VRBAL:
detecting and overcoming anxiety in speech in an embodied virtual environment

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ABSTRACT

Speech anxiety is a debilitating phenomenon that affects 70% of the population, while stuttering is suffered by 70 million people world-wide, making verbal communication difficult and deflating. Conventional approaches like cognitive therapies are expensive, time-consuming, and inaccessible in the COVID era. To help stutterers overcome speech anxiety, we created virtual environments that can mimic everyday situations while applying meditative, artistic milieu to facilitate systematic desensitization in speech therapy. Measuring when stutterers were most anxious is unnatural with the GSR sensors. Instead we used fabric-based weaved sensors to pick up stress-expressing embodied gestures to tailor adaptive training, allowing stutterers to customize their therapeutic sessions for specific contexts without leaving their homes. Co-designing with advisors from the National Stuttering Association, we tested both VR systems and weaved sensors at workshops at vrbar in Brooklyn, and in-person and virtual sessions at Parsons School of Design, finding significant satisfaction with the training and continued participation.

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[A] Testing VRBAL with a stutterer volunteer (above) with GSR sensor (left) or fabric gesture sensor (right) for stress and anxiety.

[B] Summary of VRBAL: VR application with meditative intro selector scene followed by artistically rendered counter conditioning scene followed by speaking practice with or without audience (top). 3 types of fabric stress sensors: the crumpler, the stroker, the stretcher (bottom).

Authors Keywords

virtual reality, stuttering, speech anxiety, fabric sensors, conductive weaving, systematic desensitization.

CSS Concepts

- HCI~Interaction paradigms~Virtual reality
- HCI~Interaction devices~Haptic devices

INTRODUCTION

Fear of speaking has affected almost everyone, and for stutterers, that fear is compounded by the stigma of being judged weird, nervous, incapable, and frustrating [23], even though they tend to be good communicators [D]. The result is that they hide their condition and train hard to bury it. However situations like job interviews and public addresses force stutterers into the open, making training for fluency critical. However speech therapies are expensive, time-consuming, and not currently available due to pandemic safety concerns. To help stutterers overcome speech anxiety using virtual embodied interactions that they are used to, we created a Virtual Reality (VR) platform that uses artistic scenes and pleasing sounds to counter condition against speech anxiety before allowing participants to practice speaking in customized target environments [B].

In order to customize training to individual stutterers and evaluate its effectiveness, we have to measure the anxiety levels of participants throughout the training process. However, the noise inherent in the Galvanic Skin Response (GSR) and the discomfort this caused the participants led us to abandon the plan. Strapping onto a GSR device is not natural to speakers in a virtual environment. Instead of chemical sensors, we designed conductive fabric sensors that rely on gestural interactions to indicate stress and anxiety [B]. Stutterers are given a natural means of expressing their nerves, which in turn determines the difficulty level of the next training session (in the form of noise and distraction level). These gestures include stroking of the wrist, crumpling of fabric, and stretching two sides of a sheet, showing nervousness, fear, and frustration, respectively.

BACKGROUND

Almost everyone has experienced the anxiety and fear that comes from public speaking. Over 70% of the population has been estimated to have had some symptoms of glossophobia, the fear of public speaking [32]. These symptoms include acute heart rate and perspiration in the short term and reduced confidence and quality of life in the long term [10]. For one particular segment of the population, the fear of speaking is especially dire: those who stutter. Stutterers' speech is broken by uncontrollable repetitions and prolongations, causing stereotypic facial and bodily movements that can stigmatize the sufferer when compared to social norms. Due to experiences of being teased, failure to communicate normally, and loss of self-confidence, up to 60% of stutterers suffer from social anxiety disorder, a rate 6 times as high as non-stutterers [18].

Contrary to common portrayals, stuttering is a biological phenomenon that is particularly susceptible to differences in perception. On one hand, those who are fluent at speech are aroused and annoyed when listening to stuttered speech [13]. On the other side, stutterers often only show symptoms when encountering people they don't know, because of a lack of familiarity due to lack of perception of whether the listener would stigmatize the stuttering speaker [2]. Acknowledging the severity of one's stuttering, for example, lead to favorable outcomes in performance [6]. Our interviews with psychologists and stutterers also reveal that stutterers are more likely to enter into stuttering episodes in noisy and attention-grabbing environments due to less capability to maintain proper framing of the relationship with the listener. Consistent with this view is the way stutterers avoid gaze by closing their eyes or looking elsewhere when they try to elucidate speech [35].

Stuttering is also dependent on the speaking environment [20]. When there're greater number of audience members as in an auditorium, stuttering symptoms increase [29]. Indeed, talking at a cafe and speaking at a job interview are fundamentally different social situations, calling for training that adapts to each context in turn.

[C] Systematic Desensitization. Progressively more and more threatening stimuli are introduced step-by-step before the subject becomes comfortable, reducing her stress response to the stimulus (left). In the context of VRBAL, increasingly threatening speaking situations are paired with relaxation and breathing in an artistically rendered scene with relaxing sounds to make subsequent tasks less stressful before practicing an interview (right).

Current Treatment Strategies

Almost Stuttering never goes away, but rather hides under the surface. Common strategies for treatment involve therapies like stuttering modification which attempt to reduce the severity of stuttering, and fluency shaping which attempt to start by mimicking fluent-sounding speech [11]. These mechanistic strategies, however, fail to take into account the context in which the speech event occurs, and the psychological dimension underlying the perception of the listener.

Cognitive Behavioral Therapy (CBT) is one of the most prominent methods for ameliorating stuttering by reducing the social anxiety and avoidance associated with stuttering [26]. Cognitive behavioral approaches like systematic desensitization have been found to lead to greater reduction in stuttering behavior and minimization of negative attitudes compared to traditional approaches [27]. In short, systematic desensitization [C] attempts to treat anxiety by using counter conditioning to introduce a relaxation response to the conditioned stimulus which usually evokes the anxiety response like stuttering episodes [21]. The exposure to the environment that triggers stuttering can be in vitro, meaning the speaker imagines being in the context of making a speech, or in vivo, meaning the speaker actually undergoes the exposure at the location of speech-making. Studies have shown that in vivo exposure is more effective at treating phobias and anxieties [25], suggesting that describing the context for speech will be less effective than actively taking part in the environment for speech.

Although CBT are widely used and recommended by experts in our interviews with members of the National Stuttering Association, they are also time consuming, expensive, and not available in all areas, particularly in the time of social isolation which necessitates staying away from unnecessary trips outside one's homes. Is there a way to bring the benefits of CBT to the sufferers of speech anxiety, especially the training of the in vivo variety that maximizes positive outcome? We propose here that Virtual Reality (VR) can be a medium for mimicking in vivo

[D] Stutterers in the context of their communities, including their psychologists, social norms, and social groups such as the National Stuttering Foundation, and why hiding the condition is preferred.

[E] Example GSR trace from stutterer participating in VR testing. At approx 5 sec, the scene switches from relaxation into live practice (top). The GSR sensor worn, data monitored on laptop (bottom).

systematic desensitization by allowing subjects to see the exposure as opposed to be told to imagine it by a psychologist.

While the practice of art has been applied in therapeutic settings for reduction of anxiety [1], the effectiveness of artful environments in the context of systematic desensitization has not been well documented. While art can serve a beneficial role in post-traumatic stress [33], it may serve a meditative role in CBT. Quality of life measurements following CBT were improved when patients underwent therapy in a forest vs. control condition [31], suggesting that serenity of the environment where CBT takes place makes it effective.

Virtual Reality Experiences

VR is a simulation of the environment surrounding the audience, providing an immersive view of what can be imagined. Since the 1990s, VR has been applied to psychology primarily for exposure therapy settings in psychiatric care [24], phobias [36], post-traumatic stress [7], and social anxiety [5]. However drawbacks like motion sickness, bulkiness, and discomfort has limited its widespread use in the clinical setting [28]. In some situations, VR based exposure was found to have the same level of effectiveness as in vivo exposure [8].

Exposure methodologies in VR have also been applied to speech in the realm of helping college students with public speaking [14], finding that VR exposure was more effective than passive visualization in this endeavor [15], while being less invasive than actual in vivo exposure [16]. VR has also been applied to related phenomena like stage fright [19] and musical performance [4], but adaptations specifically to those who stutter have been limited. In one study on stutterers, speaking in VR to imaginary audiences was more stressful (subjectively) than speaking in an empty room [3], suggesting that VR can mimic the contextual audience expectation critical to determining whether stuttering episodes occur. However, this work points out the need for specific CBT strategies, a variety of contexts for training, customizing training to individuals with differing levels of anxiety susceptibilities, and a more natural way of measuring stress levels.

Measuring Anxiety

Previous work has attempted to measure Galvanic Skin Response (GSR) and skin temperature throughout VR sessions for public speaking [30], but the noisiness and lack of precise event timestamps have made it difficult to interpret these signals in terms of their correlations with subjective experience [E]. One way around these issues may be to create well-timed events in VR that lead to typical fast reactions in GSR, such as a cell phone going off during the speech. Tracking gaze in VR may also inform the participants' anxiety states [9].

Another approach involves measuring the anxiety of individuals not with chemical means but by looking at the gestures of their interaction. Previous work has used video analysis of nonverbal cues to infer communication of anxiety [34] and using gesture detection for automatic stress level estimation [17]. Gestures during speech can often be subtle, and the monitoring of speech by a video system is prohibitive in home use. Alternatively, using a handheld instrument that people feel connected to may better connect the stress response to immediate expression. People interact with fabrics and clothing almost every moment of their lives, and one of the ways they indicate fear and stress is by acting upon these tangible instruments. For example, we watch a scary movie and stroking the back of our wrists when nervous; we pull on our clothes when we get frustrated; and we shake our legs when we get anxious. Conductive fabrics have been produced that can detect particular movements of the fingers for rehabilitation purposes [22], and fabric-based sensors have been used to make gloves that allow gesture detection [37]. To optimally connect participants to the fabric, conductive weaves [12] can be employed for making the design of the fabric-based anxiety-stress sensors. This also gives the participants an intimate embodied connection to the sensors so that when they are stressed, they can make natural gestures in interacting with soft materials that are within their grasp.

METHODS AND RESULTS

We began by researching the population of stutterers in the US through contacts with the National Stuttering Association (NSA, of which the co-author is a member) and volunteers. The first round of interviews revealed that many stutterers are simply hiding the fact that they are stutterers. These covert stutterers do not recognize other stutterers because they hide their stuttering. Many stutterers do not get therapy, and past interviews show that they do not even join self-help groups. Stuttering non-profit organizations (NPO) have been trying to find ways to approach these people. Like the NSA, other NPO's are struggling with how to reach covert stutters. We mapped the community surrounding covert stutterers based on their answers [D]. The first people that covert stutters are able to open up to are stutterers like themselves, then therapists, and then, finally are their friends and partners close to them. We reasoned that speech therapy groups play an important role to make covert stutterers open up about their stuttering.

Two additional insights obtained are that stutterers love expressing themselves (subject BJG) and that stutterers rely on confidence gained during practice to help them get through important functions like job interviews (DM). We also spoke with speech pathologists RM and YY, who highlighted the frequent use of incorrect methods of training and its detrimental effect on children before pointing us to what pathologists actually do in the field using systematic desensitization. Generally, job interview was a number one concern for a majority of the stutterers interviewed (including JB, SK, MG, PWS, and DM), because it represented the lack of access and a major barrier to livelihood. In particular the first stage of the interview was most crucial, as an negative performance led the stutterers to spiral into doubt, poor performance, and self-loathing. In conventional interviews, 2nd interviews are usually granted to a few, but for stutterers their 2nd interview performances are signitifantly better because of the comfort level built by the first interview. Therefore we decided to design our application as a possible training for job interviews.

[F] Alternative VR prototypes. A WebVR prototype that lets users read positive experience stories online and practice speaking virtually (top). A Google Cardboard prototype of a single auditorium scene where animated characters make noise while the user attempts to practice a speech (bottom).

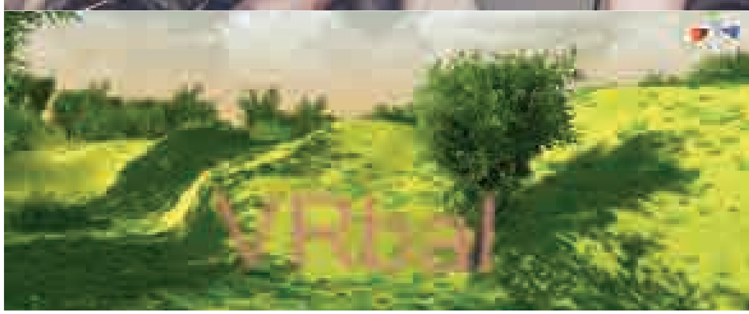
Virtual Reality Prototypes

We surmised that one of the best ways for stutterers to gain confidence is to tell positive stories about their engagements, for example passing an interview successfully. After gathering stories from our interview subjects, we created an online platform made in WebVR for stutterers to envision successful outcome [F], then practice those outcomes virtually online. If a user is going to use a story they made themselves, they should be watching it before they practice with it in the VR app. The result is the website **https://www.wearestarter.com/**, where you can read the stories each of the stutterers wrote for themselves.

To make the training goals attainable, a space more immersive than web is required. Thus we began prototyping with full VR tools. Currently, there is no effective way for cognitive behavioral therapists to make sure their patients are practicing coping techniques in a safe environment outside of their therapist's office, so the goal here is to produce a solution for a user who suffers from social anxiety due to their stuttering who hopes to reduce her anxiety for an upcoming interview. The user uses VRBAL regularly before the event to practice effective coping skills using systematic desensitization that will help them be less anxious. We created a Google Cardboard prototype to collect feedback on the scenes of relaxation and tension [F]. The scene shows a 360 video of noisy characters at an audorium in low fidelity. Using the Cardboard environment, we carried out initial testing on the tension filled test

scenes. A virtual classroom was created as a prototype in unity, and was viewed with Google Cardboard VR. The feedback gained as a result suggested that even faced with 3D figures, when the user is actually sitting in a chair, the scene is likely to induce tension. Thus, from users' actual experience of the tension scenes, we learned that it is necessary to take into account elements such as the user's line of sight, and whether they are sitting or standing when constructing scenes The scene shows how immersive environments induce anxiety in a speech-making task.

For our next prototype, we talked to two speech pathologists associated with the NSA to arrive at an implementation of systematic desensitization. Systematic desensitization is a behavioral technique commonly used to treat fear, anxiety disorders, and phobias. Using this method, the person is engaged in a relaxation exercise and gradually exposed to an anxiety-producing stimulus, like an object or place. We decided to include the above method in the VR flow. In other words, we decided to include in our VR application a method of therapy that involves repeating alternate doses of tension and relaxation. Following the introductory selection scene, the user is introduced to a low-poly artistic environment (forest, beach, or mountain locations), where a narrator in a soothing voice walks her through breathing and counting exercises designed to make her relax. The user is then asked to prepare to make a speech in a job interview exercise to test whether the systematic desensitization has helped her relax [G].

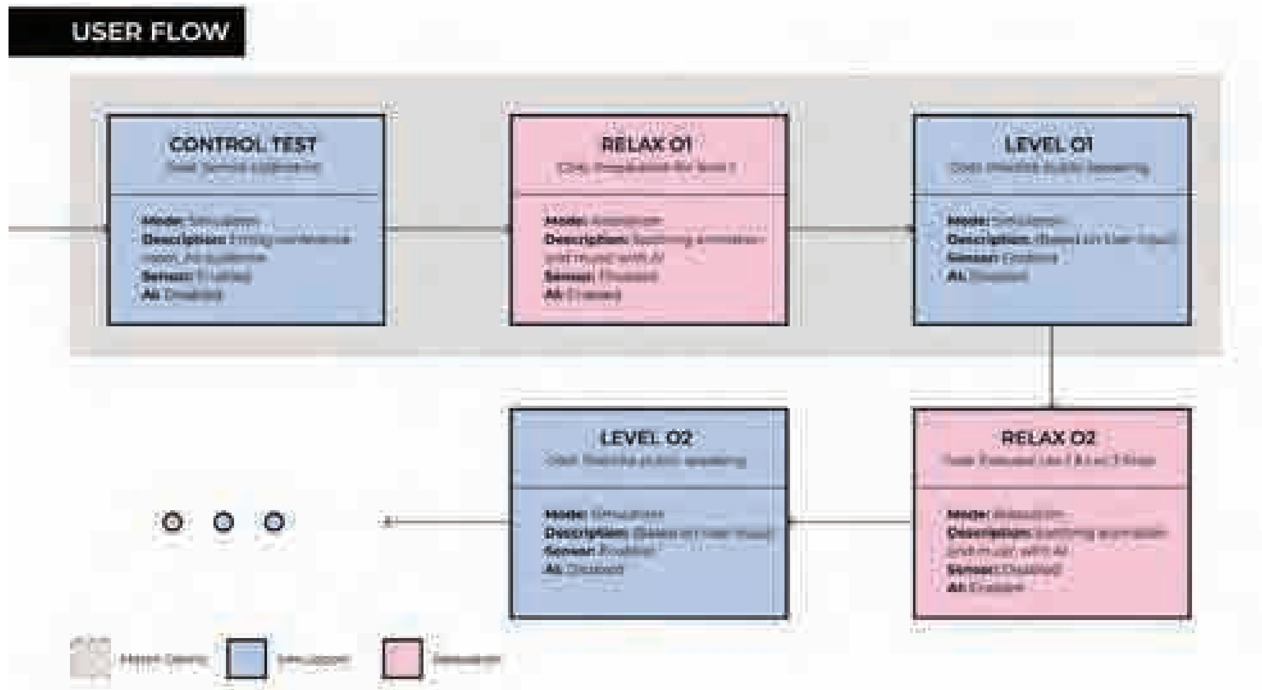


Low-poly **Realistic**

[G] First user test. Feedback was given regarding the scene being too bright and saturated. Other assets like the auditorium characters and scenes were evaluated. The highest rated scene was the low-poly desert scenes. Interestingly, users prefer low-poly scenes to realistic scenes because it gave them a chance to escape from the real world where the training occurs. For this reason, the desert scenes were used in the first prototype.

In the first set of user tests, we conducted user tests of relaxation scenarios. We designed 3D screens using gentle music and soft colored backgrounds, and then had users actually don the headset to ascertain how they felt. A total of six individuals participated in this test. We show screenshots from actual video used [G]. According to the feedback we received from the tests, the combination of sound and soft colors were relaxing enough as to make participants feel drowsy.

In the second test, we then conducted tests of the assets actually used in the relaxation scenes and collected feedback showing that the color saturation was a bit strong, and so it might be easier to relax if softer colors were used. For the testing scene, we tested both realistic 360 video assets vs. a virtual environment [H]. The advantage of the 360 video was that it reminded them of the actual situation where they have to speak as opposed to the virtual environment. While the realistic 360 video reminded them of real life situation, the virtual scene have objects that can be modified, for example for changing the distraction level on the fly. Virtual scene also makes sense for the relaxation, nonrealistic phase.



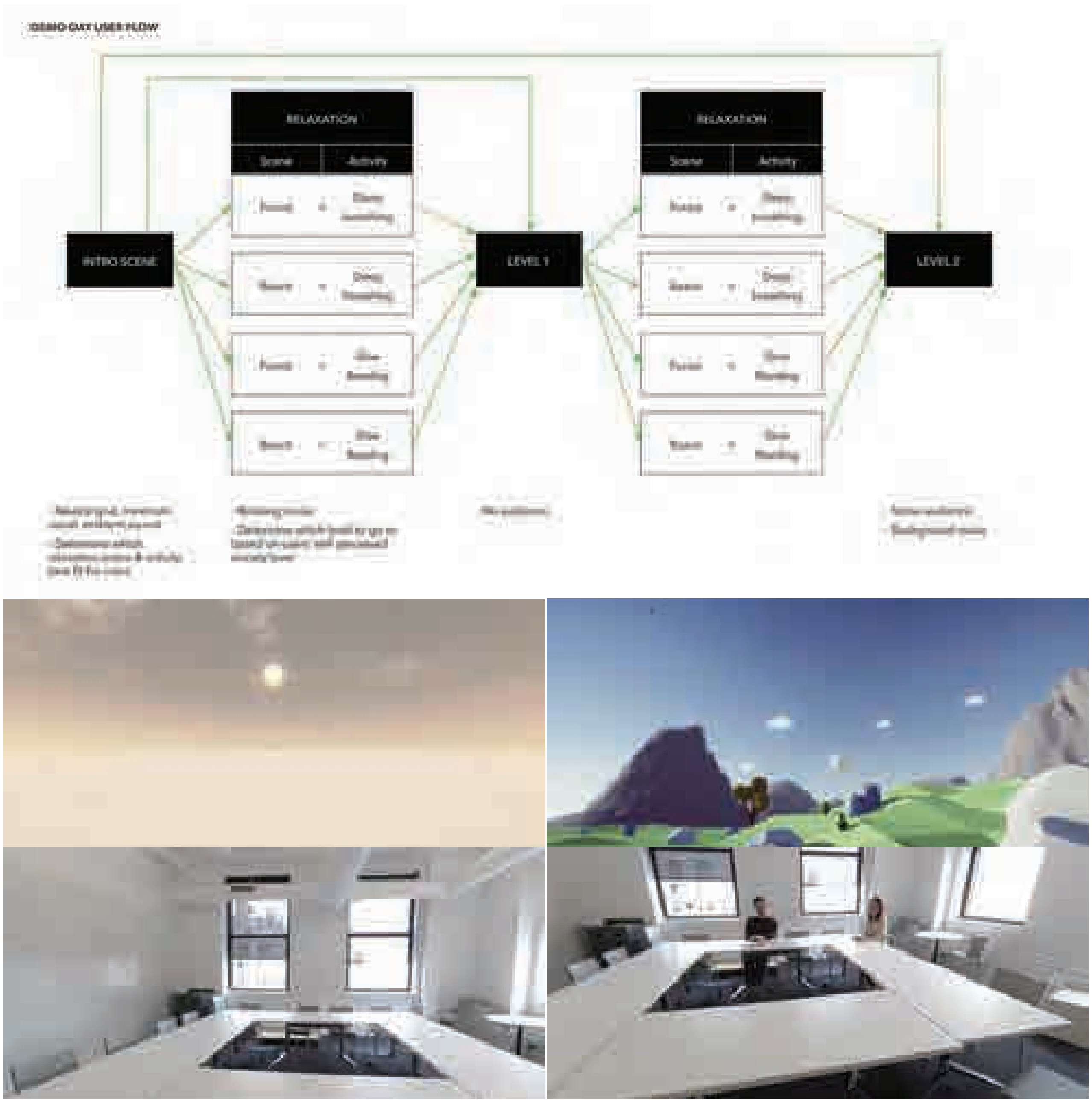
[H] Second user test. The skeleton of the program is sketched out: alternative relaxation and tension (testing) scenes (above). Stutterers are given an opportunity to progress in the testing scenes, where their stress level is measured while making a speech, getting progressively better at higher levels. A virtual assets scene vs. a realistic 360 video scene for the testing scenario (below). Users told us that the realistic scene reflected their needs.

At this point in the process, we were contemplating a structure for the application which involved measuring the user's level of anxiety with sensors and advancing them to the next level once they reach a state of lessened anxiety. For this reason, we researched what sort of anxiety might be expressed by stutterers. As a result of this research, we hit upon indicators such as eye movement, heart rate, and perspiration, eventually setting on GSR as a sensor of stress.

In the third user test, we used IBM's Watson for the user navigation AI. Then, we asked: upon actually conversing with the AI, which inspires greater tension, 360-degree or low-poly scenes? Which inspires greater relaxation? To find out, we carried out user tests. Through these tests, we were also able to gain feedback on the accuracy of the AI. Four of the test users said that they preferred the realistic environment for the practice simulations but they also expressed that it was too blurry and difficult to see. The other two expressed that they preferred the model based simulations and also expressed that they felt anxious when they say the model of the woman sitting behind a desk. Half of the users expressed that the positioning in the 360 videos was odd. Due to the preceding results, we decided to use the 360-degree method, which is able to portray more realistic situations, for the tension testing scenarios. The biggest issue that made itself known during this round of tests was that if the 360-degree recording device was of normal quality, the image quality of the video when actually viewed through the VR headset would appear to be poor and indistinct. We also decided to use the low-poly version for the relaxation scenes [I].

A Grove GSR sensor connected to Arduino IDE was used to track levels of anxiety during user tests. GSR identifies electrodermal activity (skin conductance)

[I] Third user test. 360 video realistic scenes (captured using the Ricoh Theta V and displayed on Oculus Rift) for relaxation (left middle) and testing (right middle). Low poly scenes for relaxation (left bottom) and testing (right bottom). Low poly was preferred for relaxation and realistic 360 preferred for testing (tension).



levels as a readout for anxiety. The state of the transition between levels of anxiety as measured by the sensor from one stutterer is shown in the video here: https://**youtu.be/Zqz4m1TNpBM**.

Upon employing the sensor, however, we came to understand that the reliability of the data was low [E]. In some cases, the sensor reacted hypersensitivity even when the user reported feeling no anxiety. The sensor also had to be strapped onto the user on two fingers, make her uncomfortable while trying to respond to prompts of the program. Thus we chose to forgo the use of the GRS, and in its place, the application was configured so advancement to the next level would be triggered by a direct declaration from the user to the AI that they would like to move to the next scene. The problem with sensing stress would be pushed to the next prototype of fabric-based stress sensors.

In the fourth user test, we learned from the stutterers about the AI agent being slow to respond, and got an insight that all users were disoriented when they entered the control scene. They did not know what they were supposed to be doing. So, we decided to add an intro scene to navigate users when they start using the VR app. A total of seven individuals participated in user tests of this prototype. The VR demo video from these user tests is at **https://youtu.be/OQtoU_bJ37U**.

We updated the user flow [J] while adding an additional relaxation scene. In addition to the desert scene, beach and forest scenes were added. From the previous hearing, we learned that the scenes which help people relax vary depending on the individual, so we aimed to include as much diversity as possible. Further, an introduction was added to the point when the user first starts up the VR application, in order to reduce confusion about how to proceed. All of this was learned from the previous round

[J] Fourth user test. Using an updated AI agent that responds more quickly and adding greater levels of scenes. The testing scenes now have different difficulty levels (low difficulty left, no one watching; high difficulty right, people watching; extremely high difficulty not shown, same scene as right but with siren noise from outside.

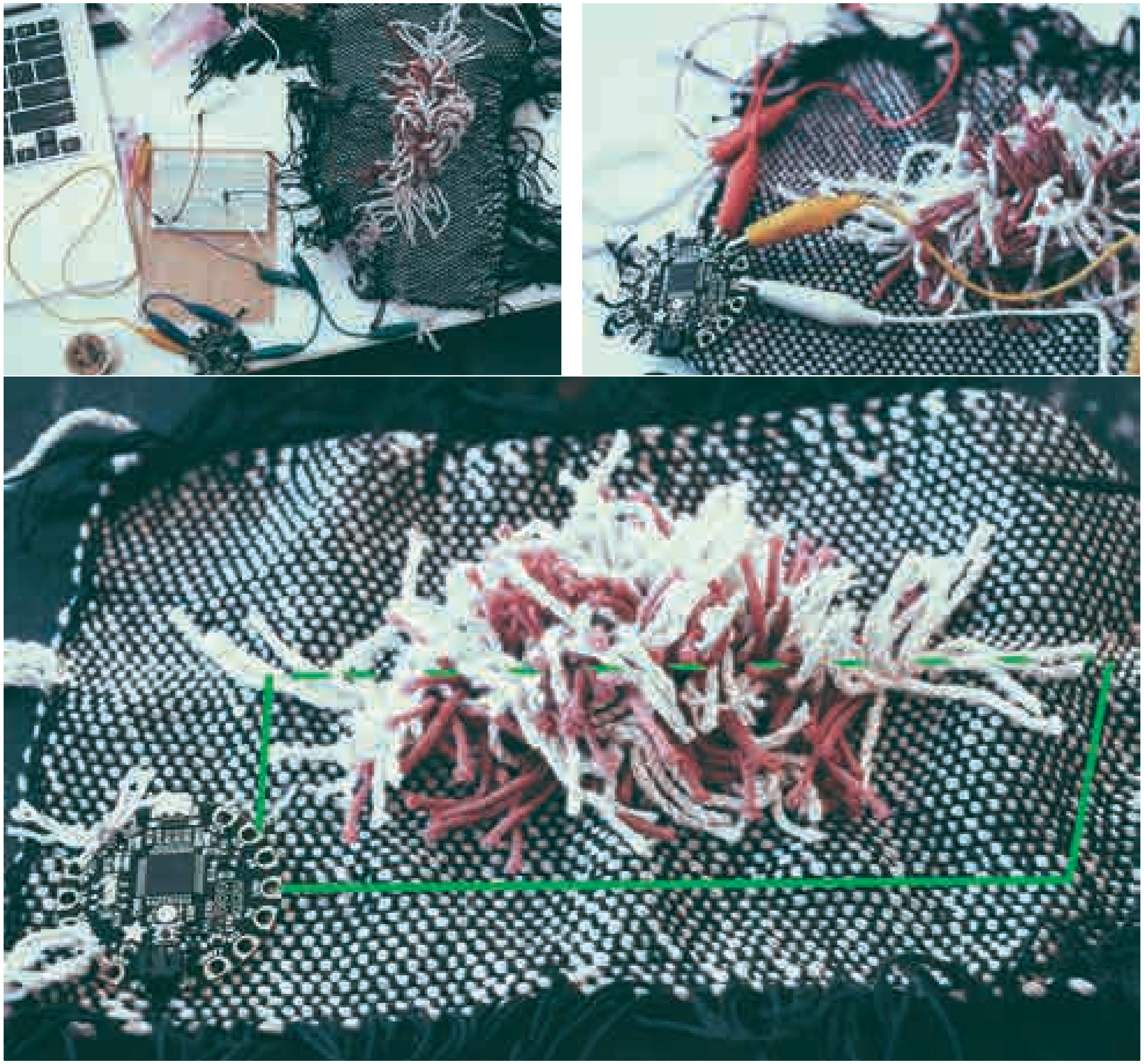
of tests. During the intro scene, the AI talks to the user, explaining features and how how to use the application. With this, implementation of all assets was complete.

As a final checkup, a VR application combining the assets and AI was prepared, and tests were carried out with a total of six stuttering individuals. To summarize, according to the feedback gained from this test, most responses were positive. Firstly, the improved accuracy of the AI made smoother conversation possible. Additionally, many people said that coming face to face with realistic people in the 360-degree video environment resulted in symptoms of nervousness/tension, including blushing and sweating. Beyond this, with respect to the relaxation scenes, users said that the relaxing music, together with the scenes of the forest or ocean allowed them to psychologically achieve a feeling of peace of mind. Not only that, but, similar to a therapist or meditation instructor, the AI's style of encouraging things such as deep breathing and a relaxed posture was highly praised by test users. Users said that being able to achieve feelings of relaxation before moving to the tension scenarios was a very refreshing experience. The last VR demo is at **https://vimeo.com/261867472**.

Fabric Stress Sensor Prototypes

In order to make the testing scenes truly interactive in the systematic desensitization, we need to have a way of measuring anxiety levels on the previous training block. Due to the unreliability of the GSR sensor, we decided to explore the use of fabric sensors that use the users' own gestures to indicate how stressed they are in an embodied interaction that is easy for them to hold and get accustomed to. Our goals is to leverage our own tendencies to clutch, chew, bite, and pull to make comfortable yet reliable cloth-based systems for sensing distress, unease, and anxiety. These sensors can then connect the user to the VRBAL AI to help tailor the systematic desensitization protocol. Since yarn is by its nature cozy and intimate, we decided to address the issue of detecting stress and anxiety using fabric-based sensors constructed out of weaved conductive yarn on a hand loom [K].

[K] Construction of each of the three stress sensors. The Crumpler is built using plain weave with a single conductive yarn thread (top). The Stroker is done using pre-cut conductive yarn that probabilistically connect in a carpet weave (middle). The Stretcher adds elastic yarn to the weave pattern.



[L] Connectivity of the Stroker, built from cut conductive thread pieces in a carpet weave. The basic premise is to connect the left and right side of the circuit using cut pieces of conductive yarn which would probabilistically conduct when you stroke it. When you grasp it, the full circuit is connected and resistance is low. When you simply stroke, the resistances are averaged in the Arduino code to give an analog level of stress indiction.

The Crumpler was constructed from both conductive yarn (Silver Spun) and a simple swatch using plain weave with a nonconductive yellow yarn and a nonconductive black warp. We included so much nonconductive material thinking that since the conductive yarn is never cut, it will be quite conductive, and more nonconductive material will be needed to render it innert, and human action (via crumpling and fisting) will be needed to increase the conductance. The resulting piece is mounted on the wrist and connected to an Arduino circuit that detects whether the front of the swatch is connected to the back. The circuit conductance increases substantially when we crumple, creating a switch-like circuit for detecting forceful action. However, the level of resistance is low to start with, and we wanted a more analog experience with gestures to tell specific anxiety levels instead of simply crumpling vs. no crumpling.

The Stroker was intended to capture stroking motions, such as the ones people make when nervous, in an analog way by a conductive-yarn-based fabric. We cut pieces of conductive yarn that are interspersed on the swatch itself. Notice here that the conductive yarn is not connected, so unlike the Crumpler, going from one side to the other on the swatch requires connecting pre-cut pieces of yarn. We connected the Arduino circuit together during construction, and found that unlike the previous prototype, this one requires more conductivity to have the circuit be connected even when stroking. The way we managed this is to increase the number of layers. Thus we create hanging rug-like elements by crossing them between two adjacent warps, then interspersed conductive and nonconductive yarn on a single thread, whose weave stops before going into the hanging elements. Because the conductive yarn is never connected to each other, we decide to reverse the order, going nonconductive where it was previously conductive and vice versa on the next layer up. We kept doing this on higher and higher layers until we got the right level of conductivity associated with stroking vs. non-stroking. Eventually participants we tested wanted to have the swatch on their wrists as a device they can stroke and crumple. We converted the Arduino circuit to one using Adafruit Flora, a wearable computing platform. The left and right sides of the strokable wrist band are joined to 3.3V and #10 pins of the Flora, respectively. The right side is also connected to ground off of a 10k resistor. The circuit is connected using conductive thread, which is imperceptible on the swatch [L]. When the circuit is stroked or crumpled to be connected, the Neopixel on Flora will turn on. When we first tested it, the stroke actions are still very much binary. To make the experience truly analog, we average across 500 trials of reading response and turn on the blue Neopixel probabilistically. This means if the stroke is less consistent, the LED will turn on in fewer segments of time, making the Neopixel less bright. If the circuit is consistently connected, we decided to go with the red Neopixel, so as to indicate that the distress is persistent and grave. Thus, stroking means there’s some nervousness associated while crumpling indicate grave stress to be sent back to the main VRBAL program.

The Stretcher attempts to see if actions involving both arms can be translated to changes in conductivity as a sensor. To continue in the analog vein, we wove the Silver Spun conductive thread together with elastic yarn thread to a pre-warped white yarn to create a stretch sensor with fabric. For the stretch prototype, we created a twill weave that makes a forward and backward pattern. This enhances the crumpled nature of the stretch sensor, although we would also like to experiment with elastic on the warp. When connected to the Arduino, you can see that resistance increases when stretched, presumably because the conductive yarn are separated better by the elastic yarn, and are less well in contact. Users tell us that this is the most satisfying of the prototypes because they can use two hands to indicate distress (a symptom metaphoric of tear their clothes when frustrated), and the weaving also has a crumpled but refined look that makes the sensor comforting.

The way these weaved sensors are used in the system is in [M]. They are shown in the way they operate here: **https://youtu.be/3Akn3Nlc90A**.

[M] Summary of VRBAL platform for embodied interactions in virtual speech therapy for stutterers. Begin in a relaxation state. Depending on gestural interaction indicating stress / relaxation in the previous training trial, determine how difficult the next training trial will be. Low difficulty is empty room. High difficulty is other people watching plus possible noise and distractions outside. Repeat until stress is low.

SUMMARY

To help stuttering individuals reduce their anxiety for tasks like presentations and job interviews without repeatedly going out to see their psychologists, we prototyped a system that uses Cognitive Behavioral Therapy paradigms to adaptively train using relaxation counter-conditioning. By using gesture-based fabric sensors to detect when stutterers are feeling stressed, we inform the system what level of noise and distraction is optimal for training. This system embodies the type of interactions that stutterers have while speaking: both in the way they have to perform tasks in realistic 360 video environments, and the way they interact with clothing-based sensors of stress. The next step will be to test this system together with stutterers again once government safety measures allow user testing.

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