Digital Care for the Physical Environment

UCL Equator Project Proposal

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"Much of what therapists engage in with their clients is the construction of artificial environments in which people can learn to overcome their fears." Prof. Chris Brewin, Department of Psychology, UCL.

1. Introduction

We propose an Equator project to be led by UCL, which provides a unifying application focus for our technical research. This builds on existing strengths and experiences of the UCL group, and also utilises strong existing contacts with a user base.

Over the past three years we have conducted research together with clinical psychologists from UCL and the Institute of Psychiatry in London. The purpose of this research at applications level has been to explore the extent to which virtual environments may be used to understand and treat anxiety orders. In particular we have focussed on social phobia, and within that mostly on 'fear of public speaking'. We have also carried out a small amount of work on more general social phobia, such as interaction within a social setting such as a party. We have more recently started a series of pilot experiments on paranoid ideation (where people attribute hostile thoughts to other people in an environment).

In each of these environments a real person interacts with virtual people in various possible settings - giving a talk to them (fear of public speaking), introducing oneself to them at a party (more general social phobia), and just being amongst them (paranoid ideation). In each case the virtual characters respond - by looking towards the real person, changing facial expression, saying things to them, changing body posture, physically moving away from the person, glancing towards and away, whispering to one another, and so on. These studies have been carried out on equipment ranging from desktop to immersive CAVE.

The fundamental computer science question asked in each case concerned what characteristics and behaviours the virtual characters had to exhibit in order for the appropriate affect to be generated in the real person. If a person speaks to what they know to be an entirely virtual audience that is hostile, to what extent will it make that person feel bad, if the audience is friendly will the person feel good? The fundamental result is that people do respond with the appropriate affect to virtual characters - in fact it seems that we cannot but help respond even at the physiological level, even though cognitively we are fully aware that our responses are logically inappropriate. Why feel bad about a negative virtual audience - there is nothing there! But our perceptual systems do not understand virtual reality at a deep level, so they respond to the sensory input as if it was input from the real world. To our sensory systems there isn't much difference between virtual reality and reality.

Since the answer to the fundamental question is 'yes' there is an affective response correlated to the conditions being experienced, then it is the case that therapists can design a treatment program using the VE system. This is exactly the point that the 'fear of public speaking' work has reached.

2. Extensions to Digital-Physical Environments

Equator is concerned with the interface between digital and physical environments. This interface can be synchronous or asynchronous (or both at the same time!). In the synchronous case digital information is present in the real world, or 'real' information is present in the virtual world, and the interest is in the seamless unification of these. In the asynchronous case there is a virtual world which is a map of some real-world place, and the human participants use the virtual world for simulations and rehearsals of activities to be carried out in the real world. In the mixed asynchronous-synchronous case, there may typically be a virtual world with synchronous real-world information, all to help in future experiences in a real world. Our proposal covers these various possibilities.

Our interest remains with the 'digital city' as described in the original proposal, in terms of the city as a framework for activities, including crowds of virtual people, places for real people to interact with one another and with virtual people. We interpret 'city' very widely to incorporate aspects of a city such as shopping malls, transport, and including lighting and weather. Our fundamental research interests are in computer graphics rendering and modelling, and understanding the effectiveness of these within a virtual environment. However, 'effectiveness' is impossible to define in the abstract, it depends on the application context, 'effective' for what purpose? With digital cities in the context of treatment of various types of anxiety disorder, we know exactly what we mean by 'effective'. Is the portrayal of this place, this crowd of people, this lighting, this density of traffic, this underground train scene - are these able to provoke the appropriate anxiety responses in people who would normally have such anxiety in everyday reality? If the answer is 'yes' then we have created an environment that clinicians can use in giving people access to safe experiences in which nevertheless they can overcome their fears. For each of the conditions there are years of research in the elicitation and measurement of peoples' responses, so that the measures are there against which we can test the effectiveness of the environments that we create. This approach also generates three levels of research:

  - How can we overcome the technical problems in building the environments and activities within them so that they can be portrayed in real time and so that people can interact with one another within them, and interact with virtual characters within them. These are essentially algorithmic problems in the real of computer graphics and virtual reality.

  - What properties do our scenes and behaviours of objects within the scenes have to have in order to maintain the sense of believability, presence and copresence, and to generate the appropriate affect in people? This is part of the 'understanding' issue.

✍ How can these systems be used to help people in the real world, to generate treatment programs, self-help and support groups? This is the highest level of the applications issue.

3. Agoraphobia

The official European description of agoraphobia is as follows:

> The term "agoraphobia" … is now taken to include fears not only of open spaces but also of related aspects such as the presence of crowds and the difficulty of immediate easy escape to a safe place (usually home). The term therefore refers to an interrelated and often overlapping cluster of phobias embracing fears of leaving home: fear of entering shops, crowds, and public places, or of travelling alone in trains, buses, or planes. Although the severity of the anxiety and the extent of avoidance behaviour are variable, this is the most incapacitating of the phobic disorders and some sufferers become completely housebound; many are terrified by the thought of collapsing and being left helpless in public. The lack of an immediately available exit is one of the key features of many of these agoraphobic situations. Most sufferers are women and the onset is usually early in adult life. Depressive and obsessional symptoms and social phobias may also be present but do not dominate the clinical picture. In the absence of effective treatment, agoraphobia often becomes chronic, though usually fluctuating.

We plan to concentrate our applications on agoraphobia in conjunction with clinical psychologists (led by Prof. C. Brewin) at UCL.

Agoraphobia involves simulation of an environment entailing the fundamental graphics and VR research that is the core of the work of our group. It further involves understanding how the features of the environment must be portrayed to maintain enough believability that agoraphobic symptoms are experienced by people who normally experience these in the real world.

Agoraphobic people have a problem, obviously, about going out. Therefore initial treatment in a fully immersive VE such as a CAVE is impractical. Here the focus would be in the creation of environments and situations that can be experienced in the home (i.e., PC based). Some features of this could include some or all of the following:

A study that starts from patients and therapists in order to elicit the critical features that must be present in any environment in order to provoke the anxiety response. We envisage that this would be carried out with Equator partners, employing techniques such as ethnomethodology, as well as possibly 'focus group' studies.

Although there are critical features fundamental to the agoraphobic experience in general there are also aspects that are specific to individuals. The idea would be to create a parameterised environment, one where patients could learn individual control over features of the environment - such as the degree of darkness, the density of crowds, the number and proxity of exists. They could be able also to control their degree of interactivity: they might be only observers, or part of the digital environment with no interaction with other people or direct one to one interaction. The type of environment should also be optional to describe the degree of stress since it can be different for each person (street, supermarket, train, etc). Even the degree of

immersion could be changed - by changing window sizes, using 3D glasses, using a head-mounted display, through to a visit to a CAVE.

When patients are out in the real world after a certain level of treatment, there is still the possibility of relapse - sudden panic attacks. Here we envisage the use of hand-held displays (in the widest sense) that can quickly take them back through procedures that have in the past had a calming effect. Such displays could range all the way from PDAs with simple text messages through to more sophisticated 'digital toys' that react to their present state.

We envisage that the hand-held displays monitor the physiological state of the patients - e.g., at the simplest level it is possible to detect anxiety through heart rate and galvanic skin responses. Wearable devices would be ideal here, to feed information both to the local digital assistant and back to a base that may be monitored by counsellors. This could apply as well when interacting with digital representations, to detect when patients present some panic physiological symptoms; 'safe memories' can automatically come to the user such as a picture of a place they like and make them feel comfortable, or a recognisable voice can comfort them.

Agoraphobics find interaction with one another difficult - because they all have the same problem about going out to places. It is envisaged that a home-based shared VE system could be used to allow the building of self-help groups - where they could of course type, talk and 'see' each other, and even have joint adventures in virtual spaces depicting the kinds of environments that typically cause anxiety. Here they could also meet synchronously real or asynchronously virtual family members, significant others (including therapists) who tend to induce a calming effect, helping to overcome anxiety.

Such research could be used for the process of understanding perceptual issues associated with such conditions. For example, there is often a marked degree of perceptual distortion accompanying (or inducing) the anxiety state. Such perceptual distortion can be simulated and introduced in an experimental program aimed at uncovering how it occurs and why it induces anxiety. For example, can a non-agoraphobic person learn to have agoraphobia through experiencing typical agoraphobic perceptual distortions? If the answer is 'yes' then no doubt the other direction can also be followed: agoraphobic people can unlearn the association between perceptual distortions and anxiety.

It was already mentioned that we have been studying social phobia and paranoid ideation. This would continue, and there are many interactions between the type of work described above and this existing work. Moreover, environments and systems that we build for one can often be applicable to others. For example, the paranoia inducing environments (street scenes, being on a bus or train, walking along a darkly lit street) also apply to some types of post-traumatic stress disorder (e.g., associated with assault).

There are many interesting avenues that this work can take, forming a focus for the technical and evaluative aspects of our research at UCL, with clear goals, and contacts with other members of the IRC.

4. The Way Ahead

This document will be presented for discussion at the Equator Plenary in October. There will be a further meeting between the UCL team and the team of Prof. Brewin, and the goal will be to map out a specific set of experiments that will be undertaken over the next few months, with a longer term plan for the next few years. These outline specifications will then be discussed with Equator partners who may be interested in collaborating in specific aspects of this work.

In proposing this project we are trying to meet a number of goals: starting with specific research questions that exist at various different levels: Providing a unifying application for the UCL group, and offering many points of contact with our Equator partners. Providing fundamental research questions at several different levels - ranging from algorithmic to evaluative to the design of effective treatments and programmes. Finally, the end-goal is socially beneficial to people way beyond the academic research environment.