The Use of Virtual Reality Environments for Training Purposes in Care Settings

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***Abstract* – In our paper we describe the outline of a project that aims to apply virtual reality (VR) technologies in healthcare education, in particular for learning how to cope with aggression in care settings. We consider a Virtual Learning Environment (VLE) populated by intelligent virtual agents a safe and effective medium. After briefly discussing current VR applications in healthcare and therapy we explore the use of VR for behavioural training and examine the critical factors for implementing effective VLEs. Finally, we discuss how to measure the impact of VLEs.**

***Keywords* – virtual reality, virtual learning environment, aggression, training, emotions in HCI**

I. INTRODUCTION

Nurses and caregivers are the most likely to suffer from aggression and violence in healthcare systems. Incidents range from verbal abuse, physical attacks to sexual harassment. Difficulties in coping with such incidents of aggression can lead to increased stress, low job satisfaction and absenteeism which in turn poses a major socio-economic problem.

This is why a 5-day aggression management training programme is offered by the Institute of Nursing Sciences in St. Gallen, which was originally developed in the Netherlands, and has been widely used in the UK and Switzerland in nursing homes, mental health care and disability care settings. It consists of a mixture of theoretical elements, exchange of experience and hands-on training. The participants are encouraged to perceive aggression from an interactional and situative context and to develop their interventions accordingly. It also emphasises the need for a clear institutional policy.

Studies demonstrate that attitudes of nurses influence their behaviour regarding aggression and that training programmes can positively change their attitudes. However, it has proven very difficult to furnish evidence for the effectiveness of such training programmes.

Although participants report a higher degree of confidence in their ability to cope with aggression, a recent study by Hahn et al. [1] did not observe any significant attitude changes. It concluded that this might be due to the impact of the pedagogical quality of training courses, lack of organisational support and/or the fact that the measuring instruments were inadequate.

So even if recent scientific literature suggests the use of more preventive measures, communication and negotiation skills and de-escalation techniques in the management of aggression, the effectiveness of different strategies so far has not been evaluated systematically. Most authors hope that future studies will help dispel some of the uncertainties that exist at present whilst it is conceded that it is very challenging to design appropriate experiments to investigate the comparative success rates of different strategies both for ethical and cost reasons. This is why we propose to use virtual reality (VR) to enhance aggression management training on the one hand and evaluate the impact of different coping strategies on the other.

II. VIRTUAL REALITY ENVIRONMENTS FOR BEHAVIOURAL TRAINING

A. Definitions and concepts related to VR

Virtual reality (VR) is a technology, which allows a user to interact with a computer-simulated environment, or – according to Thalmann -, "it refers to a technology which is capable of shifting a subject into a different environment without physically moving him/her" [2]. According to this definition virtual reality environments (VREs) aim at inducing the immersion of one or more individuals in a virtual environment by creating the illusion that they are in a place, time or situation different from their actual real-world location and/or time.

The technology was first used by Sutherland [3] and advanced rapidly, e.g. with the invention of the head-mounted display or the data glove. Currently, VREs are primarily visual experiences, displayed on a computer screen or through special stereoscopic displays because of people's binocularity. But more advanced VREs include additional sensory information such as auditive and tactile information, and attempts are currently made to simulate smell.

Users can interact either through the use of standard input devices (i.e. keyboard and mouse) or through multimodal devices such as the above-mentioned data glove. The simulated environment can be similar to the real world,

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e.g. simulations for pilot training, or it can differ significantly from reality as in VR games.

B. Current healthcare and therapeutic uses of VR

VREs have been used in a wide range of application domains: engineering, physics, medicine, education, marketing, real estate and many others.
Gradually, VR is also finding its way into the training of healthcare professional. VR technology has been used for anatomy instruction or surgery simulation. In the case of laparoscopy[1], for example, it is important to realistically visualize body parts.

More relevant to our project is the use of VR for treating various phobias. Virtual reality exposure therapy is an evolving technique that has been attracting increasing attention and research interest in a range of disciplines such as human-computer interaction, graphics design, psychiatry, clinical psychology and psychotherapy [4]. Quite basic VR simulation with simple sight and sound models, for example, has proven very effective in treating fear of flying, spider phobia (arachnophobica) or various zoophobias [5].

Another promising development is the application of VR for treating post-traumatic stress disorder (PTSD), e.g. in veterans. The U.S. Office of Naval Research is evaluating VR tools which integrate the sights and sounds of combat as well as smell and other sensory factors to treat PTSD [6].

C. Characteristics of virtual environments

Several psychological factors have come to be regarded as essential in VRE, namely a sense of presence immersion, involvement, interaction, person view (first or third person view) and emotions. The challenge consists in achieving the best balance between those factors.

In behavioural training, the realistic and believable modelling of people's behaviour and their emotional expression is important to evoke real-life reactions in trainee and to create a sense of presence and involvement in the (virtual) situation. There is a large body of research on this topic, but there is little information about emotional expression and visualization in this field. Which emotions can be depicted believably? How realistic does an emotional visualization have to be? What possibilities do we have to represent and evoke emotions? We now briefly discuss the various characteristics:

Immersion

An immersive digital environment is an artificial, interactive, computer-created scene or "world" within which users can immerse themselves. The degree of immersion is influenced by factors like the amount of detail of the 3D scenes, the degree of isolation from the physical environment, perception of self-inclusion in the VRE, natural modes of interaction and control, perception of self-movement or interactive user-input [7]. A high degree of immersion is important, as it is seen as a prerequisite for a sense of presence (see below).

Involvement

Involvement is a psychological state experienced as a result of focusing one's energy and attention on a coherent set of stimuli or meaningfully related activities and events. Involvement largely depends on the meaning that the individual attaches to the stimuli, activities or events. For many people, high levels of involvement can be obtained with media other than VRE, such as movies, books or video games. Though the factors underlying involvement and immersion may differ, the levels of immersion and involvement experienced in a VRE are interdependent: increased levels of involvement may lead users to experience more immersion in an immersive environment and vice versa [8].

Sense of Presence (SoP)

Both involvement and immersion are necessary for experiencing presence. Presence can generally be defined as the subjective experience of being in one place or environment, even when one is physically situated in another. However, SoP is not a characteristic of a medium but the feeling of the user of "being there" and thus has to be clearly distinguished from immersion.

First person view

In real-life one is able to see one's own limbs, therefore it might be disturbing not to be able to see one's own body in VREs. This perspective is called first person view, as opposed to the third person view in which the on-screen character is seen at a distance from a number of different possible angles. A third person perspective provides for more awareness of one's surroundings and position within it as well as the distances to objects and other characters. In scenarios that are especially arousing or disturbing such as is the case when confronted with aggressive behaviour, the ability to process the scene from a third person view might be very helpful.

Interaction

As already mentioned users can interact with a VR system through a range of devices and channels, e.g. haptic (data gloves), magnetic position/orientation sensors, 3D mouse, voice, gesture or face recognition. Interaction implies that users can (more or less) control the pace, order and (sometimes) occurrence of the events in the VRE. Interactivity enhances the sense of immersion, as humans are used to manipulate objects and engage in interaction with animals or other humans. Being a passive observer can be a choice in behavioural training (e.g. to learn from fixed situations), but an active involvement will be more effective.

Emotions

A factor largely ignored up to now is the expression of affect of virtual characters and the emotions this elicits in a user. Many studies have shown the ability of movies and imaging techniques to elicit emotions. Nevertheless, it is

[1] Laparoscopy is a type of surgical procedure in which a small incision is made, usually in the navel, through which a viewing tube (laparoscope) is inserted.

less clear how to manipulate the content of interactive media to induce specific emotional responses. Besides, we do not yet know which emotions, or more generally, which affective states can be conveyed through the setting or environment itself (as opposed to the virtual characters). It has been shown that humans have an inherent tendency to interact with different kinds of media in a natural and social way, mirroring interactions between humans in social situations [9]. But can a virtual character have and show complex, mixed emotions and affective states? Can, for example, aggression be conveyed convincingly? Is an emotional message transmitted through appearance or behaviour?

Even less is known about the effect of VREs on the user's affective state. Riva [10] found that the interaction with a fear-inspiring VRE produced anxiety, whereas interaction with a pleasant one produced relaxation. Besides, it turned out that a circular interaction existed between presence and emotions, i.e. the feeling of presence was greater in the "emotional" environments and in turn, the emotional state was influenced by the level of presence. The link between presence and emotion enables us to measure the sense of presence by standard psychological methods of emotion measurement.

IV. METHODOLOGY AND IMPLEMENTATION

For the design and development of the virtual learning environment (VLE) and the virtual agents we shall apply a user-centred approach. This implies that potential users are involved right from the start of the project and are consulted at regular intervals on all aspects of the VLE´s design. Their comments and suggestions for improvement are then fed back into the design of the VLE. This participatory and iterative approach relies mostly on qualitative and informal methods and will allow developers to gain a more detailed understanding of the users' attitudes and requirements.

The fundamental idea is to allow caregivers to try out various coping strategies without being directly involved themselves, i.e. the usefulness of a coping strategy can be learned safely and vicariously through the victim character's experiences. Apart from characters representing the aggressor(s) and the victim(s), the VLE will also include bystanders and/or assistants as well as locations (nursing home, psychiatric ward) and scenarios that are typical for real-life incidents. To elicit real-life reactions in trainees when faced with particular scenarios, it is important to model people's behaviour and their emotional expressions in a realistic and believable way, i.e. the VLE has to be "ecologically valid".

VR will first of all help to design scenarios that are based on incidents of aggression that have occurred in real life and have been gathered in the course of many in-depth interviews with caregivers as well as experts in the Institute of Nursing Sciences. The interviews also provide the storylines, settings and special characteristics of the intelligent virtual agents to be developed. Since for ethical and privacy concerns it will be impossible to install video cameras in relevant locations such as nursing homes, we shall have to resort to film clips and actors experienced in this type of work

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We shall then investigate to what extent VR can help induce behavioural changes by simulating the effects certain types of behaviour or communication strategies have on the patient or elderly person receiving care. VR will also allow us to combine settings, personality types and coping strategies because we are aware of the fact that the success of a particular strategy is highly dependent on context and the psychological make-up of the people involved. Thus, VR also enables us to adapt training to people's personal preferences or needs.

From previous studies [11] relevant to the aims of our project the following recommendations can be derived for the development of virtual environments in general:

Firstly, agent and environment believability can be improved by ensuring cultural similarity with target users. In our case we shall pay particular attention to professional milieu, i.e. the special characteristics of care settings.

Secondly – and closely related to the first -, the terminology and phraseology used has to reflect the language use prevalent in a particular environment. Besides, a cohesive storyline also contributes to deeper immersion in a virtual environment.

In addition to that, the possibility to interact with the characters has shown to be a major factor in successful immersion. However, since our project is primarily about letting people try out various coping strategies without being directly involved themselves, the inclusion of personal avatars is not foreseen in the design of the VLE. However, we might consider to allow at least superficial interaction – such as selecting physical characteristics of an otherwise unplayable agent, to make users identify more with a given character.

Recent findings [11] have also shown that the graphical design of the characters seem to have limited impact on the user's rating of their believability or on the elicitation of empathy. The results suggested that excellent graphical design is not necessary to create an engaging experience as long as characters act in a believable manner.

IV. MEASURING THE IMPACT OF VIRTUAL LEARNING ENVIRONMENTS (VLE)

Due to technical limitations such as processing power or image resolution problems it is still difficult and time-consuming to create high-fidelity VR experiences. Even though these limitations are likely to be overcome soon, it is still important to evaluate the effectiveness and learning impact of the VLE to be constructed. It has been shown that learning with attributes such as enjoyment, engagement and increased attention does occur in virtual environments. This is also born out by the empirical results from non-educational VR research, e.g. simulations for task training, e.g. in the military/defence industry or the visualisation of large data sets used for exploration, pattern discovery and investigation.

A common measure of the quality or effectiveness of a virtual environment (VE) is the amount of presence it evokes in users. Presence is often defined as the sense of being there in a VRE. There has been much debate about the best way to measure presence, and researchers need, and have sought, a measure that is reliable, valid, sensitive, and objective. We hypothesize that to the degree that a VRE seems real, it would evoke physiological and psychological responses similar to those evoked by real situations or environments.

Rather than measure attitudinal changes as done previously [1], we want to focus on psycho-physiological factors to measure the impact of a VLE. We therefore intend to examine the cognitive judgment of learners by using 10 bipolar rating scales. The ends of each scale comprise opposite adjectives that will be determined in a preceding survey to identify the descriptive features of the synthetic agents.

As pointed out before, the link between presence and emotion allows us to use standard methods of emotion measurement. In our project, we intend to monitor the emotional reactions to the aggression scenarios by taking psycho-physiological measurements. Skin conductance, for example, can be measured at the inner hand, heart-rate activity by means of electrocardiography and breathing movements with the help of a stretching belt round the chest.

V. Conclusions and expected results

The main benefits of using a VLE for aggression management training can be summarised as follows:

- Users can practice skills safely, without experiencing potentially dangerous real world consequences.
- The stimuli the user receives can be controlled.
- VLEs empower users with disabilities by giving them a sense of control over their environment.
- VLEs allow learners to actively participate and focus on their personal abilities.

Besides, the project is expected to contribute to advancing the following research issues:

- Identify heuristics and guidelines for user interface design to assess the impact of VR applications
- Measure the impact of learning in virtual environments (VE) ; possible indicators are presence, engagement, immersion
- Identify factors that contribute to or distract from the act of learning in a VE (e.g. social, hardware, network, content and curriculum quality issues)
- How can scaffolding be built into the software to guide the users, esp. those with cognitive impairments?
- Examine the impact of emotional models on the learning experience

The project will be implemented in close collaboration between several research organisations including the Institute of Nursing Science at the University of Applied Sciences in St. Gallen, Switzerland, the User-Centred Technologies Centre and Virtual Reality Lab at the University of Applied Sciences in Vorarlberg, Austria as well as the Institute of Medical Education at the Inselspital in Berne, Switzerland.

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