Virtual Reality Exposure Therapy for Social Phobia: A Pilot Study in Evoking Fear in a Virtual World

Virtual Reality Exposure Therapy for Social Phobia: A Pilot Study in Evoking Fear in a Virtual World

Position Paper

Willem-Paul Brinkman, Charles A.P.G. van der Mast, and Daniel de Vliegher
Delft University of Technology
Mekelweg 4, 2628 Delft
The Netherlands
{w.p.brinkman, c.a.p.g.vandermast}@tudelft.nl

ABSTRACT
Social phobia is one of the most commonly occurring anxiety disorders. Standard treatment or training involves gradually exposing patients to social situations they fear. These exposures are however difficult to control for a therapist. An alternative therefore might be to use virtual reality exposure. This paper reports on the design of four social scenarios (a bus stop, a train station, a clothing shop, and a reception desk of a restaurant) implemented in virtual reality. Results of a pilot evaluation with none phobic patients suggest that these worlds might be able to evoke anxiety, and manipulating the verbal and behavioural responses of the human avatars might give therapists the ability to control the level of fear evoking elements in these worlds.

Categories and Subject Descriptors
H.5.1. [**Information Interfaces and Presentation**]: Multimedia Information Systems - *virtual realities.*

General Terms
Measurement, Design, Experimentation, and Human Factors.

Keywords
Affective computing, emotion, anxiety disorder, e-care; social phobia, virtual reality, avatars.

1 INTRODUCTION
Social phobia, one of the most often occurring anxiety disorders, is estimated to affect 13.3% of the members of the US population [7] and 6.7% of the European population [1] during their live. The effect of this phobia on patients includes depression, substance abuse (e.g. alcoholism, drug abuse), restricted socialisation (e.g. romantic, professional, and everyday informal social interaction), and poor employment and education performance [6]. People with a social phobia have a strong fear of one or more social situations, such as talking in public, entering a room with other people, ordering food in a restaurant etc. In general these people fear that they will act embarrassingly in these situations and that others will judge them in a negative way because of signs of fear they might display. Although sufferers recognise that their fear is irrational, they feel extremely uncomfortable which often results in avoiding behaviour such as not attending parties, or changing their job. Patients that seek help for this disorder are often treated or trained with exposure in vivo (i.e. exposure to actual real-life situations) or with cognitive behavioural therapy. Although exposure in vivo is an effective method, it is limited due to the unpredictability of most social situations as it depends on the reaction of other people. One potential way of overcoming these problems is to use Virtual Reality Exposure Therapy (VRET) where patients are exposed in Virtual Reality (VR) to situations they fear. This paper will present work on creating and evaluating VR worlds that might be used to treat or train patients with social phobia. The aim of study was to examine the possibility to evoke anxiety in VR social scenarios and to control the level of anxiety evoking elements in the scenarios by manipulating the behaviour and the verbal response of human avatars.

Proceedings of HCI2008 Workshop – HCI for Technology Enhanced Learning. Liverpool, UK. Monday 1 September 2008.

ISBN 978-90-813811-2-3, Delft University of Technology, Mediamatica. The Netherlands

2 EXPOSURE IN VIVO
Although effective, exposure in vivo has limitations when it comes to providing these exposures. For example, it is relatively time-consuming. In addition, social phobic patients are very reluctant to seek professional help, and to expose themselves to these social situations in vivo. Furthermore treatment is limited due to the unpredictability of most social situations in real-life as they depend on the reaction of other people, which makes it difficult to build a proper hierarchy of exposure to gradually confront patients to more difficult social situations. Also in practice it is difficult for patients to expose themselves consecutively to these situations. Additionally, social situations are time-limited, for example, introducing oneself to another, receiving criticisms, or being looked at when entering a room. In short, these real-life situations might be too short or too infrequent for the patient to obtain adequate exposure in a short period for the anxiety to ease off.

3 STATE OF THE ART
Virtual Reality as an environment for exposure is a promising technology and in 1992 the first experiments were conducted in this area [10]. Research in this area has focussed on treatment of claustrophobia, fear of driving, acrophobia, fear of flying, spider phobia, social phobia (especially fear of public speaking), panic disorder with agoraphobia, and posttraumatic stress disorder [9]. Reports also indicate that people in general respond realistically at subjective, psychological and behavioural levels to social characters in virtual worlds [15].

Today the most extensive report of the effectiveness of VR in the treatment of social phobia comes from the EU project VEPSY UPDATED [8]. Here they studied 18 patients who underwent VR treatment with 18 patients who underwent cognitive behaviour therapy. Their promising results suggest that both treatments are similar in their effectiveness. They also reported limitations with their explorative study such as no complete randomisation of patients, relative small size of the patient group, and that no data was collected about long time effect [8].

For social phobia most experimental systems focus on the fear of speaking in front of a group of people [3], [4], [11], and [12]. In these systems people are asked to talk in front of a number of human avatars as part of a presentation to peers or a job interview. These avatars could be graphical characters or photo or film-based avatars (e.g. [8]). The avatars' behaviour has

often been limited to changing their posture, facial expression (e.g. positive, neutral, uninterested), the direction of their gaze, and uttering a few pre-recorded sentences such as making some comments, asking people to speak clearer, or some laughter. These behaviours are not directly triggered by the behaviour of the patient, but instead indirectly by the therapist. Even these relatively simple behaviours have been demonstrated to provoke anxiety. For example, the attitude of virtual audience (positive, neutral and negative) can affect the anxiety-level of people [12]. Besides more formal public speaking scenarios, environments for other scenarios have also been developed such as a bar scenario [4], [5], an informal dinner with neighbours [8], entering a public space like a cafeteria [4], public transport [5], passing by a coffee shop with people sitting outside, and a shoe store [8]. Most studies only focus on the patient side, ignoring the therapist side of the system. From their console therapists however need to control the experience of the patient. In a flight simulation, for example, the therapist controls the behaviour of the plane (taxiing, taking off, weather conditions, pilot calls, and turbulence). The therapists' confidence in controlling the system seems essential for acceptance of these systems, and therefore some research has also focussed on the usability of the therapist user interface proposing various design improvements [2], [14].

4 DESIGN OF VRET WORLDS

As reports in the literature suggest that VR social scenarios can evoke anxiety, the focus of this study was to see whether including more dynamic elements in a VR scenario would allow the therapist to control the anxiety-eliciting element even further. Four virtual worlds were developed to recreate situations in which people with a social phobia might feel uncomfortable. The worlds were created as part of a university introduction course in VRET systems for high school students (7 females and 11 males, age ranging between 16 and 18 years).

Figure 1: Bus stop

Figure 2: Platform on a train station

Figure 3: Clothing shop

Figure 4: Reception desk of a restaurant

Students worked in small groups and each group identified a scenario and with extensive support of a master student they modelled their scenario objects in Autodesk Maya 8.5 and run their world on the UnrealEngine2Runtime platform. The scenarios were: a bus stop, where the patient would have to ask avatars which bus he/she should take to go to a specific location (Figure 1); a platform on the train station, where the patient

would have to ask when the train would arrive (Figure 2); a clothing shop, where the patient would have to ask for a t-shirt, a tie or lacquer shoes (Figure 3); and a reception desk in a restaurant, where the patient has to ask for a table that was booked in advance (Figure 4).

Besides the static objects, the worlds were extended with dynamic elements, such as body movement of the avatar (e.g. scratching, stretching, turning the head away or towards the patients), background sound (e.g. flushing toilet, sound of flicking through a reservation book, train information announcement), avatars moving through the world (e.g. walking in and out a room, coming out from behind a desk), objects that passed by (e.g. train or bus), or sentences that an avatars could say. Each world had between 20 to 40 pre-recorded sentences, which the therapist could use to let the avatar respond to the patient with the aim of engaging the patient into a 2 to 5 minute conversation. Different types of sentences were recorded to allow the therapist to manipulate the anxiety evoking level of the scenario. For example in the scenario of the train station, the avatar could reply with a rather neutral reply "The train will arrive within 5 minutes. But often it will arrive late" or with a less friendly reply "Just go away!". Furthermore, the set of sentences also included neutral type questions (e.g., for the shop "Welcome, are you looking for something specific, or do you just want to look around?", or potentially more socially uncomfortable questions (e.g. for bus stop "Are you religious? And what do you believe in?"). As people with social phobia fear social situations in which they feel being evaluated by others, sentences were included of an evaluating nature such as "I wouldn't know…You got a cute butt though. Are you in a relationship at the moment?", "You clearly haven't got any taste", or "Is everything alright? You look a bit red". The therapist could trigger these events or play these pre-recorded sentences by pressing a combination of 2 keys.

5 EVALUATION

The aim of the pilot evaluation was to examine whether the VR social scenarios could evoke anxiety, and if so, if a therapist could manipulate the level of anxiety with the verbal response and behaviour of the avatars. Although the target population of the system are patients with social phobia, ethical and practical constraints made an initial evaluation with non-patients more preferable. Besides studying the effects of VR worlds, a secondary aim was to study the usability of the therapist user interface.

5.1 Method

In the evaluation, the members of each student group acted as participants for the other student groups. The evaluation took place in a 2-hour practicum class in which all four VR worlds were evaluated in parallel. One member of the group instructed the participant, while a second member manipulated the avatars and navigated the participant through the world. For both the restaurant and the shop scenario, participants sat on a chair in front of a large projection screen on which the VR world was projected. In the bus scenario, participants wore a Visette Pro head mounted display (Field Of View (FOV) of 70 degrees diagonally and a resolution of 640 x 480 colour elements). At the same time, the virtual world was also displayed on a computer screen for the experimenters. A similar set-up was used for the train scenario world where participants wore a Z800 3DVisor from eMagin (FOV of 40 degrees diagonally and a resolution of 800 x 600 triad pixels per display). Each participant was exposed to two conditions; in one condition the avatars' reply was relative neutral, whereas in the other condition their reply and behaviour was more anxiety provoking. To control for learning/order effects, the order in which participants received these conditions was counterbalanced. To measure the level of anxiety participants where asked to rate their anxiety by means of Subjective Unit of Discomfort (SUD) scale [16], which ranged from 1 to 100. Furthermore, to measure their feelings of presence in the VR worlds, participants were asked to complete the Igroup Presence Questionnaire (IPQ) [13].

5.2 Results

When analysing the collected data, it became clear that because of administrative problems the data collected in the bus and shop scenarios could not be analysed statistically. Therefore the analysis reported here only focussed on the two remaining scenarios. The group that had evaluated the restaurant scenario had asked their four participants to rate their anxiety level at the start, during and at the end of the session. It was therefore possible to conduct an ANOVA with repeated measures with as within-subject variables the attitude of the avatars (neutral or less sociable) and the exposure time (begin, during, or at the end of a session). The analysis found no significant main effect ($F(1,3) = 2.08$; $p. = .245$) for the avatars' attitude, but found a significant main effect ($F(2,6) = 8.69$; $p. = .017$) for the exposure time. Figure 5 shows that as the exposure time increased the participants rated their anxiety relatively higher than before, which suggests that this VR social scenario could evoke anxiety, or alternatively participates became more frustrated with the session or some other reason that might provoke this response. Unfortunately, in this scenario the IPQ inventory could not be analyzed because of some missing data.

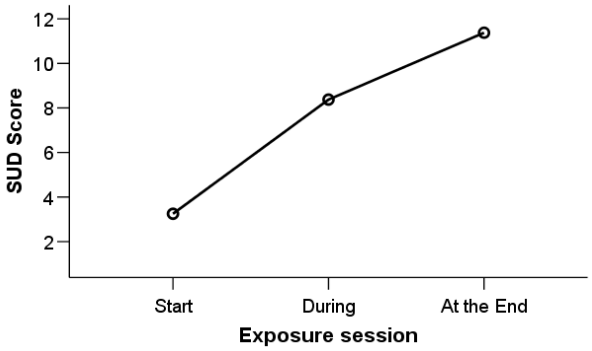


Figure 5: Anxiety level in the restaurant scenario.

The student group that analyzed the train scenario only collected SUD and IPQ scores at the end of each session from all their six participants. A paired sample *t*-test ($t(5) = -2.47$; $p. = .056$) on the SUD data revealed an effect for avatars' attitude that approached the significant level of 0.05. Whereas the mean anxiety score was 12 in the neutral attitude condition, in the less social condition this mean increased to 18 points. For each of the complete IPQ inventory a General score was calculated as well as a score for the Spatial Presence, Involvement, and Experienced Realism dimensions. A MANOVA was conducted on these dependent measures, with as independent within-subjects variable the avatars' attitude. Both the multivariate and the univariate analyses did however not reveal a significant main effect for avatars' attitude. Still, when analyzing the correlations between the change in anxiety rating between the two attitude-conditions and the change in presence rating between these two conditions, a significant correlation ($r = .87$; $n = 6$; $p. = .026$) was found between the change in anxiety

rating and in the general feeling of presence. This finding might suggest that an increased level of anxiety coincide with an increased feeling of presence in the virtual world.

The evaluation also gave an insight into the usability of the system from a therapist perspective. Students that controlled the virtual world encountered problems with quickly finding an appropriate response. They had to search through a paper listing with avatar's behaviour and speech options and their associated key combination to trigger them. Therefore in some instances participants had to wait relatively long before the avatar responded to their verbal action. Besides the search time, the response delay was also affected by the time operators needed to decide on an appropriate response. This is somewhat alarming, since the student operating the system had also designed the scenarios and created the speech recording, and therefore might be expected to be more familiar with all options than a potential future therapist.

6 FINAL REMARKS

Although this pilot study gives some interesting and encouraging insights into the potential ability to evoking anxiety in a VR social scenario with verbal responses of the avatars, limitations in the evaluation still makes that these findings should be treated with caution. Future evaluation should therefore use more participants, and also participants that are less involved in the system design process and be less aware of the design objectives. To avoid the possibility of participants giving social desirable answers even further, future studies might also consider including physiological measures besides a self-reported anxiety measure. Once studies with non-patients have convincingly demonstrated the ability to evoke controlled anxiety in a VR social scenario, the real evaluation will be to conduct a controlled experiment in a clinical setting, where patients are randomly assigned to treatment in vivo or in VR.

Work is also underway to improve the system from the therapist side. This includes structuring the patient avatar dialogue in such a way that patient responses become more predictable and the system would be able to provide the therapist with a subset of potential appropriate responses. This structuring could mean giving patients cue cards on their screen with sentence they could use to talk to the avatar at specific points in the discussion. Manipulating the text on these cue cards and the response of the avatars could give the therapist even more control to manipulate the anxiety eliciting elements in the social scenario, something the pilot study already indicated might be possible with verbal responses of the avatars alone.

ACKNOWLEDGMENTS

Our thanks to all students of the introduction course for their help in designing the VR social scenarios and conducting the pilot evaluation.

REFERENCES

[1] Fehm, L., Pelissolo, A., Furmark, T., and Wittchen, H.-U. Size and burden of social phobia in Europe. *European Neuropsycholopharmacology, 15*, 4 (2005), 453-462.

[2] Gunawan, L.T., van der Mast, C., Neerincx, M.A., Emmelkamp, P., and Krijn, M. Usability of therapist's user interface in virtual reality exposure therapy for fear of flying. In *Proceedings of the Euromedia* 2004 (Hasselt, Belgium, April 19-21, 2004), 2004, 125-132.

[3] Harris, S.R., Kemmerling, R.L., and North, M.M. Brief virtual reality therapy for public speaking anxiety. *Cyberpsychology & behaviour, 5*, 6 (2002), 543-550.

[4] Herbelin, B. *Virtual reality exposure therapy for social phobia*. Ph.D. Thesis, École polytechinque fédérale de Lausanne, Université Louis Pasteur, Strasbourg, France, 2005.

[5] James, L.K., Lin, C.-Y., Steed, A., Swapp, D., and Slater, M. Social anxiety in virtual environments: Results of a pilot study. *Cyberpsychology and behaviour, 6*, 3 (2003), 237-243.

[6] Kessler, R.C. The impairments caused by social phobia in the general population: implications for intervention. *Acta Psychiatrica Scandinavica, 108*, s417 (2003), 19-27.

[7] Kessler, R.C., McGonagle, K.A., Zhao, S., Nelson, C.B., Hughes, M., Eshleman, S., and Wittchen, H.-U. Lifetime and 12-month prevalence of DSM-III-R psychiatric disorders in the United States. *Archives of General Psychiatry, 51* (1994), 8-19.

[8] Klinger, E., Légeron P., Roy, S., Chemin, I., Lauer, F., and Nugues, P. Virtual reality exposure in the treatment of social phobia. G. Riva, C. Botella, P. Légeron, and G. Optale (eds). *Internet and virtual reality as assessment and rehabilitation tools*, IOS Press, Amsterdam, 2004.

[9] Krijn, M., Emmelkamp, P.M.G., Olafsson, R.P., and Biemond R. Virtual reality exposure therapy of anxiety disorders: a review. *Clinical Psychology Review, 24* (2004), 259 – 281.

[10] North, M.M., North, S.M., and Coble, J.R. Effectiveness of virtual environment desensitization in the treatment of agoraphobia. *Presence: Teleoperators and virtual environments, 5* (1996). 346-352.

[11] North, M.M., North, S.M., and Coble, J.R. Virtual reality therapy: An effective treatment for the fear of public speaking. *International journal of virtual reality, 3*,3 (1998), 2-7.

[12] Pertaub, D.P., Slater, M., and Barker, C. An experiment on public speaking anxiety in response to three different types of virtual audience. *Presence: teleoperators and virtual environments, 11*,1 (2002), 68-78.

[13] Schubert, T., Friedmann, F., and Regenbrecht, H. Embodied presence in virtual environments. In R. Paton, &I. Neilson (Eds.), *Visual representations and interpretations,* Springer-Verlag, London, 1999, 268-278.

[14] Schuemie, M.J., van der Mast, C.A.P.G., Krijn, M., and Emmelkamp P.M.G. Exploratory design and evaluation of a user interface for virtual reality exposure therapy. In J.D. Westwood, H.M. Hoffman, R.A. Robb, D. Stredney (Eds.), *Medicine Meets Virtual Reality 02/10*, IOS Press, Amsterdam, 2002, 468-474.

[15] Slater, M., Antley, M., Davison, A., Swapp, D., Guger, C., Barker, C., Pistrang, N. and Sanchez-Vives, M.V. A Virtual reprise of the Stanley Milgram obedience experiments. *PLOS ONE, 1*,1 (2006).

[16] Wolpe, J. *Psychotherapy by reciprocal inhibition*, Stanford University Press, Stanford, 1958.

Presentation

Virtual Reality Exposure Therapy for Social Phobia

A Pilot Study in Evoking Fear in a Virtual World

Willem-Paul Brinkman,
Charles A.P.G. van der Mast
and Daniel de Vliegher

TUDelft

Topics

- What is Social Phobia
- Treatment
- State of the Art VRET
- Design of VRET Worlds
- Pilot study
- Future work

TUDelft

What is Social Phobia

- People with social phobia have a strong fear of one or more social situations.
- They fear they will act embarrassingly and others will judge them in a negative way because of their signs of fear
- For example:
  - Entering a room, talking in public, ordering food at restaurant
- Sufferers recognise that their fear is irrational

TUDelft

What is Social Phobia

- Two types of social phobia
  1. Generalized type: fear is evident in most social situations
  2. Specific social phobia: fear and avoidance of rather discrete social situations (e.g. speaking in public, or using public lavatories)

TUDelft

What is Social Phobia - Effects

- Depression, substance abuse (e.g. alcoholism, drug abuse) , restricted socialisation (e.g. romantic, professional, and everyday informal social interaction)
- Avoiding behaviour
- Reluctant to seek professional help (average of 15 years)
- Western world, social phobia leads to intensive use of (mental) health services
- US 13.3% (life-time prevalence), Europe 6.7% (life-time prevalence) and 2-3% (12-months prevalence), the Netherlands 7.8% (life-time prevalence) and 4.8% (12-months prevalence, close to a million people !!)

TUDelft

Treatments

- Cognitive therapy
- Relaxation methods
- Training
- Exposure in vivo

TUDelft

Treatment – Exposure in Vivo

- Person is exposed to the social situation he/she fears
- Hierarchy exposure, start from least to most fearful situation
- For example:
  - Sit in front of the bus and look at everyone getting in
  - Ask someone out for dinner
  - Ask for product information in a shop without buying the product

TU Delft

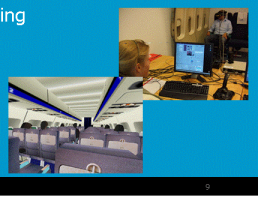
Treatment – Exposure in vivo - limitations

- A single exposure is very short
- Infrequency of the required social situation
- Exposure is very uncontrollable
- People are very reluctant to agree to this treatment

TU Delft

Virtual Reality Exposure Therapy

- Instead of exposing people a situation in real life, they are exposed to a situation in virtual reality
- This has already been effective for the treatment of fear of heights and fear of flying



TU Delft

VRET – State of the Art

VRET for social phobia

- Focus mainly on speaking in public
  - Avatars behaviour can provoke more or less anxiety
- Other existing VR worlds:
  - Bar scenario
  - Informal dinner with neighbours
  - Entering a public space like a cafeteria
  - Public transport, passing by a coffee shop with people sitting outside
  - Shoe store

TU Delft

VRET – State of the Art

VRET system has two User interfaces

- Patient UI
- Therapist UI
  - Therapist need to control the exposure, i.e. needs to be able to control the amount of anxiety that VR worlds evoke
  - Needs to be easy to use

TU Delft

Research questions

- By controlling the dialogue can a therapist control the anxiety level?

TU Delft

Design of VRET Worlds

- Worlds were created as part of university introduction course in VRET systems for high school students (7 females, 11 males, age range 16-18 years)
- In small groups identified a social situation, and Master Student implemented this in a VR
- Autodesk Maya 8.5 and UnrealEngine2Runtime platform

TU Delft

Social Situation – Bus Stop

TU Delft

Social situation – Platform on a train station

TU Delft

Social situation – Clothing shop

TU Delft

Social situation – Reception desk of a restaurant

TU Delft

Design of VRET Worlds

- "Therapist" could control:
- Body movement of avatar (e.g. scratching, stretching, turning the head away or towards the person)
- Background sound (e.g. flushing toilet, sound of flicking through a reservation book, train information announcements)
- Avatars moving through the world (e.g. walking in and out a room, coming out from behind the desk)
- Object that passes by (e.g. train or bus)
- Sentences that an avatar could say (20-40 pre-recorded sentences for each world)
- Therapist can trigger a event of sentence by pressing a combination of 2 keys

TU Delft

Design of VRET Worlds - Dialogue

- Aim was to engage the person in 2-5 minute conversation.
- Person was sent into social situation with the instruction such as "Ask when next train will leave"
- Avatar response could be neutral ("The train will arrive within 5 minutes. But often it will arrive late") but also less friendly ("Just go away!")
- Avatar could also ask neutral questions ("Welcome, are you looking for something specific, or do you just want to look around?") or potentially more social uncomfortable ("Are you religious? And what do you believe in?").
- Also sentences suggesting evaluation of the person ("I wouldn't know...You got a cute butt though. Are you in a relationship at the moment?", "You clearly haven't got any taste").

TU Delft

Pilot study – set up

- 2-hour practicum
- The high school student would be each others participants
- 4 experiments in parallel
- One person instructed the participant and another manipulated the avatar
- Each person was exposed to 2 conditions (avatars reply was relatively neutral, or reply was more anxiety provoking) counterbalanced
- Restaurant and shop scenario, participants sat on a chair in front of a large project screen
- Bus and train scenario, participants wore head mounted display.

TU Delft

Pilot study - Measures

- Subjective Unit of Discomfort (SUD)
- Igroup Presence Questionnaire (IPQ)

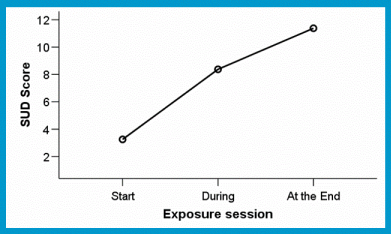
TU Delft

Pilot study - Results

- Administrating problems with bus and shop scenario
- **Warning: This was not a clean and thorough experiment!! Findings should be treated with caution!!**

TU Delft

Pilot study – Results – restaurant scenario



Anxiety level in the restaurant scenario ($F(2,6) = 8.69$; $p. = .017$) of the four participants

TU Delft

Pilot study – Results – Train scenario

- Mean SUD score: 12 points in neutral condition, and 18 points in the less social condition
- Attitude to avatars had effect on anxiety level that approaches the sign. Level (t-test, $t(5) = -2.47$, $p. = .056$)
- Correlation ($r = .87$, $n = 6$, $p. = .026$) between presence rating and anxiety rating
- UI therapist: it was difficult to find a quick response for the avatars.

TU Delft

Future work

- Redo the experiment in more controlled manner
- Use cue-cards to control the dialogue
- Considering speech recognition
- Including also more objective measures

TU Delft

Workshop discussion

[Fiona Carroll] Have you looked at photorealistic virtual environments?

> [Willem-Paul Brinkman] Yes, for example Herbelin used only a room with photos of eyes. He reported that this already had an effect. Research in this area has also looked at the relation between the feeling of presence and the effectiveness of a VR treatment. The results showed that once a certain level of presence has been obtained improving the feeling of presence had no large effect on effectiveness of the treatment.