An Exploratory Investigation into the Potential of Mobile Virtual Reality for the Treatment of Paruresis – a Social Anxiety Disorder

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ABSTRACT

This paper describes the initial exploratory phase of developing a VR intervention designed to alleviate the problems people with Paruresis experience when they need to utilise public toilet facilities. The first phase of the study produced a virtual environment, based upon a public toilet, which would run on the widely available Gear VR or Oculus Go HMD. The purpose of this prototype was to facilitate an informed discussion with a focus group of Paruresis patients, to obtain preliminary conclusions on whether they were interested in such an intervention and whether it offered potential to help alleviate the condition. In partnership with the UK Paruresis Trust the software was reviewed by both potential users and domain specialists. Results showed that the majority of participants reported a stress response to the stimulus of the virtual public toilet, indicating that it could be effective as a platform for graduated exposure therapy. Focus group feedback, and input from domain experts, was utilised as part of a participatory design methodology to guide the priorities for a second phase of development. The exploratory study concluded that this approach offers great potential as a future treatment for people with Paruresis

1. INTRODUCTION

Paruresis is a specific type of social anxiety disorder, also known as Shy Bladder Syndrome. The individuals suffering from this disability are characterized by the fear or phobia of urinating in the presence of other individuals. It is a spectrum disorder, ranging from an inability to urinate in busy public restrooms, to, in more severe cases, the inability to use a private lavatory at home when guests are present in the house. The effects of Paruresis are tremendous anxiety, embarrassment, reclusive behaviour and social isolation which impact the psychosocial conduct of an affected person (Boschen, 2008). According to the International Paruresis Association (IPA, 2017) 7% of the global population are afflicted at some level by this disability. Avoidant Paruresis suffers from a generalised lack of awareness and understanding among medical personnel and the general public along with inadequate treatment procedures; this adds to the suffering of the patients and raises the fear and embarrassment factor, ultimately making them unlikely to seek treatment.

2. BACKGROUND & PREVIOUS TREATMENT REGIMES

Williams and Degenhardt (1954), first coined the term ‘Paruresis’, after carrying out an in depth survey on a total of 1419 students belonging to various colleges in New Jersey. The questions asked by Williams and Degenhardt targeted the particular social scenarios or ‘triggers’ which initiated the dysfunction. Their results enabled them to uncover patterns correlated with age and change in environment of the patients. Analysing the results of the survey provided with the first clear picture that Paruresis not only existed but affected people on a substantial scale.

The earliest methods of shy bladder treatment were surgery based, such as bladder neck surgery by Winsbury-White (1936), or urethral sphincter surgery by Emmett, Hutchins & McDonald (1950) approaches which were drastic, invasive and largely unsuccessful. In vivo treatment by Wilson (1973), applied ‘imaginary supplanting’ to help aid a college student to completely recover from his phobia of urinating in the college restrooms. The methodology involved asking the patient to urinate alone, in a safe and empty bathroom environment, but to imagine the presence of another person just as he was about commence. In a space of two weeks this test subject was able to urinate, even in the presence of others around him. The success of this study led to further work (Anderson 1977) adopting a similar methodology with 5 patients, concluding with similar

levels of success. Alternative methods of treatment (Lamontagne and Marks, 1977) have utilised "flooding", the drinking of copious quantities of water prior to visiting a public toilet as a physiological stimulus to help overcome the blocking physiological response to the phobia.

For patients where such techniques failed, Ascher (1979) and Jacob and Moore (1984) developed the approach of paradoxical intention, a technique involving a patient visiting a public lavatory, unzipping their trousers and pretending they are urinating. Key to the intervention was the rule that despite their actions, they were not permitted to urinate. Repetitive exposure to this treatment resulted in reduced anxiety levels and a reduction in urinary retention. Mozdzierz (1985) was able to report a high level of success in a single participant with long term Paruresis by combining paradoxical intention with self-hypnosis. Limited interventions based upon medication have also been applied to the problem, for example Zgourides(1988) trial of Bethanechol Chloride and Thyer and Curtis (1984) trial of Furosemide, both being desensitising medications, however there is no direct evidence pointing to the potential of a drug based cure for Paruresis yet.

The current therapeutic approach is fundamentally built upon the work of Nicolau, Toro and Prado (1991), this entails the adoption of a multi-channel therapeutic approach, utilizing social intervention, cognitive restructuring and in vivo desensitization. Treatment and support for people with Paruresis is predominantly organised under the umbrella of the International Paruresis Association, in particular though workshops and counselling sessions. These are structured programs incorporating specialised graduated exposure therapies (GET) as a component within a programme of Cognitive Behavioural Therapy (CBT). In addition to the workshops, there are support groups and online discussion forums for information and experience sharing. They also provide information about existing drug therapies and support extended research into exposure therapies. The partner in this project, The UK Paruresis Trust is a registered charity providing these therapeutic workshops in the UK, along with workshops and support groups. They are also active in increasing awareness of the condition amongst medical professionals and the general public and promote consideration of the requirements of people with Paruresis in the design of public conveniences.

3. AIMS

The hypothesis underpinning this project is that a virtual environment simulating a public toilet can be utilised to increase arousal in people experiencing Paruresis. Evidence of an anxiety response in association with exposure to a simulated environment would thereby point to a future potential use of a virtual environment as a form of exposure therapy to help mitigate the condition.

Despite an exhaustive literature search, it appears that there has been no prior work in this area to investigate the potential application VR has as a therapeutic medium in the treatment of Paruresis. Such a finding is somewhat surprising, particularly when considered against the widespread prevalence of the condition, and the debilitating nature of the ailment. The previous lack of interest in this area is also noteworthy when examined from the perspective of the extensive body of literature covering the application of VR Exposure Therapy to a broad range of phobias, social anxiety, and mental health conditions (Valmaggia, Latif, Kempton & Calafell, 2016).

To help investigate this hypothesis two key aims were identified, the first was to consider the possible hardware platforms and software approaches which could be brought to bear upon this problem. The second aim sought to prototype an initial VR solution. The purpose of this prototype development was primarily to facilitate informed discussion in a focus group context, allowing genuine participant input into the direction and design of subsequent iterations. A secondary role of the first developed prototype was to evaluate the user experience and to obtain preliminary results indicative of increased anxiety levels, paralleling the real world experience of somebody with Paruresis. Such a result would thereby support further work, informed by participants, to refine and improve the virtual environment based upon user input.

4. DISCUSSION OF POSSIBLE VR APPROACHES

It was clear to the authors that VR technology offers great potential in this field, and several potential pathways which could alleviate the symptoms of the condition are apparent. In one scenario, the availability of low cost, portable VR systems could be deployed in the role of distraction therapy (Weiderhold, Gao and Weiderhold, 2014). In this context one could imagine somebody with Paruresis closing themselves off in a toilet cubicle utilising the headset and headphones to block out the triggers of the anxiety, replacing them with visual and auditory stimuli which are more comfortable, familiar, or psychologically sedating, than the real world environment they are situated in. VR Experiences such as "*Zen Parade*" (Mack, 2018) might be particularly effective in this context. Such an approach is very much a "Sticking plaster" solution, as it could provide a method of overcoming the symptoms of the ailment without any attention to the root cause. It would however be quick and easy to pilot at low cost using currently available hardware and software.

Of more interest, and the subject of this paper, is the potential to utilise VR in the context of CBT, specifically the potential offered by VR as a form of exposure therapy. Current in vivo treatment regimens are encumbered by several limiting factors. Initially there is an embarrassment threshold to overcome; People seeking treatment are required to disclose that they are suffering from a condition that they may regard as very personal and private. A VR solution would permit anonymity, both in the acquisition and the utilisation of the software. There are also issues of availability. In vivo treatment is limited by spaces available on a therapeutic workshop, and despite the best efforts of the relevant charities, when the prevalence of the condition is considered it is clear that face to face therapy will ultimately fall short of universal accessibility. Furthermore, improvement substantially depends on the individual carrying on the graduated exposure after the workshop; this is difficult for most due to the lack of availability of scenarios suitable for the stage the individual is at. Finally there are the cost implications. For some people this is a minor consideration, particularly when looked at from the perspective of the liberation that overcoming the condition brings. For others however the costs of treatment may be prohibitive, or for individuals at the less extreme end of the spectrum, may simply not represent a reasonable value proposition. It seems clear that utilising VR exposure therapy is a convenient and cost-effective potential solution, offering the possibility of greater capacity/availability and lower cost than existing in vivo approaches.

A closer examination of the specific nature of the VR experience falls into three distinct possible categories. 360 degree immersive video could be utilised. This would enable a high fidelity rendition of a toilet facility to be reproduced without a substantial investment in 3D modelling or programming. Prearranged scenarios incorporating a range of anxiety triggers could be storyboarded, and actors could perform the role of agents and avatars. There are some foreseeable problems with this approach, the prevalence of mirrors and reflective surfaces in toilet facilities permitting participants to see the technical equipment, or observe a “false” avatar. Obtaining the necessary ethical clearances and questions of privacy and decency were also identified as potential problem at this stage. It is however a concept that the researchers are keen to return to.

There is also a very clear role which augmented reality could fulfil in this context. This could offer the opportunity for the participant to relieve themselves in a natural manner, whilst augmenting their perspective of the toilet facility with computer generated humanoid agents. Such agents could be configured so as to facilitate a controllable stress response, based upon factors such as their level of realism, their proximity to the participant, or their behavioural actions. Recent SDK developments such as Apples ARKit or Googles ARCore make such a system feasible to develop. Whilst there are some complex implications associated with anybody wearing a head mounted display in a public toilet facility, it remains an approach which could be deployable in a controlled setting, such as at home or “out of hours” access at a workplace. It may also be viable to maintain an accurate “target” for toileting purposes whilst overlaying a full computer generated toilet facility, particularly of smaller spaces such as plane or train toilets, or individual cubicles.

An alternative, and the form of VR trialled in this study, is a simulated 3D environment produced using 3D modelling tools and made immersive and interactive through the utilisation of the Unity Game engine. The interactive nature of this kind of simulation offers enhanced potential to tailor the experience to meet the specific needs of different groups of users. Offering the ability to interact with the environment also enhances the degree of presence, known to be a factor predicting a successful outcome for VR exposure therapy (Price and Anderson, 2007).

5. METHODS

6.1 Equipment

The low cost Oculus based Samsung GearVR was selected as the head mounted device. This operates in combination with any Samsung Galaxy S series phone.The device costs approximately £50, so is a relatively inexpensive platform, a key factor when considering the potential for widespread adoption. It is also the highest sold, advanced consumer VR device of all time with over 5 million units in circulation by the start of 2017 (Batchelor 2017). This platform is therefore a mature and viable test bed for a potential rollout of the system. It is also worth noting that the development methodology employed, in particular the utilisation of the Unity Game Engine, means that the application developed is somewhat platform agnostic. The software is fully compatible with the recently released Oculus Go headset and deploying the existing codebase to Google’s Daydream VR ecosystem to make the therapeutic software available to an even broader audience is a relatively trivial step.

6.2 Selection of Participants

From the outset it was determined that, given the pioneering nature of the work, the participation of people suffering from Paruresis and those who are experts in the field would substantially improve the trajectory of the work. Discussion with Dr Steven Soifer of the International Paruresis Association (IPA) led to a meeting with the UK Paruresis Trust (UKPT) and after multiple follow up discussions, the board of trustees enthusiastically agreed to collaborate with the facilitation of the study. Time was allocated during a residential weekend workshop organised by UKPT, and participants at the workshop were able to volunteer to take part in the VR experience and focus group.

6.3 Metrics

A decision was made to use the Shy Bladder Scale (Soifer, Himle and Walsh 2010) to quantify the level of Paruresis in the patients. This questionnaire provides a simple benchmark to help understand the profile of the focus group participants. At this stage it was not intended that this assessment would be further analysed against the feedback responses of participants, though for future work the Shy Bladder Scale could provide a measure against which any alleviation in symptoms could be measured.

Since anxiety is a relatively subjective experience, it was determined that a validated questionnaire tool which could more clearly quantize the anxiety continuum would be adopted. A ten point version of Wolpe and Lazarus's (1966) "Subjective Units of Distress Scale" (SUDS) was utilised. Participants were asked to indicate an integer on a scale of 0 (no fear) to 10 (severe distress or incapacitating fear). The SUDs is frequently used in exposure therapy based studies as it is easy to explain to the patient, does not require any elaborate answering and easy to identify various levels of fear associated to the disability. In the context of this study we asked participants to complete the SUDS questionnaire twice. One questionnaire was completed immediately prior to using the simulator, and another immediately following the removal of the HMD. A change in scores therefore implies a psychological impact attributable to the experience of using of the virtual environment.

Qualitative feedback was gathered through a 30 minute focus group involving all the test subjects. This was designed as an open ended, facilitated discussion, to gather their opinion and feedback about the potential of a VR intervention as a treatment. It also sought to assess the suitability of the commercial HMD, and comments about the existing features of the prototype software, with suggestions for changes and additions which could be incorporated into the next development iteration. This approach should be viewed in the context of a user centred, or participatory design methodology where the initial prototype serves to focus discussion and facilitate concrete, informed opinion, guiding the priorities and trajectory of the second development iteration.

6.4 Description of the Trial

Nine participants present at a UKPT workshop volunteered for the VR trial. All were male with an age range of 22-60 years and a median age of 34 years. The Shy Bladder Scale (SBS) was used as a tool to rate the severity of Paruresis experienced by the participants. Out of a maximum achievable tally score of 76, patient scores ranged from as low as 28 to as high as 63. The Median score for the group was 49, with most patient scores falling within the range of 40-50.

The procedure involved the participant wearing the Gear VR HMD, noise isolating headphones and holding a wireless motion controller to track hand movements. The design of the simulation placed the participant in a virtual public restroom. This incorporated factors designed to induce manageable levels of anxiety for people with Paruresis i.e. presence of another human being, footsteps, or talking. It was intended that these could form a controllable exposure level, so factors which are liable to have a higher anxiety inducing effect can be controllably and gradually introduced as the patient's sensitivity decreases. Mechanisms to achieve this under the control of the participant or under the control of the researcher / facilitator were explored. Ultimately, to simplify the testing sessions a mechanism of gradually increasing severity triggers was used for this pilot study, with participants instructed to remove the headset if they found the level of anxiety induced to be excessive. The test session lasted up to 10 minutes, though participants were instructed that they were free to shorten this duration in accordance with their own comfort or level of interest.

Interacting with the first cubicle teleports the patient inside the toilet in a seating position and introduces an audio clip that creates presence of one or multiple individuals in the toilet adjacent to it. Interacting with the second cubicle does the same action as the first but puts the user inside the body of a static avatar sitting on the toilet. The differing approaches were intended to help facilitate a discussion about the importance of an avatar representation within the environment.

Patients were advised to spend a minimum of 2 minutes inside the cubicles in order to experience the range of triggers set up for the experience. They could however leave at any point by taking off the headset or focusing their gaze upon the cubicle locks which would facilitate an interaction to exit the cubicle, returning the patient to the starting coordinates in front of the wash basin. The application also gave the user a choice to teleport to the urinal, where triggers of adjacently standing human avatars and audio cues are. The user is allowed to turn, gaze and interact with the hand dryer whenever they wish to return to the starting location. The software developed incorporated both female and male toilets, with the user free to pick which door they went through. The single sex nature of the focus group meant that ultimately only the male version was trialled by potential users.

5. RESULTS & EVALUATION

The initial hypothesis was that exposure to the virtual environment could increase the arousal in people who experience Paruresis. Evidence of an anxiety response in association with exposure to a simulated environment could thereby support a future potential use of a virtual environment as a form of exposure therapy to help mitigate the condition. One of the objectives of the testing phase was therefore to obtain a measure which would support the potential utility of a virtual environment being deployed for the purpose of desensitisation. For any VR exposure therapy to be effective it is important that the user is psychologically engaged to the extent that there is suspension of disbelief and some degree of cognitive association made between the virtual world and the stimulus it purports to reconstruct. For this initial study we utilised the SUDS scale, looking for a rise in reported anxiety. This may seem at first glance to be counter intuitive, as the ultimate goal is the reduction of distress. In this context though, a measured rise in anxiety is indicative of the simulated environment promoting an analogous response to that which they might experience when visiting a real public toilet.

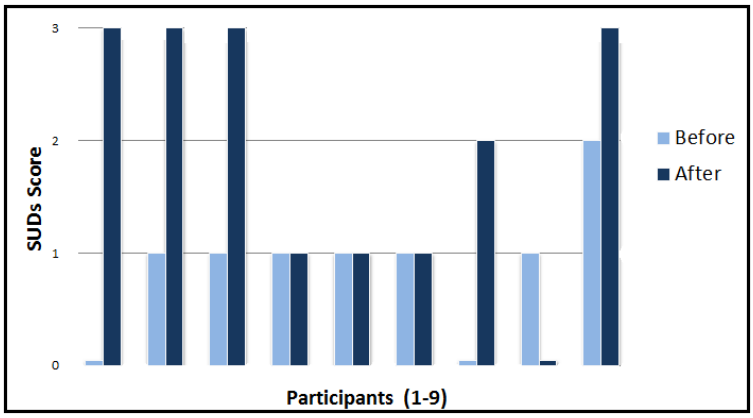

Figure 1 – SUDs Scores pre and post use of the virtual environment

When comparing a mean average of before and after SUDS scores, a total of nine patients showed a pre exposure mean anxiety score of 0.89. A similar mean average for the post exposure scores show a reported rise in anxiety, with the score reaching 1.89, so a mean increase of 1 step in the SUDs scale is reported. Applying a t test to these results yields a P value of 0.036, so statistically speaking the response is significant. That said, the sample size is small, and in this context the aggregated statistical results perhaps reveal less than can be inferred from an individual appraisal of each participants own scores. Looking more closely at the results five patients showed a clear rise in post exposure anxiety scores, while 3 showed unchanged scores and one patient recorded a lower anxiety score. It should be noted that the highest recorded SUDs score is 3, in both pre and post-test phase.

The results recorded from the SUDs are encouraging however care is needed in terms of interpreting the results. As more than half of the participants experienced the desired reaction from the use of the software, is can be implied that extended trialling of the software with this sub group is likely to yield interesting results. It is possible that this sub group finds it easier to quickly achieve psychological immersion, or that the stress cues present in the environment were more acute triggers for these individuals, accounting for a response. For the subgroup reporting no increase in anxiety it is possible that they did not achieve psychological immersion, that the environmental triggers were not in alignment with their own stress factors or that the triggers were not convincing enough to elicit an anxiety response. It is of course also possible that some participants were very slightly anxious about experiencing VR or participating in the study, and these confounding factors, which would amplify the pre-test score are a key limitation of this part of the study. It is possible that this interpretation explains the scores of the participant whose anxiety was reduced after using the simulator, and, if this factor was significant overall its impact would be to downplay the potential effectiveness of the simulation in eliciting a stress response.

The key intention of the study was to engage potential users of the software and to offer all participants in the study the opportunity to comment upon the first prototype, and to have input into the design and feature priorities of the next iteration. The focus group commenced by talking about the visual fidelity of the environment. One of the patients stated, "The quality of the structure was enough for me to believe I was actually there". The participants were all broadly in agreement with this point, and there was a generalised view that "realism" was an important factor in triggering their anxiety levels. This discussion of "realism" highlighted an issue with the interaction mechanic, of providing a colour change visual cue to highlight to the virtual objects which could be interacted with. This "unrealistic" mechanic was, with the benefit of hindsight, unsuitable for incorporation into an exposure therapy simulator where believability is central to success.

When questioned about the priorities for improving upon the prototype, the key feature requested was the incorporation of "other people". Whilst the simulation did in fact contain a representation of another person, these are such a key anxiety trigger that the lack of believability in the humanoid models utilised was immediately noted. It was therefore deemed to be important to incorporate high fidelity animated human models into the environment for future iterations. On the subject of avatars it is interesting to note that a preference was expressed for no avatar, rather than the self-avatar, after users had experienced both approaches.

One of the key issues discussed was the limited peripheral vision due to hardware restrictions on the Gear VR headset. For example, an agent urinating in the adjacent urinal couldn't be noticed unless the user turned their head around. A patient stated, "Peripheral vision, the way we are able to see 180 degrees without turning our head, I felt that was missing from the VR application because VR can't produce that".

Several users questioned the exclusion of free movement in the environment, a patient enquired, "Don't you think that being unable to move freely is an issue?" When the rationale for limiting movement in this prototype was explained they felt it was a reasonable feature to exclude from the environment, and it did not affect the primary functionality of the application. However the desirability of making the environment more explorable was noted and the potential of 6DOF mobile VR, such as that offered by the Oculus "Santa Cruz" could potentially facilitate this.

Finally, the focus group were not overly encouraging about its potential as a standalone treatment, being more supportive of its potential as adjunct to the existing workshop. As one participant stated "it would be a great option for patients to utilize it on their own between Cognitive Behavioural Therapy (CBT) workshops organized by the UKPT." One of the patients said, "I think we should start off by reading Steven Soifer's book in order to identify the problem. I'll definitely agree that this VR therapy is more effective for severe patients, like I was 12 years ago". An expert present, and a trustee for UKPT, stated, "I don't think that this VR exposure therapy can cure Paruresis by itself. However we can train our patients to use this in combination with Cognitive Behavioural Therapy. It will also help them by introducing a self-training programme to gain better control in the early stages".

In terms of priorities for new environments to be developed, toilets based upon those found in airplanes and trains were highlighted as the most useful alternative environments to now focus attention upon. Reference to the impact upon freedom to travel experienced by people with Paruresis is present throughout the background literature, and with hindsight would have been a good starting point for the first prototype. This finding perhaps

serves to reinforce the value of consulting with potential users at the earliest possible opportunity, and is already informing the path of ongoing and future developments.

In the weeks following the focus group five of the participants contacted the researcher, expressing an interest in future involvement with the project and reviewing future prototypes. One participant stated, "I have a Gear VR at home and if you can build something more specific for the triggers that affect me, please let me know"

Figure 2 - One of the UKPT trustees testing out the VRET

7 – CONCLUSIONS & FUTURE WORK

While the existing results are preliminary and tentative, they are nevertheless encouraging. There is good evidence that the initial hypothesis is well founded, and that a majority of users experience some stress response in association with the experience of being present in a virtual public toilet. There are also several technical avenues identified utilising VR technology which are worthy of further exploration and evaluation, with the likelihood that a portfolio of different experiences and approaches will ultimately be shown to have value in this context. There are however some significant issues which ultimately need to be addressed. The view of the users was that VRET software has a lot of potential to be used in conjunction with CBT and should not be considered as a complete replacement to present cognitive therapy techniques for treating Paruresis. This finding somewhat tempers the potential of an anonymous, self-administered therapeutic virtual experience envisaged at the outset. From a technical perspective mobile VR using the Samsung GearVR has proved acceptable in terms of low cost and environmental believability. However, there is a key limitation in terms of lack of peripheral vision affecting the perception of participants. This is particularly notable in the key context of standing at a urinal with somebody adjacent. While extremely wide field of view headsets such as Star VR or Pimax could resolve this, it would currently come at the cost of the low cost, and ease of access, offered by Mobile VR technology.

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