Applying Stress Management Techniques in Augmented Reality: Stress Induction and Reduction in Healthcare Providers During Virtual Triage Simulation

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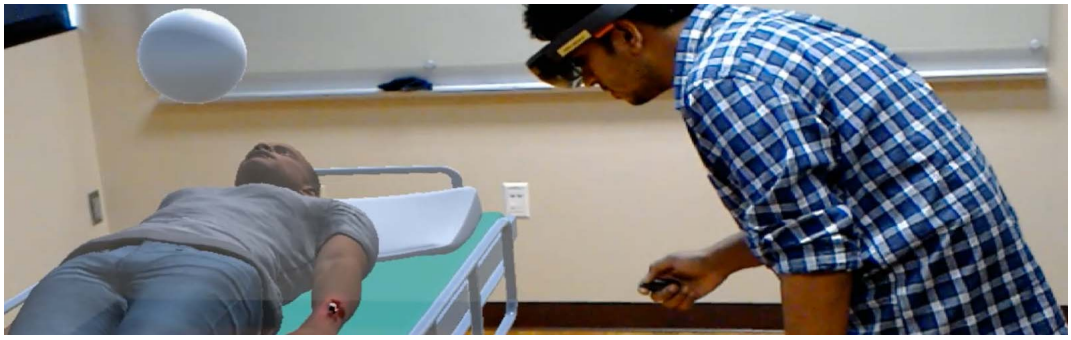

Figure 1: Participant inspects an injury on the virtual patient. The sphere above the patient is used to apply a triage tag.

Abstract

Exposure to realistic stressful situations during an educational program may help mitigate the effects of stress on performance. We explored how virtual humans in an augmented reality environment induce stress. We also explored if users can effectively utilize stress management techniques taught during a simulation. We conducted a within-subjects pilot experiment (n=12) using an exploratory mixed-method design with a series of virtual patients using the Simple Triage and Rapid Treatment (START) system. This work proposes a need to explore how realistic scenarios using virtual humans can induce stress, and which techniques are most effective in reducing user stress in virtual simulations.

Keywords: Augmented reality, stress, training, virtual humans

Index Terms: Human-centered computing—Mixed / augmented reality; Software and its engineering—Virtual worlds training simulations

1 Introduction

Virtual medical training simulations have previously demonstrated the ability to elicit the same stress levels experienced in real-world crisis management scenarios [2–4, 6]. Using this work as a foundation, we explored how a virtual simulation using interactive virtual humans could be delivered to users via augmented reality (AR) as a means for healthcare providers to practice stress management techniques. An augmented reality intervention based on triage was created in order to explore this area. The intervention was used to investigate whether stress can be induced in participants over time and whether stress management techniques can be taught in augmented reality. This work proposes future directions for the IEEEVR community to explore the use of virtual patients in augmented reality to induce stress in healthcare professionals, and how stress management techniques can be learned and applied in augmented reality to help reduce stress levels for healthcare professionals.

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2 Research Question and Hypothesis

- RQ1: Can using virtual humans in an augmented reality triage scenario increase stress?
- RQ2: Can teaching stress management techniques to virtual simulation learners help decrease perceived stress in an AR triage scenario?

For RQ1, it was hypothesized that stress could be induced using virtual humans in augmented reality. Participants' self-reported stress levels were measured on a scale of 0-10, with 0 being no stress. These stress ratings were written down by the participant after interacting with each virtual patient.

For RQ2, it was hypothesized that having participants learn and implement stress management techniques would reduce their reported stress levels. Stress levels of participants were compared before and after using a stress management technique while triaging virtual patients as evidence to support our hypothesis.

3 System Design

We developed an augmented reality simulation to allow healthcare providers to practice using stress management techniques during triage. This simulation used high-fidelity, 3D virtual humans with life-like voices for moans and breathing as well as computer-generated voices for conversational dialogue.

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The scripts of each virtual patient were designed based on their respective injuries and backstories created for them. The virtual patients were able to respond to over 400 questions. Patient responses can provide information to participants needed for triage and allow participants to try to connect emotionally with the patient.

Injury design is a critical part of designing virtual humans for simulation in healthcare. Designing injuries for this purpose requires a higher fidelity to facilitate the appropriate identification of the injuries and to reflect their accuracy for the scenario. Injuries chosen for the virtual humans were based on injuries that occur in actual bus crash accidents, and the virtual injuries were verified to look representative of their real-life counterparts by collaborators in the nursing field. Three aspects were chosen to determine the difficulty to triage a patient: visibility of the injury, assessment of the injury, and patient disposition. For many of the patients, the injuries were easily viewed by moving around the patients, but for some, the injury could only be discovered by speaking with the patient. The assessment of the injury refers to the trainees' ability to easily discern the correct severity level of an injury. Patient disposition was the final aspect used and this aspect encompasses a patient's behavior, attitude, and ability to speak with the trainee.

4 Experiment Methodology and Procedure

4.1 Participants

In total, 12 participants (2 male, 10 female) with ages ranging from 20 to 60-years-old, participated in the study. Four participants were faculty volunteers, and eight were nurse practitioner students. Six participants had previous experience performing triage, and the other six had no previous experience. One participant did not complete the study so the results were excluded from analysis of stress levels.

4.2 Procedure

Participants consented to the experiment and were then directed to the simulation room to watch a priming video giving background on the bus crash scenario involved in the simulation. Once the video was complete, the participant put on the HoloLens and began the simulation [5]. The first patient served as a tutorial for how to interact with the patients in the simulation. After triaging the tutorial patient, the training simulation began, and the participant triaged the next three patients. After the third patient, participants were introduced to a stress management technique that they were asked to use for the remaining patients. This stress management technique, which was found to be a successful strategy by Hunziker et al., consisted of participants asking and answering questions aloud to themselves [1]. The participants were asked to rate their stress on a scale of 0-10, with 10 being the worst and 0 being no stress at all, for each patient they triaged. This stress level was used to evaluate the effectiveness of the stress management technique. As the participant continued through the simulation, the difficulty to triage increased with each patient as measured by aspects discussed previously (see Section 3). Once all the patients were triaged, the participant continued to a one on one debrief with nursing faculty to review the simulation and receive feedback.

5 Results

The goal for the first research question (RQ1) was to explore whether previous research showing virtual humans can induce stress in healthcare professionals could be replicated in augmented reality [3]. The results showed that the average stress level of all participants was 3.35, with a standard deviation of 1.85, which indicates that some level of stress existed for each participant. Since the baseline measurements for stress were not measured, we cannot conclusively state that the reported stress was due to the simulation. Stress levels between patients were compared to measure if patients with different symptoms/features cause variation within stress levels for participants. The average stress level for all virtual patients was 3.35, with a standard deviation of 0.32. There was slight variance in the stress levels of patients, but since features between virtual patients were not controlled, which features of each virtual patient were increasing stress could not be conclusively determined.

For the second research question (RQ2), stress levels of participants before and after using a stress management technique while triaging virtual patients were compared to measure whether the chosen stress management technique could be effectively learned and deployed during the simulation. The stress management technique led to a reduction of stress levels for 5 out of the 11 participants with an average stress reduction of 0.73 per patient after the stress management technique and a standard deviation of 0.42 .The participants for whom the stress management technique did not reduce their stress saw an average increase of 1.22 in their reported stress levels after implementing the stress management technique.

6 Conclusion and Future Work

The current study provided an opportunity for healthcare professionals, nurse practitioner students, and nursing professionals to perform triage on mass-casualty victims using augmented reality, recognize their stress levels during their performance, and learn to manage their stress while triaging virtual patients. Similar to the findings from prior literature [2–4, 6], these findings support that stress can be induced in healthcare professionals using virtual humans in augmented reality. This initial exploration into stress management in AR has provided support to further investigate this topic through curricular integration of the simulation. We plan on integrating the nursing triage in AR simulation in a nursing class and have students practice stress management techniques.

This initial exploration has led to two research questions that warrant further investigation:

- FRQ1: What different features of virtual patients can be used to increase or decrease stress in healthcare professionals?
- FRQ2: What stress management techniques can be implemented in augmented reality simulations to help participants find techniques that may be more effective for coping with their own stress?

Our long-term goal is to refine and enhance the training for healthcare professionals by helping to improve their stress management skills before they are needed in real-world scenarios. Answering these questions, along with continuing verification of current research, will help to move towards providing effective stress exposure training for healthcare professionals in the future.

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