AR-Based Mobile Applications
for Exposure Therapy

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Abstract. Facing one's fears could be a way forward for people whose anxieties debilitate them. Exposure-based treatment is an evidence-based approach to reducing pathological anxiety. As a part of treatment, therapists who practice exposure therapy create environments to provide opportunities for patients to experience (and ultimately, overcome) the anxiety that arises for patients in feared situations. More than 50% of anxiety patients, however, never receive treatment. We developed an Android application that uses augmented reality (AR) for providing opportunities for exposure to spiders, a relatively common presentation of specific phobia. With this app, users can engage with exposure therapy without visits to a therapist. In the next phase, we will conduct a user study to determine whether mobile applications equipped with augmented reality technologies can be used to reduce the anxiety response to a feared stimulus (i.e., a tarantula), and whether the app is considered easy to use and acceptable. In this poster, we will provide details about the mobile app and describe the study setup.

Keywords: Mobile · Augmented reality · Spider · Anxiety
Exposure therapy

1 Introduction

People are often surprised to learn that approximately 1 in 4 people will experience an anxiety disorder at some point in their life [1]. Although these conditions are debilitating, more than 50% of people with an anxiety disorder will not receive any treatment during their lifetime [2,3]. Although clinical science has spent the past 30 years developing and refining effective psychotherapies, the overwhelming majority of people experiencing anxiety disorders will not access these treatments, highlighting the importance of developing interventions that are accessible.

Clinical research has established that cognitive behavioral therapies (CBT) effectively reduce symptoms of anxiety disorders, in many cases to non-clinical status [4]. A core component of CBT in the treatment of anxiety disorders is exposure, or systematically facing feared situations or stimuli [5]. As such,

this treatment involves routinely conducting planned exposures to increasingly anxiety-provoking stimuli or situations to provide patients an opportunity to recognize that their symptoms of anxiety habituate over time and gain a sense of mastery over these feared situations or stimuli. For example, an initial exposure exercise for a patient with significant anxiety about social interactions may involve asking a cashier at a store check-out how their day is going, whereas an exposure much later in treatment may involve presenting a speech to an audience. However, exposure therapy treatments have several challenges. One, therapists need to locate the appropriate stimuli or create a situation that triggers anxiety for the patient. When patients fear stimuli that are either difficult to locate or recreate (e.g., rare insects or flying on airplane, respectively), generating effective exposure situations can be particularly challenging. Two, creating exposure situations of graduated intensity is a particularly important challenge given participants may choose not to engage with the stimuli or participate in the situation due to fear [6]. Encouragingly, virtual reality (VR) based techniques offer enormous potential value to the work of exposure therapists since virtual reality allows patients to engage with a variety of potential feared stimuli gradually. In this way, VR technology provides an important capacity for clinicians to tailor treatment to target both the nature and the intensity of a patient's fear [7].

Suppose we could provide people with a way to experience these environments and allow them to track the way they engage with the environments when they are at their homes. Immersive technologies such as virtual and augmented reality allow people to experience situations as if they were physically in them, and although there has been initial work testing the efficacy of these approaches in the lab and in the context of clinician-supported psychotherapy, there is little work addressing the potential for these approaches to be effective independent of a structured clinical environment. The latest smartphones support augmented reality (AR) technology and make it possible for users to experience immersive technologies outside of a clinician's office.

The goal of our research is to conduct an initial test of the acceptability and efficacy of a mobile application that provides opportunities to engage with a feared stimulus in an augmented reality environment without the guidance of a therapist. In this paper, we present the design and implementation of the app.

2   Related Work

Immersive Technologies for Exposure Therapy. Prior research has shown great promise when using immersive technologies for treating anxiety. Previous work demonstrates that virtual reality can elicit distress when interacting with virtual spiders [8,9], with public speaking in front of a virtual crowd [10] and when standing on a plank[11]. Researchers also demonstrated that a VR-based one-session therapy (OST) for spider phobia is not inferior when compared to a traditional OST [12,13]. However, this previous work has relied on virtual reality, in which patients immerse themselves in virtual environments rather than

scenarios in which patients interact with a feared stimuli or participated in the feared situation in their current environment but they immersed themselves in a virtual environment. For example, in VR exposure therapy studies on arachnophobia, users wore a headset to observe virtual spiders in virtual rooms [8,9]. In another exposure therapy study, participants used a TPAD phone that gave haptic feedback when they touched a spider on the phone screen [14].

In more recent studies, researchers developed interfaces that allowed patients to interact with stimuli in their current environment. A system called the therapeutic lamp allowed for face-to-face therapy involving direct confrontation and interaction with a virtual animal in a real environment, but with a therapist present [15]. In a similar study, researchers developed a system where participants could pick up everyday objects with virtual cockroaches on them [16]. Researchers also developed an interface to help therapists monitor and control the virtual spiders during a session [17]. Ben-Moussa et al. proposed the design of Djinni, a system based on wearable glasses, to help patients with social anxiety disorder to give them feedback in stressful situations in their real life; although the researchers have not yet evaluated a study to determine the acceptance of this system [18]. Our app, similar to Djinni, is designed for use without the presence of a therapist or researcher.

Mobile Apps for Anxiety Disorder. Given the growing demand for mobile apps and the rapid adoption and popularity of mobile health, there are a large number of mobile health apps available on online app distribution platforms; research showed an estimate of over 200,000 mobile health apps in 2017, which is predicted to grow up to over 600,000 by 2025 [19]. Out of these apps, the American Psychiatric Association estimates that there are around 10,000 anxiety and depression related downloadable self-help apps. Unfortunately very few of these have undergone rigorous evaluation to test their efficacy and study their outcomes. Dekker et al. discovered 20 mobile apps that were designed as games to engage user while treating their anxiety and/or depression [20]. There is initial work implementing an AR mobile app in which AR was used for one patient as a way to reduce her fear and anxiety before a VR exposure therapy session [21]; in this case, however, the mobile app was a game involving virtual spiders to help ease the patient's anxiety before the exposure therapy session with a therapist. In a recent study, participants used an AR app similar to ours to interact with virtual spiders for an entire month, but this study was also conducted in a lab setting in the presence of a researcher [22]. In our study, participants will use the mobile app to interact with virtual spiders on their own, so that we can determine whether it is acceptable for use by patients who cannot get to formal treatment or in the context of clinician-supported psychotherapy.

3   App Design

Our mobile app allows users to view and interact with virtual spiders that are projected on to the user's environment using augmented reality (AR). As shown in Fig. 1 below, the spider is projected on to the printout of an image provided

with the application; in this case, an image of rocks. The image is placed in front
of the user and the spider appears on the image when the image is in the view
of the phone's back camera.
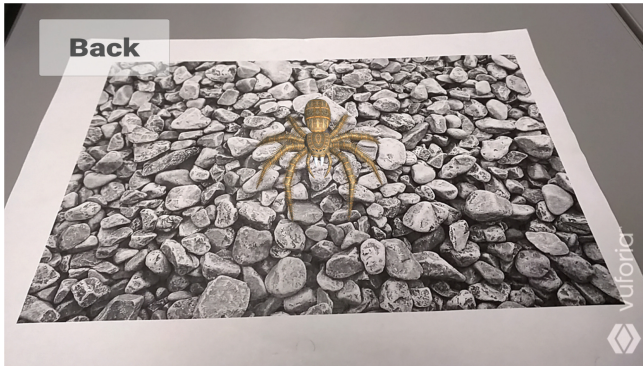
Fig. 1. Screenshot of the spider on the mobile app prototype

The user can interact with virtual spiders in seven different scenarios on
the app. In the first scenario, the spider is stationary, but of moderate size.
Since it is stationary, it does not respond to any user interaction. In the second
scenario, the spider is much larger in size but remains stationary. There are two
moderately-sized stationary spiders in the third scenario. In the fourth scenario,
the spider "attacks" by jumping towards the user when the user places their
hand below or on the virtual spider. In the next scenario, the virtual spider's
gaze follows the users as they move the phone around the image; the spider also
attacks or jumps towards the users if they move the phone closer to the image.
In the next scenario, the spider turns towards the user, walks towards the user
and crawls up their hand; once the spider goes off the screen, it turns around and
walks back towards its original position and repeats. In the final scenario, there
are multiple spiders and most of them are stationary; a random spider attacks
when the user brings the phone closer to the spiders.

The scenarios were chosen to present graduated exposure scenarios consistent
with evidence-based practices for exposure therapy. The application gives them
feedback to keep the patients engaged in the app and try something they have
not done before. The application also keeps track of the user's progress, such as
the time the user spent on each scenario, the distance between the phone and the
virtual spider as well as the time the user spent interacting with the spider. The
application also uses gamification to encourage the patient to beat their "best"
interaction, by listing the most time they interacted with spiders and spent on
different scenarios, as well as the closest they brought their phone to the virtual
spider.

4   App Implementation

The application prototype was developed using Unity3D and Vuforia and tested on a Nexus 6 phone. Unity3D is a game engine used to create video games with built-in features for 3D object creation and user interfaces. Vuforia is an augmented reality (AR) software development kit (SDK) that supports AR on mobile devices [23]. Vuforia utilizes a database of images, chosen by the developer, along with computer vision to recognize these images, for e.g., the picture of the rocks. The images are tracked using the camera from a mobile device and virtual objects, for e.g., the spiders, are then rendered on the images in such a way that the virtual objects appear to be part of the real world scene, viewable on the screen of the mobile device. Vuforia is supported by Unity3D, and so the virtual objects to be rendered correspond to the scenarios designed in Unity3D. We also developed C# scripts using MonoDevelop IDE to add interactivity to the virtual objects rendered by the Vuforia software and to monitor the user's interaction with the virtual objects.

5   Study Design

We will use our mobile application in a user study with participants who scored in the top 50% of the distribution on the Fear of Spiders Questionnaire (FSQ) [24]. The user study will have three phases: in the first phase, participants will have their fear of spiders assessed using the FSQ and a Behavior Avoidance Test (BAT) [25]. In the second phase, participants will use the mobile application on their own. In the final phase, their fear of spiders will be re-assessed using the FSQ and BAT, followed by an open-ended interview describing their experience using our mobile application. With this study, we expect to determine the ease of use and acceptability of our application as well as determine whether it can indeed reduce the participants' anxiety response to spiders.

6   Summary

The recommended first-line treatment for anxiety disorders is exposure-based psychotherapy. We developed an Android application that uses augmented reality (AR) for providing exposure therapy, so users without formal access to psychotherapy can benefit from it. Next, using the app, we plan to conduct a user study to determine whether mobile applications equipped with augmented reality technologies can be used to reduce the anxiety response to a feared stimulus without the guidance of a therapist, and whether the app easy to use and acceptable.

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