Lina Gega, Richard White, Andrew O'Neill, David Fowler

7 Virtual Environments With Chroma-Keying Video Capture In Psychological Therapy

Abstract: A novel system of virtual environments (VEs) was developed and evaluated in the context of cognitive behaviour therapy (CBT) for socially anxious patients recovering from psychosis. The system uses chroma-keying video-capture to allow the person to see a life-size projection of their self interacting with specially-scripted and digitally-edited filmed environments played in real time on a screen in front of them. Two feasibility studies collected self-reported ratings of anxiety and paranoia along with narrative feedback from 32 patients before and after using three non-interactive VEs. Six patients also used a variety of interactive VEs to carry out exposure-type behavioural experiments during a single therapy session. About two-thirds of patients found that the VEs variably evoked responses that were similar to real life. These types of VEs can potentially be used as a therapy tool to help patients understand psychological processes, practise social skills, and gain the impetus to carry out real life behavioural experiments. Patients experience VEs in different ways - albeit as surreal, strange, or weird - depending on what is relevant and meaningful to them, what extraneous factors they find stressful or distracting (e.g. the presence of the researcher in the room or using the equipment), whether they perceive the VEs as realistic or immersive, and whether they use safety behaviours and avoidance strategies while in the VEs to control anxiety or paranoia.

7.1 Introduction

Effective psychological therapies, particularly cognitive behaviour therapy (CBT) for anxiety disorders, require that patients carry out repeated and prolonged exposure to anxiety-provoking situations either in real-life (in-vivo exposure) or in imagination (imaginal exposure) (Scholing & Emmelkamp, 1993; Feske & Chambless, 1995). In-vivo exposure is very effective but can be time-consuming or impractical to do due to logistical or safety issues in finding appropriate situations. Also, it may be difficult to contain or control live exposure situations to suit patient needs because real life is unpredictable. Using imaginal exposure, such as going over a script or running images in one's mind, lacks realism and intensity because most people are not able to hold-on to images for long enough and can easily disengage from them when they become distressed. Also, patients often find it difficult to progress from practising exposure in imagination to doing exposure tasks in real life. To overcome some of these limitations, virtual environments which simulate appropriate exposure

conditions (in virtuo exposure) have been used effectively as part of CBT (reviews by Powers & Emmelkamp, 2008; Marks, Cavanagh & Gega, 2007).

Virtual environments (VEs) are artificially generated scenes or objects which are presented or conveyed through visual, tactile, motion, and/or auditory media. One type of VE is Virtual Reality (VR) which uses a head-mounted display system (like a pair of goggles) to present three-dimensional computer-generated graphics including virtual characters (avatars). VR systems have been used as part of CBT for post-traumatic stress disorder by simulating exposure conditions such as helicopter flying and jungle clearing in Vietnam (Rothbaum, Hodges, Ready, Graap & Alarcon, 2001), earthquakes (Salcioglu & Basoglu, 2010), and the World Trade Centre attack (Difede & Hoffman, 2002). VR has also been used in the treatment of the fear of flying (Rothbaum et al, 2000) and social phobia (Klinger, Bouchard, Légeron, Roy, Lauer, Chemin & Nugues, 2005).

Another use of VR has been to influence psychological processes, such as the perception of pain, rather than as a means to deliver therapy for mental health problems. An example is "Snow World", a VR system which is reported to act as a non-pharmacological analgesic during burns wound-dressing. Patients are immersed into scenes of flying through an icy canyon filled with rivers and waterfalls, as snowflakes drift down, and shoot snowballs into the scene and hear them splash into the river (Hoffman, Chambers, Meyer, Arceneaux, Russell, Seibel et al 2011). The VR works by distracting patients and by creating a stimulus which evokes the opposite sensation (cold) to the trigger of pain (fire).

In the field of psychosis, a VR system showed promise for understanding delusional beliefs such as paranoia (Freeman, 2008; Fornells-Ambrojo, Barker, Swapp, Slater, Antley & Freeman, 2008). Researchers used this VE system to compare paranoid beliefs across people with low paranoia, high non-clinical paranoia, and delusional beliefs (Freeman, Pugh, Vorontsova, Antley & Slater, 2010). The assessment of paranoia is an inherently difficult process because both interview and questionnaire-based measures rely on retrospective recall of events and cannot rule out the possibility of paranoid thoughts being based in reality. VR allows access to live thinking processes and ensures strict experimental control but has not yet been used in the delivery of psychological therapy for psychosis.

Another type of VE which has lent itself well to CBT can be described as visual display (VD) systems. These systems use two-dimensional computer-generated scenes similar to computer games. The person who uses the VD system guides an on-screen character through the virtual environment. VD systems have been used in the context of psychological therapy for agoraphobia (Chandler, Burck & Sampson, 1986) and obsessive-compulsive disorder (Clark, Kirkby, Daniels & Marks, 1998). These systems lack the immersive qualities of VR but are still engaging because of their interactivity and the users' identification with a character on the screen.

By definition, all different types of VEs comprise two elements: first, the technological media and equipment which convey the artificial scene or object,

and second, the experience of the scene or object itself. The use of VEs requires the user to interpret the artificial world as real and respond to it in a manner true to real life. One way of conceptualising the quality of this experience is through the idea of "virtualisation". Virtualisation refers to an individual's conviction that the artificial environment is real. This is important on the basis that the more realistic the artificial environment feels, the more natural the individual's reactions to that environment would be.

A marker of virtualisation is having a sense of 'presence' in the VE; this could be either a "physical presence", when the individual feels that they are physically "there" in the VE, or a "functional presence", which refers to the individual's ability to respond to the VE in the same way as they would have done in real life. Presence, whether physical or functional, can be influenced by factors either external or internal to the individual who uses the VE. External factors include the immersive qualities of the VE equipment, its ability to match the conditions of the real life environment, and its interactivity, vividness, and reproduction of accurate and quick feedback information to the user. Internal factors which may influence presence in the VE relate to the user's idiosyncratic interpretations, feelings, and reactions because of their personal experiences, personality traits, or mental state.

Presence in virtual reality has been suggested as a necessary ingredient for successful exposure therapy (Price & Andersson, 2007; Wiederhold & Wiederhold, 2005), though not all studies have supported this (Krijn, Emmelkamp, Biemond et al, 2004). This comes back to distinguishing physical from functional presence and identifying which of these two types makes more sense to evaluate in the context of psychological therapy. The literature seems to suggest that the value of VEs in a therapeutic context lies in their ability to induce the feelings, thoughts, and behaviours that an individual would have if they encountered the real-life alternative (e.g. Difede & Hoffman, 2002; Klinger et al., 2005).

7.2 Virtual Environments With Chroma-Keying Video Capture

7.2.1 System Description

To use the system, the person goes into a 1.5 x 1.5 meter portable booth within which are enclosed a video-processing unit with a camera linked to a computer and video-recorder, a screen-monitor, and an adjustable sitting stool. The user sits in the booth facing the screen with the camera pointing to them at a half-profile angle. There is a grey screen (illuminated by a green light) in the booth which provides a background to the user. Real-time chromo-keying technology is used to separate the image of the participant from the background and to combine the person's image with the pre-filmed scene and then display it on a video- screen in front of them. This chromo-keying technology allows users to simultaneously observe the scene and view

themselves interacting with the characters of the film. The system automatically creates digital recordings of the person's interactions in the VEs which the person can take away with them and watch retrospectively.

Users can experience scenes selected from a library of specially scripted video-clips that last 2-10 minutes. Non-interactive scenes depict familiar environments, such as a city centre, a bus route, and local cafes. Interactive scenes include characters who could be hostile (e.g. a fellow customer at a bar who insists to be served first), rude (e.g. a medical secretary with a condescending tone of voice who speaks on the phone and ignores the patient), neutral (e.g. a waitress taking an order), or friendly (e.g. a helpful bus driver). Some characters ask innocuous questions (e.g. at a job interview or a street survey) and other ask personal or intrusive questions (e.g. during speed-dating or a medical survey). In some environments, the patients have to initiate conversations which could vary from "safe" to highly embarrassing (e.g. asking the shopkeeper of a local shop for products such as washing powder, toilet roll, or condoms).

7.2.2 Use of video clips and chroma keying video-capture in VEs

The VE system discussed here has two main differences from conventional VR or VD systems. First, it does not use a head-mounted display or computer-generated graphics with avatars but uses custom-scripted and digitally-edited filmed environments played onto a screen. Second, it uses chroma-keying technology to capture the person's image and superimpose it onto the virtual scene. The person sees a life-size projection of themselves (an inverse and not a mirror image) observing and verbally interacting with people in the environments played in real time on a screen in front of them.

Video-clips or photographs rather than computer-generated graphics have been used in other VR or VD systems, for example to recreate virtual audiences to help with fear of public speaking (Anderson, Rothbaum & Hodges, 2003; Lee, Ku, Jang, Kim, Choi, Kim & Kim, 2002).; however, these systems did not include the user within the scene. Video-capture and motion-capture systems have also been used to treat phantom-limb pain (Cole, Crowle, Austwick & Henderson, 2009) and in the rehabilitation of stroke patients (Jack et al., 2001; Merians et al, 2002); however, these systems involved either artificially re-created parts of the body or avatars rather than real-time capture and projection of the user themselves.

7.2.3 An "Out-of-Body" Experience?

The VE system described here offers a "self-observation" view, similar to an out-of-body experience, because the person sees a life-size projection of themselves

interacting with an on-screen environment (third-person perspective). This is neither the first person perspective of conventional VR systems (watching the environment through goggles) nor the vicarious experience of computer games (identifying with a small avatar on the screen). It is also different from a mirror image because the person sees an inversed image of their back in an over-the-shoulder shot rather than a face-on picture (fig 1). Researchers in the field of psychology have previously used this projected image to create an "out-of-body" experience, like the "rubber hand illusion" (Botvinick & Cohen, 1998) but not within a therapeutic context and without placing the person in an interactive environment.

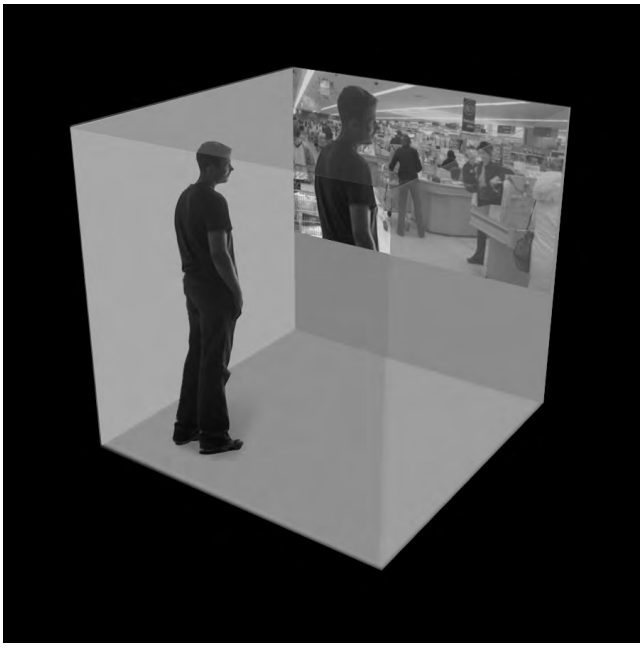

Figure 7.1. Representation of Virtual Environment with Chroma-Keying Video-Capture

7.3 Feasibility Studies With Social Anxiety & Paranoia

7.3.1 Design

Two feasibility case series explored the use of this novel VE system as part of CBT with patients who had been recovering from psychosis and also had social anxiety. This is a particularly complex, vulnerable, and socially disabled group of patients who is usually difficult to engage in therapy and has received little attention in research. The first study used three non-interactive standardised VEs at baseline (before the

patients began CBT). The second study used several VEs tailored to the patients' specific feared triggers as part of a single therapy session half-way through a 12-week CBT programme (Gega, White, Clarke, Turner & Fowler, 2013).

The reason for using non-interactive standardised VEs in the first study was to exercise caution and prevent our patients from becoming overwhelmed at baseline (we had assumed that the more interactive and tailored the VEs had been, the stronger the emotional responses they would have evoked). Interactive and tailored VEs were used as part of therapy in the second study because the patients had already experienced the non-interactive VEs at baseline and developed a trusting relationship with their therapists.

7.3.2 Objectives

The two feasibility studies aimed to generate hypotheses about the potential value of VEs with chroma-keying video-capture as a psychological therapy tool. They also explored patient experiences of these VEs specific to a clinical population with social anxiety and paranoia. The studies addressed four questions:

1. Can the VEs evoke emotional, cognitive, and behavioural responses which are similar to their "real-life" alternatives?
2. What factors may influence patients' emotional, cognitive, and behavioural responses to the VEs?
3. What do patients "learn" while using VEs in the context of psychological therapy?
4. How do patients feel about seeing themselves projected and interacting live on a screen?

7.3.3 Participants

Patients who had received treatment for an acute psychotic episode and reported symptoms of social anxiety were assessed for eligibility for the study at a community psychiatric service where they routinely received follow-up care. Patients were eligible to participate in the study if: a) they scored a minimum of 30 on the Social Interaction Anxiety Scale (SIAS; Mattick & Clarke, 1998) denoting the presence of clinical social anxiety and b) their residual positive psychotic symptoms were mild-to-moderate (not scoring more than 4 on the positive symptoms sub-scale of the Positive and Negative Syndrome Scale (PANSS; Kay, Oplar, & Lindenmayer, 1987). A distinctive feature of social anxiety in patients with a history of psychosis is their self-perception of being vulnerable and their view of the world as threatening, partly due to the stigma and social disability associated with psychosis, and partly due to residual positive psychotic symptoms such as paranoia (Birchwood, 2006; Fowler, 2006).

7.3.4 Intervention

Three standardised non-interactive VEs were used at baseline before patients started therapy: a) a street scene which featured a crowded cityscape with the point of view as if you were sat outside a shop on the main road, b) a drinks party, which was recorded at a local college during a display of artwork with people engaging one another in conversation in small groups; and c) a bus trip in which the vantage point was from the top floor of the bus having a view of the seats opposite as well as outside.

As part of a therapy session, several interactive VEs were used including travelling on the bus where a young woman sits opposite the patient and makes friendly conversation, sitting at a bar and having to order a drink while another customer gives his turn to order, being at a drinks party where two different people initiate small talk and ask personal questions, and others.

Therapy was based on a CBT approach for social anxiety (Butler et al, 2007) and the VE system was used as part of a behavioural experiment to: explore patients' thoughts and feared outcomes in social situations; demonstrate the role of their safety behaviours in maintaining anxiety; modify unhelpful responses to other people during social interactions. A researcher (assistant psychologist) was in the room but did not interact with the patient whilst using the VE.

7.3.5 Data Collection

Patients were assessed at baseline using a structured clinical interview and a battery of psychometric tests, including the Social Interaction Anxiety Scale (SIAS; Mattick & Clarke, 1998) and the Green et al. Paranoid Thought Scales (GPTS, Green et al, 2008). The SIAS is a 20-item scale assessing symptoms of anxiety in a range of social situations on a five-point (0-4) scale; the total score range is 0-80 with higher scores indicating higher levels of social anxiety. The GPTS comprises 2 x 16-item sub-scales assessing ideas of social reference and persecution, each rated on five-point scale from 1 (not at all) to 5 (totally). The aggregate range of scores for both sub-scales is 32-160 with higher scores denoting higher levels of paranoia.

Before and immediately after participants used each of the three VEs at baseline, they self-rated their situational anxiety and paranoia on a visual analogue scale presented to them with two questions: "on a scale of 0-100, how anxious do you currently feel?" and "on a scale of 0-100, how paranoid do you currently feel (having thoughts or worries that others are trying to harm you)?". When the VEs were used as part of the therapy session, narrative and numerical data were collected via behavioural experiment forms and from therapist field notes detailing which VE scenes were used, how they were used within the context of CBT, and what patients said during their VE therapy session.

7.3.6 Analysis

We tabulated qualitative and quantitative data into a template that included the patients' narrative feedback on the use of each VE and of the equipment overall, along with their paranoia and anxiety scores before and after using each VE. No personal identifiers (apart from gender and age) have been used in order to protect patient identities. Thematic analysis of patients' narrative feedback looked for evidence of virtualisation, e.g. if patients described the VEs by using words such as "immersive" and "realistic", if they demonstrated or expressed strong emotional responses to the VEs, etc. Visual inspection of individual anxiety and paranoia scores in the context of the received narrative feedback explored how virtualisation and other factors influenced patients' emotional, cognitive, and behavioural responses to the VEs.

7.3.7 Findings

7.3.7.1 Sample characteristics

Thirty two patients gave informed consent to use the VE system at baseline. Of those, five patients consented to also use the system half-way through therapy and an additional sixth patient, who was too nervous to try it at baseline, gave consent to use it as part of therapy. The sample of 32 participants who used the VEs at baseline included 21 men and 11 women. They were all White British with a mean age of 25 years (sd=6, range=17-36). A few participants were in full-time education (n=3) or employment (n=7), while the rest spent their days at home doing activities such as watching television, browsing the internet, or reading. Mean SIAS and GPTS scores at baseline were 51 (sd=13) and 85 (sd=32) respectively, which denoted high levels of social anxiety and moderate levels of paranoia in our sample.

7.3.7.2 Can the VEs evoke emotional, cognitive and behavioural responses which are similar to their "real-life" alternatives?

Out of the 32 participants, 4 gave no feedback about the system and 8 thought that the system was "not very interesting", "did not feel real", and "was more like watching TV". Participant no. 39 commented: "The drinks party felt like watching a YouTube video clip. I was expecting something to happen, like something to jump into view like in a horror movie…".

About two-thirds of the participants (n=20) showed or reported strong responses of either anxiety or paranoia to at least some of the environments: "I started to breathe heavily like when I get anxious in real life" (no. 35); "There were young people laughing, were they laughing about me?" (no. 34); "I thought other people were talking about me and saying negative things" (no. 54); "I felt anxious and paranoid in the scene and thought 'who is behind me? What are my escape routes?'"(no. 17).

Interestingly, some participants did not report anxiety or paranoia in response to the virtual environments or reported a reduction in their symptoms; this was representative of their "real" life responses: "I found [the street scene] relaxing, it is something I would do normally" (no. 43), "I don't get anxious on the bus in real life...I was looking at the scenery" (no. 53).

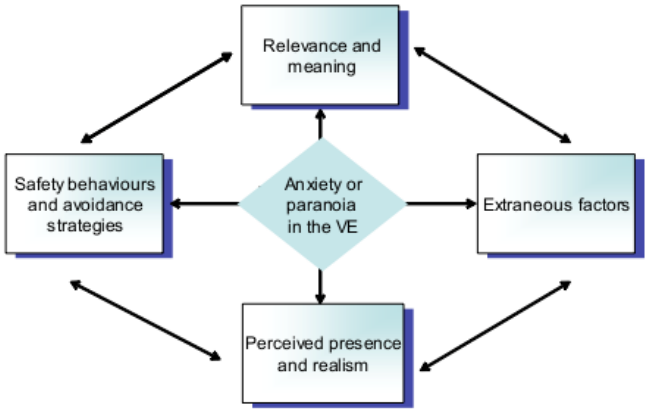

Figure 7.2. Factors influencing responses to virtual enviroments (VEs) in therapy

7.3.7.3 What factors may influence patients' emotional responses to the VEs?

Figure 2 illustrates the four main factors that we observed influencing anxiety and paranoia ratings of different patients about the same VE and of each patient about different VEs: relevance and meaning of the VE, using or refraining from safety behaviours and avoidance strategies while in the VE, patients' perceived presence in and realism of the VE, and extraneous factors relating to the use of the VE but not the VE per

The first factor, relevance and meaning of the VEs, is associated with the fact that an individual's anxiety or paranoia may be triggered by different situations and driven by different fears; therefore, the more relevant and meaningful a specific VE is in terms of an individual's fears and circumstances, the more likely the individual is to have an emotional response to that VE. Indicative quotes are: "The bus felt horrible as I hate using the bus" (no. 9); "I was less anxious on the bus but felt a bit more paranoid because I wasn't able to see the people that were talking in the background. It was a bit like the voices I sometimes hear due to my illness" (no. 48).

The second factor relates to the safety behaviours and avoidance strategies that participants may instinctively use while in the VEs such as reassuring themselves that the environments were not real, or looking away from the screen. The use of safety

behaviours and avoidance strategies may dampen the level of anxiety or paranoia evoked by the VE experience: "The [street scene] was easier as I was thinking 'it's not real life... you know the people aren't real'" (no.21). "I would look away when I started to feel anxious" (no. 9). On occasions when the VEs made it impossible for patients to use avoidance strategies, anxiety increased: "On the bus I felt anxious... I didn't feel that I had control... in real life I could get off" (no. 44); "[Street scene] I felt anxious, I watched people to see if I recognised any of them. In real life I would have been with someone or rolling a cigarette which would lessen my anxiety" (no. 53).

The third factor of perceived presence in and realism of the VEs meant that the more realistic a VE felt the stronger the resemblance of an individual's emotional response to real life, or the greater the magnitude of emotional change pre-post VE. Participant no. 35 showed an increase in anxiety and paranoia scores from 0 to 30% at the drinks party scene: "[it] felt a lot like being there. I started to breathe heavily like when I get anxious in real life". Participant no. 34 showed high levels of both anxiety (pre-post VE: 80-90%) and paranoia (pre-post VE: 60-70%) while experiencing the street scene: "[the street] was unnerving – I didn't like the idea of people walking behind me. It felt very realistic and I am familiar with [the street]". On the contrary, no 47, whose anxiety and paranoia scores pre-post VE were 0-10% commented on the lack of perceived realism and presence: "It didn't feel like any of the scenes were realistic, it was like watching myself on TV".

Finally, several extraneous factors influenced anxiety in anticipation of, or in response to, using the VE, including the presence of the researcher in the room, the technological equipment per se, or seeing oneself on screen. The influence of extraneous factors tended to wear off with time: "The equipment made me feel anxious... I was worried what you [researcher] were thinking" (no. 22); "The equipment was initially daunting but I didn't notice it by the third clip" (no. 39); "Watching myself on a camera made me feel self-conscious and was not pleasant... it was easier after the start (no. 32); "The equipment was ok but a bit weird at first" (no. 35). Some patients' also reported a reduction in anxiety at the end of a clip because of their task finishing rather than because of the VE per se.

7.3.7.4 What do patients "learn" while using VEs in the context of psychological therapy?

Patients' feedback about using the VEs as part of their therapy was that the system offered a safe stage for them to correct unhelpful safety behaviours, such as looking at the floor or looking out for trouble, and to practise helpful social skills, such as making eye contact and small talk. Patients also reported that using the system helped them gain impetus to go to crowded public places and engage in social interactions in real life. The VEs were conducive to challenging patients' anxiety/paranoia-driven misperceptions about themselves and others, for example by realising that they looked/spoke better than they thought or expected, and that they could feel

threatened without actual threat being there. Repeated rehearsal of social skills while in the VEs (e.g. making small talk) made the point of 'practice makes perfect' and that anxiety subsides with time. Case examples under each key learning point are outlined on table 1.

Table 7.1. Key learning points from using VEs in psychological therapy

Key learning point	Participant	Use of the VE system
"Even if someone or something feels threatening, it does not mean that it is actually threatening"	No.17 male 30 years SIAS=63 GPTS=83	The participant had the strong feeling that someone on the screen was "looking at him funny", which made him feel anxious and scared. Talking about the virtual experience afterwards, he said that, as he knew it was artificial, the person on the screen could not have been looking at him with bad intentions, so it must have been his own mind creating the threat or blowing things out of proportion.
"*Having rehearsed something in the virtual world, makes it easier to do it in the real world*".	No.15 Male 30 years SIAS=66 GPTS=121	The participant used a virtual environment to engage in polite conversation and make eye contact with a young woman, whom he perceived was flirting with him, whilst both were travelling on a bus. Encouraged by his achievement of facing up to his two worst fears in a virtual environment (public transport and young women), the patient decided to go into "real-life" social situations that he would otherwise have avoided: he used public transport and he waited at the job centre despite feeling nervous and uncomfortable when a young woman sat opposite him.
Things are better than expected and get easier with time and practice	No. 13 Male 27 years SIAS=60 GPTS=32	The participant used four virtual environments (talking with a young woman while travelling on the bus, ordering at a bar and interacting with a fellow-customer, making small talk at a drinks party) to test his belief that he might stutter or not know what to say. The participant's anxiety response, a 'stomach feeling', was at its worse at the beginning of his first virtual small-talk, but it improved the longer he spent in the each environment and having rehearsed what to say to the characters on the screen. Even when he felt at his worst, the participant said that he did not do as bad as he thought he would.
Safety behaviours make anxiety about social situations worse	No. 18 Male 31 years, SIAS=76 GPTS=95	To demonstrate that the safety behaviour of looking at the floor rather than at eye-level when meeting people maintained social anxiety, we conducted a behavioural experiment with a participant alternating between looking at the ground and then deliberately making eye contact in three virtual environments (standing in a supermarket, at an arts exhibition, and at a busy street in the middle of the city). The participant reported that he surprisingly felt less anxious when he was looking up and making eye contact rather than when he was looking at the floor; he also said that he wouldn't have dared test this in real life.

7.3.7.5 How do patients feel about seeing themselves projected and interacting live on a screen?

Several patients commended that the system felt "weird" and "surreal": "I thought the angle I was sat at on the bus was unusual. It was weird to watch myself" (no. 32). Other patients found that seeing themselves on screen helped them shift their attention focus from themselves to the environment: "Because I could see myself I was thinking more about what other people were doing" (no. 39).

7.4 Discussion

A novel VE system, which uses specially-scripted and digitally-edited video clips and real-time chroma-keying video-capture of the patient's image, was evaluated in two feasibility case series as part of a CBT intervention for patients with social anxiety and paranoia. The VEs evoked the same responses as the real life alternatives for at least for two-thirds of the patients who used them. The case series suggest that everyone experiences the system in a different way and that several factors may influence users' responses to it. Researchers and clinicians who may use and evaluate the system in different clinical settings or with different clinical populations need to:

- Select VEs that are tailored to each patient's fears and triggers by asking patients how anxious/paranoid they would have felt if they had to experience similar scenarios in real life.
- Monitor patients' safety behaviours and avoidance strategies while in the VE by asking them what they do, or avoid doing, or say to themselves to feel better or less anxious/paranoid about using the VE.
- Control for extraneous factors, such as technological anxiety, by helping patients get used to the equipment through non-threatening or relaxing VEs at first.
- Use standardised measures of presence and immersion to assess whether the VE system feels real and absorbing to patients.

Our case series also suggests that a simple way of evaluating the VE system is to ask patients whether they felt in the VE the same as, or better/worse than (e.g. as anxious as or less/more anxious than), they would have felt in a similar situation in real life. This is more helpful than simply measuring state anxiety or paranoia in the VE because of all the different confounding factors that may influence emotional responses to the VE. Any discrepancies between the VE and real life could be further explored, e.g. feeling less anxious in the VE than would be expected in the real life alternative may be because the system was not perceived as realistic/immersive enough or because patients used safety behaviours while in the VE.

Some patients in our studies perceived the virtual environments as "not real" but this was not necessarily a disadvantage. Given that an artificial environment still evoked anxiety or paranoia, maintaining a certain degree of control in the knowledge

that the situation was indeed artificial proved helpful for some patients for two reasons. First, it made patients more willing to take "risks", i.e. face up to the worse case scenario and drop safety behaviours. Second, it helped patients challenge their paranoid or anxious interpretations of social situations, e.g. realising that an artificial character cannot possibly intend to harm the patient or think badly of them, so there must be an alternative explanation as to why the patient felt threatened.

A major difference between VEs and real life is that VEs are standardised and constant, whereas real life is unpredictable and varied. These case series have not explored whether the repetitive and standardised interactions of the VEs helped reduce anxiety because patients knew what the characters would say. Although this is helpful for social skills training, having slight variations in the virtual characters' reactions may be more helpful as a transferable "relationship" skill that would lend itself better to the unpredictability of real life. An interesting question is how patients relate to the virtual characters and whether they can develop a relationship with them as they would do with real people.

A pertinent question for future research is whether having a "self-observation" view by watching a full-sized image of oneself interact live on-screen may resemble an out-of-body experience. The projection of self in the VEs can be confused with depersonalisation (Sierra, 2009) which in itself can be a symptom of anxiety or psychosis; however, in depersonalisation one feels detached from themselves, whereas in the VE one identifies with their projected image. We do not know whether, in the context of CBT with patients who have both conditions, inducing such as feeling could be helpful in the context of exposure therapy.

An additional research question following from this is whether it is important that the patient sees himself or herself in real-time (chroma-keying) or whether a recording of the scenario played back to them (retrospective feedback) is sufficient to achieve the same results. Some studies support the use of video in the treatment of social anxiety, though others have demonstrated that video-feedback has an added value to CBT only if it is combined with cognitive preparation (patients make predictions prior to using the video) (Harvey et al, 2000) and cognitive review (therapists follow up the video with restructuring of patients' unhelpful beliefs) (Orr & Moscovitch, 2010). An interesting objective for future research is to compare patients' emotional responses when they see themselves on screen versus when they interact with the VE without being present in the scene versus when they see only part of their body (e.g. an arm or a leg).

Future research needs to test whether the added value of the VEs, over and above real life or imagination, is in engaging difficult-to-reach or difficult-to-treat populations, in speeding up therapy because of opportunities for mass practice, or in there being less need for therapist-assisted in-vivo exposure and quicker transition between a clinical setting and "real life". Completion of self-efficacy measures and standardised real-life behavioural tests is necessary to test whether patients feel more confident to confront their feared social situations "in-vivo" after doing it "in-virtuo".

7.5 Conclusion

Virtual environments (VEs) using video clips and chroma-keying video-capture can evoke emotional, behavioural, and cognitive responses that are similar to those of real life. VEs can potentially be used as a therapy tool to help patients understand psychological process, practise social skills, and gain the impetus to carry out real life behavioural experiments. Patients experience VEs in different ways - albeit as surreal, strange or weird - depending on what is relevant and meaningful to them, what extraneous factors they find stressful or distracting (e.g. the presence of the researcher in the room or using the equipment), whether they perceive the VEs as realistic or immersive, and whether they use safety behaviours and avoidance strategies while in the VEs to control anxiety or paranoia.

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References

Anderson, P., Rothbaum, B.O. & Hodges, L.F. (2003). Virtual reality exposure in the treatment of social anxiety. Cognitive and Behavioral Practice, 10(3), 240-247.

Birchwood, M., Trower, P., Brunet, K., Gilbert, P., Iqbal, Z., & Jackson, C. (2006). Social anxiety and the shame of psychosis: a study in first episode psychosis. Behaviour Research & Therapy, 45, 1025-37.

Botvinick, M., & Cohen, J. (1998). Rubber hands “feel” touch that eyes see. Nature, 391, 756.

Butler, G. (2007). Overcoming Social Anxiety and Shyness Self-help Course (3 Parts): A 3-part Programme Based on Cognitive Behavioural Techniques. London: Robinson.

Chandler, G.M., Burck, H.D. & Sampson, J. (1986). Generic computer program for systematic desensitization: Description, construction and case study. Journal of Behavior Therapy and Experimental Psychiatry, 17, 171-174.

Clark, A., Kirkby, K.C., Daniels, B.A., and Marks, I.M. (1998). A pilot study of computer-aided vicarious exposure for OCD. Australian & New Zealand Journal of Psychiatry, 32, 268-275.

Clark, D.M. (1999) Anxiety disorders: Why they persist and how to treat them. Behaviour Research and Therapy; 37:S5-S27.

Cole, J., Crowle, S., Austwick, G., & Slater, D. H. (2009). Exploratory findings with virtual reality for phantom limb pain; from stump motion to agency and analgesia. Disability and Rehabilitation, 31(10): 846-854

Difede, J. & Hoffman, H.G. (2002). VR exposure therapy for World Trade Center posttraumatic stress disorder: Case report. Cyberpsychology & Behavior, 5(6), 529-535.

Feske, U. & Chambless, D. L. (1995). Cognitive Behavioral Versus Exposure Only Treatment for Social Phobia: A Meta-Analysis. Behavior Therapy, 26, 695-720.

Fornells-Ambrojo, M., Barker, C., Swapp, D., Slater, M., Antley, A. & Freeman, D. (2008) Virtual reality and persecutory delusions: safety and feasibility. Schizophrenia Research, 104, 228-36.

Freeman, D. (2008). Studying and treating schizophrenia using virtual reality: a new paradigm. Schizophrenia Bulletin, 34(4), 605-10.

Freeman, D., Pugh, K., Vorontsova, N., Antley, A. & Slater, M. (2010). Testing the continuum of delusional beliefs: an experimental study using virtual reality. Journal of Abnormal Psychology, 119, 83–92.

Gega, L., White, R., Clarke, T., Turner, R. & Fowler, D. (2013) Virtual Environments using Video-Capture for Social Phobia with Psychosis. Cyberpsychology, Behavior, and Social Networking, 16(6): 473-479.

Green, C. E. L., Freeman, D., Kuipers, E., Bebbington, P., Fowler, D., Dunn, G. and Garety, P. A. (2008). Measuring ideas of persecution and social reference: the Green et al. Paranoid Thought Scales (GPTS). Psychological Medicine, 38, 101–111.

Harvey, A.G., Clark, D.M., Ehlers, A., Rapee, R.M. (2000). Social anxiety and self-impression: cognitive preparation enhances the beneficial effects of video feedback following a stressful social task. Behaviour Research & Therapy, 38(12), 1183-92.

Hoffman, H.G., Chambers, G.T., Meyer, W.J. 3rd, Arceneaux, L.L., Russell, W.J., Seibel, E.J., Richards, T.L., Sharar, S.R. & Patterson, D.R. (2011) Virtual reality as an adjunctive non-pharmacologic analgesic for acute burn pain during medical procedures. Annals of Behavioral Medicine, 41(2):183-91.

Jack, D., Boian, R., Merians, A.S., & Tremaine, M. (2001). Virtual reality-enhanced stroke rehabilitation. Neural Systems and Rehabilitation Engineering, 9 (3), 308-318

Kay, S. R., Oplar, L. A., & Lindenmayer, J. P. (1987). Reliability and validity of the positive and negative syndrome scale for schizophrenics. Psychiatry Research, 23, 111–114.

Klinger E., Bouchard S, Légeron P, Roy S, Lauer F, Chemin I, Nugues P. (2005). Virtual reality therapy versus cognitive behavior therapy for social phobia: a preliminary controlled study. Cyberpsychology & Behavior, 8(1), 76-88.

Krijn, M., Emmelkamp, P.M.G. Biemond, R. de Wilde de Ligny, C., Schuemie, M.J., van der Mast, C.A.P.G (2004) Treatment of acrophobia in virtual reality: The role of immersion and presence. Behaviour Research and Therapy, 42(2), 229-239.

Lee, J.M., Ku, J.H., Jang, D.P., Kim, D.H., Choi, Y.H., Kim, I.Y. & Kim, S.I. (2002) Virtual reality system for treatment of the fear of public speaking using image-based rendering and moving pictures. Cyberpsychology & Behavior, 5(3), 191-5.

Marks, I.M., Kavanagh, K. & Gega, L. (2007) Hands-on Help: Computer-aided Psychotherapy. Maudsley Monograph – No. 49. Hove, UK: Psychology Press.

Mattick, R. P., & Clarke, J. C. (1998). Development and validation of measures of social phobia, scrutiny fear and social interaction anxiety. Behaviour Research and Therapy, 36, 455-470.

Merians, A. S., Jack, D., Boian, R., Tremaine, M., Burdea, G.C., Adamovich, S.V., Recce, M. & Poizner, H. (2002). Virtual Reality–Augmented Rehabilitation for Patients Following Stroke. Physical Therapy. 82(9), 898-915

Orr, E.M., Moscovitch, D.A. (2010) Learning to re-appraise the self during video feedback for social anxiety: Does depth of processing matter? Behaviour Research & Therapy, 48(8), 728-37.

Powers, M.B. & Emmelkamp, P.M.G. (2008) Virtual reality exposure therapy for anxiety disorders: A meta-analysis. Journal of Anxiety Disorders, 22, 561–569.

Price, M. & Anderson, P. (2007) The role of presence in virtual reality exposure therapy. Journal of Anxiety Disorders, 21, 742–75.

Rodebaugh TL, Holaway RM, Heimberg RG (2004) The treatment of social anxiety disorder. Clinical Psychology Review; 24:883-908.

Rothbaum, B.O., Hodges, L., Ready, D., Graap, K., and Alarcon, R.D. (2001). Virtual reality exposure therapy for Vietnam veterans with posttraumatic stress disorder. Journal of Clinical Psychiatry, 62, 617-622.

Rothbaum, B.O., Hodges, L., Smith, S., and Lee, J.H. (2000). A controlled study of virtual reality exposure therapy for the fear of flying. Journal of Consulting Clinical Psychology, 68, 1020-1026.

Salcioglu E & Basoglu M. (2010) Control focused behavioral treatment of earthquake survivors using live exposure to conditioned and simulated unconditioned stimuli. CyberPsychology, Behavior, and Social Networking, 13, 13-19.

Scholing A. & Emmelkamp, P.M.G. (1993) Exposure with and without cognitive therapy for generalized social phobia: effects of individual and group treatment. Behaviour Research & Therapy, 31(7), 667-681.

Sierra, M. (2009). Depersonalization: A New Look at a Neglected Syndrome. Cambridge, UK: Cambridge University Press.

Wiederhold, B. K., & Wiederhold, M. D. (2005). The effect of presence on virtual reality treatment. In: B. K. Wiederhold, & M. D. Wiederhold (Eds.), Virtual reality therapy for anxiety disorders: advances in evaluation and treatment (pp. 77–86). Washington, C: American Psychological Association.