system the experimenters tested the dialogue options with human participants, using a version of the utterances printed on a piece of paper, and reading it out loud (simulating the virtual agent). In these pilot studies the participants also went through a brief introduction of the RPI process, so that the structure of the conversation was expected to be bound to the RPI stages. The goal was to anticipate most types of questions and diversions that participants would make in real time and provide an utterance for most possible types of utterances.

The pilot dialogues included approximately 30 participants in total, included the same population as the studies-either members of the general population or professional therapists. As part of the iterative design process, an initial script that included 50 utterances was written based on the clinical experience and research of the clinical expert, an expert on SPI and RPI. The pilots that followed focused mainly on natural formulations of conversation flow rather than content changes. The second round of the pilot was conducted with counseling professionals to verify the reliability of the patient we created. During the production the researchers acted the role of Daniel and received feedback from clinical psychologists. The acting was video-recorded, and the recordings served as the basis for the for the animator and, importantly, for the human voice actor who was a professional actor. Regarding animation, eye gaze was carefully controlled, and specifically eye contact was reduced during the more difficult responses. An operator of the VR system is required to spend 1:30-2 hours practicing controlling the virtual agent, which includes learning the various utterances, switching between menus, and operating the VR system. The Role-Play condition was conducted by the same research assistants that operated the VR. They were trained together and were instructed to ‘copycat’ the VR simulation: script, intonation, gestures, and practiced several simulations before taking part in the studies. Approximately 10 people have learned to use the menu system successfully (five for each study) and an additional five have learned it as part of an applied project with a defense agency.

Figure 1: Interacting with a virtual distressed agent 'Daniel' in the RPI: in this scenario the virtual meeting took place at the patient's virtual home.

Figure 2: The operator using the menu system to control the agent in real time.

2.2 Materials and Measures

2.2.1 VR. We ran the study on a Quest 2 device connected to a laptop running a 3070 Nvidia GPU card.

2.2.2 RPI. The RPI, based on the SPI [32], includes four components: a) recognizing the signs of personal emotional distress; b) defining intrapersonal coping strategies; c) defining interpersonal coping strategies and; d) contact with mental health professionals. These components can be used to alleviate a future emotional crisis.

2.2.3 Questionnaires. Coping Self-Efficacy [35] was measured by Likert scale assessing internal and external coping strategies and evaluating the perceived self-efficacy of participants to identify signs of emotional distress and to use internal coping strategies, social support, and professional help when needed. The reliability in the current study was acceptable (Cronbach's α =0.78). Self-Efficacy in Helping Others while experiencing emotional distress was assessed by a brief 11-item self-reported 1-7 Likert scale based on Bandura guide and the Gatekeeper Self-Efficacy Scale [3,36]. The reliability in the current study was good (Cronbach's α =0.85).

Level of Presence was assessed with the 14-item Presence Questionnaire (PQ) [39] and Social Presence was assessed with 24-items adapted from the subscales found within the Social Presence from Temple Presence Inventory (TPI) [20]. The Presence Questionnaire was also adapted for use for the role-play condition: participants were asked about their feeling on the extent to which the role-play was perceived as real and the actor was convincing. The reliability in the current study was high (Cronbach's α =.91, Cronbach's α =.89; respectively).

2.3 Study I: Results

To examine the effect of RPI on the participant's coping self-efficacy and self-efficacy in helping others, a repeated measures Multivariate Analysis of Variance (MANOVA) examined the main effect of time (Time 1: before the intervention; Time 2: immediately after the intervention), condition, and their interactions, with condition as a between-subject factors and time as a within-subject factor. The outcome variables were coping self-efficacy and self-efficacy in helping others.

As hypothesized, the analysis showed a significant multivariate time effect when predicting coping self-efficacy (Fig. 3a) (Wilks' Λ= 0.1, F(1,111) = 956.34, p < .001, partial η2 =.89) and self-efficacy in helping others (Fig. 3b) (Wilks' Λ= 0.84, F(1,111) = 20.62, p < .001, partial η2=.16). As hypothesized, there was no significant time x condition interaction, neither for coping self-efficacy and self-efficacy in helping others (Wilks' Λ=.99, F(1, 111) = .27, p = .61, partial η2 =.002; Wilks' Λ=.99, F(1, 111) = 0.34, p = .56, partial η2 =.003, respectively).

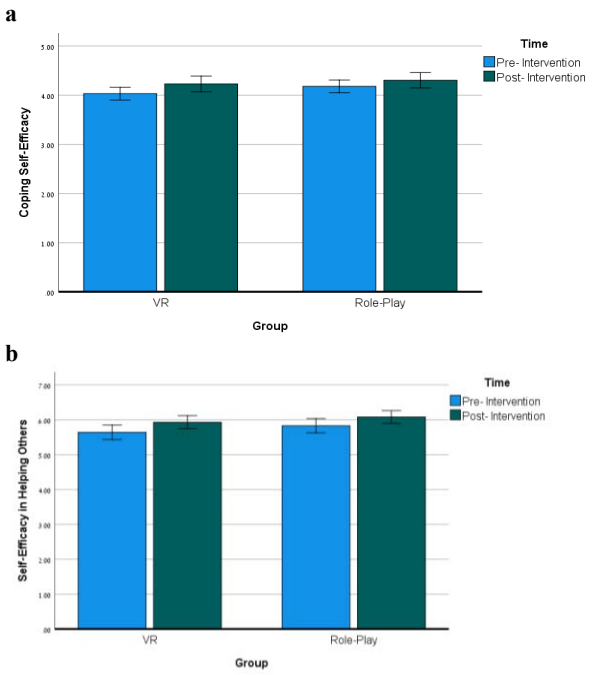

Figure 3: A bar-plot displaying pre- vs post-intervention self-efficacy in a) coping and b) helping others; error bars indicate ±2 SE.

An independent two-sample t-test was performed to compare presence scores between both groups. As expected, presence in the VR group (M = 4.78, SD = 1.05) was significantly lower (t(109) = -3.78, p = <.001; Cohen's d = .979, 95% CI [-1.07, -.33] than in RP (the role play control group) (M = 5.48, SD = .89); however, in both cases scores were high and well above mean (Fig. 4).

We have performed bivariate correlations of presence, social presence, coping self-efficacy and self-efficacy in helping others in the VR group (N=55). Social Presence was positively correlated with both coping self-efficacy (post intervention) (r=0.426, p<0.01) and self-efficacy in helping others (post intervention) (r=0.286, p < 0.05). Presence levels correlated positively with coping self-efficacy (r=0.357, p < 0.01). The correlation between presence and self-efficacy in helping others was also positive but not significant r=0.243, p=.074).

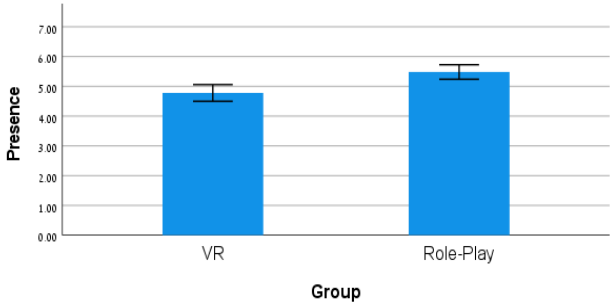

Figure 4: A bar-plot displaying presence's scores in VR group and role-play group; error bars indicate ±2 SE.

3 Study II: Suicide Prevention Intervention for Professionals

3.1 Method

This study is very similar to study 1 and we only report the differences.

3.1.1 Participants Study 2 included 106 mental health professionals aged 25-61 (M = 38.4, sd = 9.2) (86 females: 81.1%). 71 participants were licensed experts (70%), 30 in training – students and interns (28.3%), and 5 other (4.7%). Participants were randomly assigned to one of two experimental conditions, with 52 participants in the VR group and 54 participants in the Control group. The study was also approved by the local IRB.

3.1.2 Procedure The study is identical to study 1 except for the following details: all participants received guidelines and practiced the full-6-stages SPI, rather than the 4-stage subset of RPI. The session took place in a virtual clinic (Fig. 5), rather than at 'Daniel's' virtual home. The SPI agent eventually included 78 responses divided into 7 stages according to the 7 different stages included in the SPI and 27 fillers in an additional menu.

Figure 5: Interacting with the agent in the SPI at the virtual clinic.

3.2 Materials and Measures

4.2.1 Measurements. Self-efficacy in treating a suicidal patient was measured with a questionnaire used by Stern et al., (2020), which includes two items on a Likert scale ranging from 1 (very low) to 6 (very high). The reliability in the current study was good (T0: α=.91, T1: α=.81) [12]. Presence and Social Presence were assessed as in study 1. The reliability in the current study was high (Cronbach's α =.91, Cronbach's α =.94; respectively). The emotional response to "Daniel" was measured by the therapist response questionnaire – suicide form (TRQ-SF) [4], which is a questionnaire designed to measure the intensity of the therapist emotional response (e.g., affiliation, hopefulness, and distress) to a patient in suicide risk. The questionnaire had overall good internal reliability in the current study (Cronbach's α = 0.83).

3.3 Study II: Results

As in study 1, we examined the main effect of time (pre vs post intervention), condition (VR/Role-play), and their interactions. Expertise level was included as a covariate because of the baseline difference between conditions, and we carried out a repeated measures ANOVA. The analysis showed a significant effect for time in predicting self-efficacy to treat a suicidal patient when controlling professional experience as covariate (Fig. 5) ($F(1,96) = 10.65$, $P=.002$, partial $\eta 2 = 0.1$). As hypothesized, there was no significant time x condition interaction for self-efficacy ($F(1, 96) = .27$, $p = .6$, partial $\eta 2 =.002$), nor a significant time x rank (expertise level) interaction for self-efficacy ($F(2, 96) = .45$, $p = .63$, partial $\eta 2 =.009$).

As expected, presence in the VR condition (M = 4.17, SD = 0.87) was significantly lower ($t(97.08) = 5.03$, $p = <.001$; Cohen's d = 1.02, 95% CI [0.59, 1.44]) than in the Role-play condition (M = 5.03, SD =0.83), but we note a relatively small difference between VR and physical world (Fig. 7).

A close examination of the presence questionnaire revealed no significant difference between participants' report of acting as if they were in a real therapy session in both VR (M=4.98, sd=1.1) and Role-Play (Mean=5.22, sd=1.02) conditions ($t(97.43) = 1.13$, $p = 0.259$; Cohen's d = 0.23, 95% CI [-0.17, 0.63]). Also, the VR (Mean=4.67, sd=1.33) and Role-Play (Mean=4.4, sd=1.41) conditions did not differ in the assessment of Daniel's level of distress ($t(93.65) = -0.97$, $p = 0.335$; Cohen's d = -0.20, 95% CI [-0.61, 0.21]).

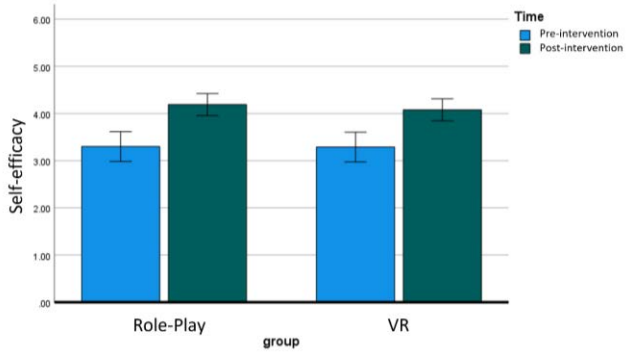

Figure 6: A bar-plot displaying pre-vs post-intervention self-efficacy treating a suicidal patient; error bars indicate ±2 SE.

We have performed bivariate correlations of presence, social presence, and self-efficacy in treating a suicidal patient (post intervention) in the VR condition(N=52). Both presence and social presence showed a significant positive correlation with self-efficacy post-intervention ($r=0.43$, $p=0.002$ and $r=0.49$, $p < 0.001$, respectively).

An independent two-sample t-test was performed to compare the differences in emotional response to "Daniel" (agent / actor). The emotional response to "Daniel" was significantly lower ($t(80.04) = 14.64$, $p < .001$, 95% CI [8.51, 11.19]; Cohen's d = 3.27, 95% CI [2.60, 3.94]) at the VR group (M = 12.3, SD = 2.64), compared to Role-play group (M = 22.2, SD = 3.77).

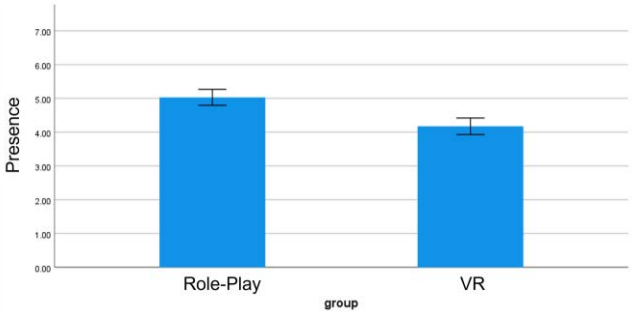

Figure 7: A bar-plot displaying the presence's scores in the VR group and role-play group; error bars indicate ±2 SE.

4 Discussion

We report two studies: VR-RPI with the general population and VR-SPI with mental-health professionals. In both cases we include a comparison with a role play condition and the results are encouraging: in both conditions there is a significant increase in self-efficacy, and VR and role play yield very similar scores.

In general, it is not easy to compare VR to 'reality'. In this study we chose to compare VR with role-play. We use presence questionnaires to compare between the subjective experience of being in the counseling session and the experience of interacting with another "real" person; not only the virtual agent may appear non-believable, but also the actors in the role play. As expected, we see that role play results in higher reported presence, but in both studies, both conditions yield high results, well over average. There were small and statistically non-significant differences between VR and Role-Play conditions in participant rating of Daniel's emotional distress, and in reporting that they felt like they were in a real therapy session. VR simulation is resource-efficient and keeps the focus on the development of skills instead of the quality of the actors. In addition, VR allows for a more controlled and consistent simulation; this contributes to experimental validity, and also decreases the chances that human idiosyncratic behavior would cause deviation from the intentions of the training designer.

Moreover, we see that presence is significantly positively correlated with the main outcome measure – self efficacy (Coping self-efficacy, self-efficacy in helping others and self-efficacy in treating suicidal patient). While this is only a correlation, this suggests further study for determining whether the intervention may have been less successful if presence and sense of presence were lower; e.g., if a non-immersive setup was adopted.

In study 2, the therapist's emotional response towards the virtual agent was considerably lower in VR as compared to role play. It is not possible to know if indeed the virtual agent induced a lower emotional response, or whether this is because participants (all professional therapists) may have felt reluctant to report that they were emotionally affected by a virtual agent. Importantly, despite this difference, both VR and role play conditions had very high levels of both presence and self-efficacy. This calls for further investigation – why was there a mismatch between reported emotional response and presence? Importantly, the low emotional response did not come at the expense of reported self-efficacy.

The implementation of the agent is relatively un-sophisticated: we have produced the VR carefully, but it did not include any sophisticated algorithms in either verbal or non-verbal communication, and the architecture is straightforward. One of the advantages of a simplified pre-determined dialogue is that we could use pre-recorded actor voices; despite continuous progress such voices are still more realistic than automatically generated voices. Given the successful results, the advantages that may be obtained by using more advanced methods in animation (non-verbal behavior), photo-realism, intelligent behavior – are unclear. Of course, an automated dialogue agent would have clear advantages like scalability and practice of a wider population, which will allow for better quality training that includes personal practice in a cost-effective manner. Nevertheless, we see that in this sensitive application, a human-in-the-loop operator may still be desired, and this has also been preferred when deploying the VR experience and the protocols in the field.

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