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Agoraphobia Research

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INTRODUCTION

This paper presents the design of an on-going experiment that aims to identify the features that induce the sense of presence in six virtual environments with different level of realism. The subjects for the experiment will be drawn amongst people with agoraphobia and also people without this condition.

The idea is to advance knowledge, methods and techniques for making virtual experiences believable whilst investigating the use of virtual environments and mixed realities as a therapeutic tools for the treatment of phobias.

BACKGROUND

What is Agoraphobia

The term of "*agoraphobia*" according to Salovskis & Hackmann (1997)

> "*refers to a interrelated and overlapping cluster of phobias embracing fears of leaving home, fear of entering shops, crowds and public places, or travelling alone in trains, buses or aeroplanes*." (p27)

Agoraphobia is a disabling condition. According to Davidson (2002) most agoraphobics feel uncomfortable in social scenarios, where the presence of others seems to lead personal freedom, uncontrollably, and provoke the fear and the apprehension of gaining other's visual attention in an explosion of panic attack. "*This means that agoraphobics to overcome their anxiety have to become especially skilled at finding ways to cope with others being around*" [Davidson, 2002, p11].

Treatment of Phobia in Virtual Environments

University College London has been working for a number of years on the use of Virtual Environments within the area of phobia treatment. Previous work focussed on social phobias [Pertaub et al._1, Pertaub et al._2, 2001] with a number of experimental and pre-clinical trials focusing on the utility of immersive virtual environments in treating related conditions. Currently several studies are being undertaken with Equator's assistance on the realism of virtual environments, in particular this study on agoraphobia goes under the umbrella of Digital Care research.

Our main objective is to study suffers of agoraphobia can learn how to cope with their anxieties using the latest technology in the area of Virtual Reality (VR)? As in previous trials, the first step is to create believable artificial environment, that is artificial environments that generate anxiety of the correct order. Once this is done we can then plan programmes to help people to learn how to overcome their fears, acquire stable strategies of situational behaviour and deal with the world of others, in a public spaces.

Studies have shown that one of the biggest difficulties for anxious people social situations and public spaces, like shops, restaurants and busses [Davidson, 2002]. This distressing condition forces agoraphobic to acquire coping strategies to manage their anxieties, and the simplest is avoidance, to stay in the boundary of their house and family. Thus in order to study our main objective, we derive the following initial research questions:

Would the agoraphobia sufferers feel uncomfortable in the presence of virtual people as they do with real people? What makes virtual people and buildings effective?

In moving towards treatment programmes, we note that unlike the real world the virtual environment is highly pliable. Thus the environment could offer the users the control of the situation allowing to grade the exposure of their environment to their ability to overcome their fears. If in distress it is easy press a button and remove people or shops. The hypothesis of the second stage will thus be: will the users be able to learn how to cope through a gradual exposure of increasingly realistic environments?

Finally, we using the techniques of mixed-reality we can hypothesise about programmes that associate virtual experiences with experiences in the real world. We can then ask what further can we provide to help them manage their anxiety in the real world?

Virtual Reality Technology for Medical Applications

A number of studies have considered the possibility of using virtual reality (VR) technology for medical applications [Rizzo, 1998] [North et al., 1996] [Rothbaum et al., 1995] [Rothbaum et al., 1997] [Schuemie et al., 2000] and in particular phobia treatment as in Emmelkamp at al. [Emmelkamp at al., 2001] research. The results are encouraging, since they found that virtual reality exposure is at least as effective as exposure in vivo for acrophobia.

Most of the works is done using not immersive virtual reality and only few studies involve the use of head mounted display (HMD) or slightly more immersive systems.

As shown by Schuemie and van der Mast [Schuemie et van der Mast, 2001], the use of VR technology in phobia treatment produces good results, especially in immersive systems. The search for realism supports the use of more immersive systems like CAVE™[1]s. When viewed through the shutter-glasses the images projected created the illusion of having three-dimensional (3D) objects appearing in the surrounding of the person in the CAVE. The more natural and immersive interaction with the virtual world in a CAVE encourages people to experience the virtual environment focusing on the world rather than the devices they are wearing or the solution for the movement. In a

[1] CAVE is a trademark of the University of Illinois. We use it here to refer to a general class of similarly immersive systems.

virtual representation of a room, the user can walk and move around as in a real room, depending on the dimensions. The system is less restrictive the other immersive systems like HMD, and offers a complete view of the VE, rather than restricted view offered by a screen or a HMD.

We believe that virtual environments, whether fully digital or a combination of mixed realities, can become the theatre in which agoraphobics learn how to exercise their skills in coping with the real world.

Another advantage in the use of virtual reality technology for phobia treatment comes from tracking. After each experiment, the researchers have data recording of all the movements that the participants have used as coping strategy during the stressful situations.

Virtual Therapy and the Role of Presence

The idea behind the development of a virtual therapy for the treatment of phobias is to recreate a believable artificial environment that stimulates physical responses similar the real one, but with the advantage that it can be individually controlled by the phobic or an experimenter or therapist thus allowing the experience to contain only the features that can be handled at the time. As the techniques to cope with the anxiety are learned trough a number of virtual sessions, the richness of the environment is increased to transform the virtual into a real world bringing the patient to be able to cope with the anxieties in the everyday experience.

The stimuli deriving from the virtual experience, if believable, might be a substitute for the real phobic object/situation. The underlying assumption that drives our work is that it is possible to create a VE in which the interactions with the synthetic places/objects are experienced as equivalent to those in a real world. The research we conduct aims to maximise the amount of time this "illusion of non mediation" [Lombard & Ditton's, 1997] can be sustained.

Since Agoraphobics are more sensitive to bodily sensations triggered by the environment, understanding what makes them anxious could allows us to understand how to make virtual environments more effective, and their heightened responses can guide us to tune the properties of digital worlds. Furthermore while we understand what can help phobics to cope with their anxiety in virtual environments, and bring this help as a portable digital support into the real world, we would also learn how to build useful relationships between the physical and the digital world and investigate possible effective interfaces between the two.

The Risks of Using Virtual Reality in Mental Health

One of the risks of using virtual reality technology for mental health applications is to force a highly technological solution, with higher costs, at least in the early day of its application, than the traditional approaches [Rizzo, 1998]. Due to the cost and space necessary for experiencing immersive synthetic environments similar to those we are using in our study, the equipment is not affordable by the average person or therapist. In the later stages of this research it is to propose the use of alternative and possibly more effective solutions to problems using mixed-reality systems.

The added values of the VR approach is the capability to replicate real situations in a controlled manner, the disadvantage is that reality is not ultimately controllable. Consequently a virtual

therapy should also considered driving the phobics from handling the virtual controllable towards handling the real uncontrollable world. We believe this can be done delivering scenarios and support form a virtual to a mixed reality, and once these are mastered, in the real world. "*The sense of presence could ensures that the perceived experience is interpreted as being real and makes it likely that skills learned in the VE will be transferred to the real world* "(p 265) [Romano& Brna, 2001]. The question whether learning in virtual environments can be transferred to the real world is still unsolved for a virtual therapy, although several studies have reported successful transfer at least for some skills, like navigation and spatial awareness, see [Romano& Brna, 2001] for a review.

EXPERIMENTAL DESIGN

Research question for initial studies

The research questions that we try to answer in this study are:

1. Do different virtual environments, with different characteristics produce different presence score on the Presence Questionnaire?
2. What is there in common between worlds with similar presence scores on the Presence Questionnaire for non-phobic people?
3. Do agoraphobics feel present in the same virtual environment as people without this condition? and if so do they rate them as having higher or lower presence score than the average non-phobic person?
4. Do agoraphobic identify the same features in common in a VE compared to people without this condition?

We have decide to answers the above trough two set of sub-studies, one will ask question 1 and 2 concerning Presence in virtual environments and a second one more concerned with phobia that will try to answer question 3 and 4.

The virtual environment chosen

The experiment goal is to evaluate the reaction and feeling of the phobic and non-phobic participants to the different levels of realism of six virtual environments. The aim is to be able to identify features that can allow us to evaluate the realism of immersive virtual environments (IVEs).

The simulations all reproduce real world environments and present each a different range of features. From open uncluttered to close clutters spaces, with different realism in the avatars populating the world, from no-texture to detailed textures, with different setting in the collision detection. Below in Table 1 there is a description of the features of each of the virtual environments chosen, while in Figures 1 to 6 there are snapshots of the environments themselves.

Table 1: Features of the virtual environment chosen.

Virtual Env.	Space	Texture Mapping	Avatar
VE 1	Open Space	No texture mapping	No avatars
VE 2	Open space with some enclosure	No texture mapping	Static Black billboards
VE 3	Large closed space uncluttered	No texture mapping	Static textured billboards
VE 4	Large closed space densely furnished	Texture mapping	Static 3D un-textured
VE 5	2 rooms scarcely furnished	Texture mapping	3D textured with head animation
Level 6	Open space	Texture mapping	3D textured walking

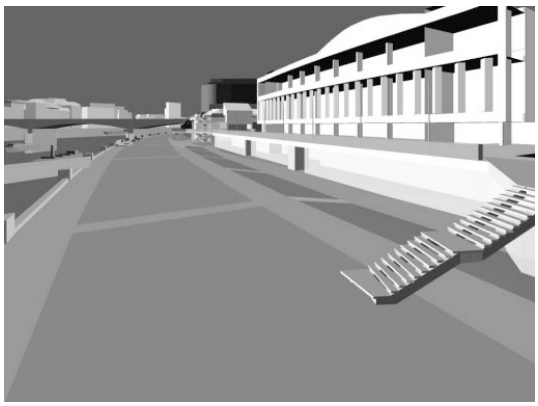

Figure 1: VE1 – Virtual London, South Bank.

Figure 2: VE2, Virtual London, Dome.

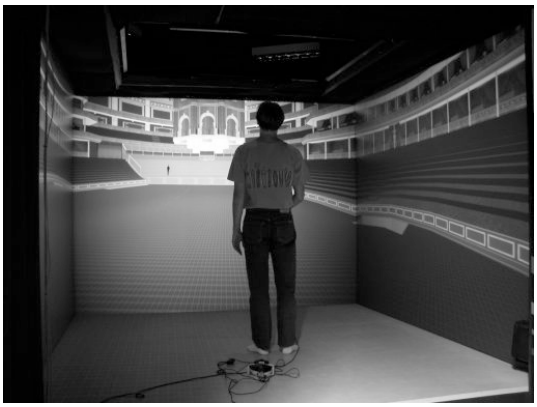

Figure 3: VE3, Virtual London, A participant visiting Royal Albert Hall.

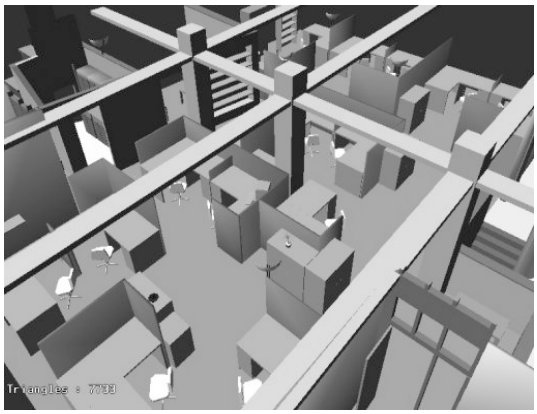

Figure 4: VE4 Virtual London, office in UCL campus.

Figure 5: VE5, a library

Figure 6: VE6, a busy day in a city.

Equipment

The participants are placed inside a CAVE [Cruz-Neira, 1993] [Roy et al., 1994] in which the images composing the six chosen virtual environments are projected. The CAVE system used is a ReaCTor made by Trimension, consisting of three 3m x 2.2 m walls and a 3m x 3m solid acrylic floor. It is powered by a Silicon Graphic Onyx2 with 8 processors MIPS R12000 at 300MHz, 8GB RAM and 4 InfiniteReality2 graphics pipes. The participants wear CrystalEyes stereo glasses, which are tracked by an Intersense IS900 system, with 6DOF ultrasonic sensors.

The participants are allowed to navigate in the Virtual Environment, one at the time, using a navigation device joystick-like, with movement direction determined by the pointing direction. The frame rate of the simulation will be taken around 45 Hz.

The heart rate tracking will be done using the ProComp+ encoder by Thought Technology Ltd. This is a precision device for biofeedback and real-time physiological monitoring that is capable of digitizing data, using up to 8 non-invasive sensors. The sensor information is digitally sampled and the resulting information is sent to the computer via a fiber-optic cable. Every sensor has sensitivity $<0.1\mu V_{RMS}$ and accuracy of ±5%, ±0.3μV, working in a bandwidth of 20Hz – 500Hz. This allows the system to work with an accuracy of ±5% and a Sample Rate/Channel of 20 - 256 samples/second.

Participants

In the first sub-study concerned with the sense of presence sixty non-phobic volunteers experience the virtual environments chosen for the experiment. Their recruitment will take place within the university campus, excluding those that have any relation with the computer science department, to avoid the risk of having person with good experience in virtual reality, which might have increased their sense of presence.

Furthermore, for the sub-study concerned with phobia, we have recruited six self-declared agoraphobics through the National Phobic Society bulletin board and newsletter.

The task

The participants, phobic and not, will be asked to act as a tourist visiting the virtual space, representing in most cases well known tourist attractions in London. They are free in their movements and allowed to go wherever they like within the virtual environment in the boundary of the CAVE.

Procedure

Training in BIPs

The participants are trained in the recognitions of break in presence (BIP) [Slater and Steed, 2000] through the visualization of a series of 2D images that provide a different perception of the object represented according to the features that one consider as constructing

the picture he/she is looking at. Does figure 7 depict an old woman or a young woman? This figure was was first drawn by W.E.Hill in 1915. It became known as the Boring Figure.

***Figure** 7 – Is this a young or old woman ?*

Sometimes it is difficult for participants to see one or the other image, but once they have, their perception can switch from one to the other. The participants in this way will be introduced to the idea that not everything we see is really as one perceive it and that it is possible to switch between perceptions.

Subsequently they are trained in to use of the navigation device in the virtual environment, a joystick-like device, and introduced to a first 3D world in the CAVE. This time they are going to experience a new three-dimension illusion.

Three rooms, two on the same level and one placed below constitute the 3D training world. The participant starts experiencing the simulation in a first room and is asked to go to the other room and look on the floor. In the adjacent room, accessible via a door, the floor seems to be missing in the central area and the room below and its furniture are clearly visible at some distance. For a more detailed description of the environment see [Usoh et al.1999].

The first impression is that a person has looking down in the room below, especially being at the edge of the missing tiles, is that walking over that area one might fall. The vision produces an adrenaline release that can excite or scare according to one own fear of highs. The participant is asked to do exactly that, to place his feat over the missing tiles. Once a feet is placed over the apparently empty area there is a switch in reality, a BIP; since one realises that the floor is actually solid the reality of the CAVE and the laboratory becomes predominant, breaking the illusion created by the synthetic environment.

What we ask the participants during these training session is to learn to recognise the switch between realities, the BIPs, and to keep a track of how many times this happen with experiencing the virtual environments on a hand-counter.

Experiencing the virtual environments

Of the sixty non-phobic volunteers participating to the study, fifty-four have experienced only one virtual world and rate it on the presence questionnaire. While six of them have been asked to rate all the six virtual environments, and subsequently interviewed to identify the features that the environment might have in common. In doing so we hope to be able to have some rating of statistical significance on the first synthetic world a non-phobic person experience and a case study result on the common features.

Also we asked the six agoraphobics volunteers to experience all six virtual

environments, each of them starting with a different one, to rate them on the presence questionnaire and after to describe in a interview the features that they believe the worlds have in commune.

Measuring instruments used

The latest version of the presence questionnaire used in previous studies of the VR group of the department of Computer Science, University College London, has been used to rate the level of presence in each of the virtual worlds.

In addition for the second sub-study interviews with the 12 participants, 6 non-phobics and 6 phobics, have been conducted using the Repertory Grid, a technique proposed by Kelly (1995) [Kelly, 1995] as part of the Personal Construct Theory (PCT).

Originally developed for clinical psychology, the repertory grid technique is here used as a tool for conversation with the users of the virtual environments aimed to identify the personal constructs. Personal constructs are dimensions or items trough which each individual perceive the worlds under comparison and through which they attribute meaning to their perceptions. The way they respond to the subjectively significant dimensions of each of the worlds depends much on their previous experience and familiarity.

A repertory grid analysis proceeds by the interviewer selecting three of the six worlds and asking the subject to identify a construct with two poles that distinguishes two of the three from the other. An example construct might be "sociability", with the poles "hostile" and "friendly". This process of extracting constructs is repeated several times each until no more distinct constructs are elicited.

Once a set of constructs is generated, the subject then rates the all of worlds against these constructs, placing them in a scale order between two extremes of opposing poles. Once a table of ratings has been constructed, a cluster analysis is performed to achieve a measure of distance between the worlds and the items through which they are perceived. This exercise gives an insight into perception of the various worlds.

Finally the researcher asks the participants why certain construct are important to him/her, "laddering up", and how they differentiate amongst one another, "laddering down"

Agoraphobics and non-phobics groups experiencing all 6 worlds have gone through the same interview technique with the aim to understand the items that each of the two groups perceives from the chosen virtual environments and the rating of the worlds amongst them.

The heart rate of the 12 volunteers experiencing all six worlds has been recorded, being those 6 non-phobics and 6 agoraphobics. The hope to be able to compare the reactions of the two groups while experiencing the synthetic illusion.

We have the timings of BIPs recorded by the participants.

Finally the physical behaviour of the 12 participants whilst experiencing all six worlds had been recorded with a video camera.

STARTING POINT FOR DISCUSSION

Hypothesis

We believe that the four research questions formulated above, will have the following answers.

- *Do different virtual environments, with different characteristics produce different Presence score on the presence questionnaire in non-phobic people?*

We believe that the answer to this question is yes, and that the differences in realism in the elements composing each of the virtual scenes will influence the perception of presence in the world.

- *What is there in common between worlds with similar presence scores on the presence questionnaire for non-phobic people?*

We can not clearly answer to this questions until we have actually analysed the repertory grid, BIPS and heart rate of the phobics and non-phobics participants. We believe that they will be related to the varying characteristics of each of the worlds as shown in *Table 1*.

- *Do agoraphobics feel present in the six virtual environments?*

The answer to this question we believe will be yes.

- *Do agoraphobics rate them as having higher or lower presence score than the average non-phobic person?*

We suppose that since the agoraphobics are more sensitive to the real world stimuli, if they feel present in the virtual worlds, they should also rate presence with a value somehow higher than non-phobics people.

- *Do agoraphobic identify the same features in commune amongst the virtual environment than non-phobics people?*

We expect the agoraphobics to identify items of the environments that are also noticed by non-phobics people and in addition to highlight items that belong to their own fearful perceptions of real urban environments.

SUMMARY

We have summarised here the background and setting of a study on the identification of the features that make virtual immersive cities believable. We have also placed this within a larger programme of research on studying agoraphobia and its treatment using virtual reality and mixed reality systems.

We also hope that we can advance research in the general area of development of believable virtual worlds by studying the complex reactions of agoraphobic to the real world urban spaces

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