Annual Review of CyberTherapy and Telemedicine

Virtual Healing: Designing Reality

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ARCTT is a peer-reviewed all-purpose journal covering a wide variety of topics of interest to the mental health, neuroscience, and rehabilitation communities. The mission of ARCTT is to provide systematic, periodic examinations of scholarly advances in the field of CyberTherapy and Telemedicine through original investigations in the telemedicine and cybertherapy areas, novel experimental clinical studies, and critical authoritative reviews.

It is directed to healthcare providers and researchers who are interested in the applications of advanced media for improving the delivery and efficacy of mental healthcare and rehabilitative services.

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Editorials

I am honored to welcome you to the fourth volume of *Annual Review of CyberTherapy and Telemedicine*. This year's theme, "Virtual Healing: Designing Reality," acknowledges the importance of two related types of scientific studies: clinical applications of virtual reality (VR) and other technologies, and experimental research on why it has such a powerful impact on behavioral healthcare, medicine, and neuroscience. The theme also highlights changes that have occurred in the past decade; that which was once in the ream of science-fiction has now increasingly become part of our reality. As readers, you will therefore have the opportunity to play a role in designing the future. By utilizing technology for training and therapy, we are able to improve existing protocols, and disseminate care to a wider segment of the population.

Much has changed over the past eleven years since the inception of the CyberTherapy Conference. We have now tapped further into the potential of VR than many of us could have ever imagined. An exciting body of research regarding the utilization of advanced technologies in behavioral healthcare has emerged over the past decade, revealing the continuous advances and discoveries made by over 450 investigators to help patients with both mental and physical disorders. I am proud to report that as VR's use in behavioral healthcare has grown, so have submissions to the *Annual Review of CyberTherapy and Telemedicine.* For the first seven years, CyberTherapy was represented by a specialized symposium at the Medicine Meets Virtual Reality (MMVR) Conference featuring presentations that dealt primarily with conceptual matters and future possibilities. Over the years, the symposium continued to grow in both size and scientific evidence. In 2003, the symposium spun off into a separate three-day conference. The 10th Annual CyberTherapy Conference, held in June 2005, highlighted the largest program ever presented on controlled clinical trials of VR and other cutting-edge technologies in the areas of mental health, rehabilitation, disabilities, training, and education. It involved representatives from 21 countries, reflecting its truly international character.

I sincerely hope that you will find this year's volume to be an interesting and intellectually stimulating read. I continue to believe that together we can change the future of healthcare.

Sincerely,

Brenda K. Wiederhold, Ph.D., MBA, BCIA
Co-Editor-in-Chief

Editorials

According to recent reports presented by IST Advisory Group (ISTAG) - the Unit within the European Union providing independent advice concerning the strategy, content, and direction of research work to be carried out in Information and Communication Technologies (ICT) (http://cordis.europa.eu/ist/istag-reports.htm) - the evolution of technology in support of the Knowledge Society of the 2010s will be rooted within three dominant trends:

- Pervasive diffusion of intelligence in the space around us, through the development of network technologies and intelligent sensors toward so-called "Ambient Intelligence" (AmI);
- The increasingly relevant role of mobility through the development of mobile communications, moving from the Universal Mobile Telecommunications System (UMTS) to "Beyond 3rd Generation" (B3G);
- Increase of the range, accessibility, and comprehensiveness of communications, through the development of multi-channel multimedia technologies.

The convergence of AmI, B3G, and multi channel multimedia technologies manifests itself as the next frontier of ICT. This convergence stimulates a change in the way health care is carried out, making it a globally distributed process in which communication and collaboration between geographically dispersed users plays a key role.

In reaching this goal, "Immersive Virtual Telepresence" (IVT) will be essential. In IVT tools, distributed virtual reality (VR) systems are combined with wireless multimedia facilities (real-time video) and innovative input devices (tracking sensors, biosensors, brain-computer interfaces).

In general, the IVT perspective is reached through:

- Widening of the input channel through the use of biosensors (brain-computer interface, psycho-physiological measurements, etc.) and advanced tracking systems (wide body tracking, gaze analysis, etc.).
- Induction of a sense of "presence" or "telepresence" through multimodal human/machine communication in the dimensions of sound, vision, and touch-and-feel (haptics). Typically, a sense of presence is achieved through multisensorial stimula, such that actual reality is either hidden or substituted via a synthetic scenario, (i.e. made virtual through audio and 3-D video analysis, and modelling procedures). In high-end IVT systems, multimedia data-streams, such as live stereo-video and audio, are transmitted and integrated into the virtual space of another participant remotely, allowing geographically separated groups to meet in a common virtual space while maintaining eye-contact, gaze awareness and body language. A sense of presence with other people who may be at distant sites is achieved through avatar representations using data about body movement streamed over a high-speed network.

Since distance learning and e-health are principally involved with handling and transmission of medical information**,** *IVT has the potential to enhance their user experience through the expansion of human input and output channels.* The two principle ways in which IVT can be applied are:

- *as an interface, which enables a more intuitive manner of interacting with information*, and
- *as an extended communicative environment that enhances the feeling of presence during the interaction*.

These approaches will be strengthened by the development of 3rd generation IVT systems including biosensors, mobile communication, and mixed reality. Introducing IVT in cybertherapy will provide significant advantages:

- IVT-based treatment differs from traditional therapy in that computer graphics and various display and input/output technologies are integrated *to provide the patient with a sense of*

presence or immersion. In more detail, IVT provides a new human-computer interaction paradigm in which users are no longer simply external observers of images on a computer screen, but are also active participants within a computer-generated three-dimensional synthetic world. In this world, the patient has the possibility to learn to manage a problematic situation.

- Moreover, IVT offers a high level of control over the experience without the constraints usually found in computer systems. IVT environments are highly flexible and programmable. They enable the therapist to present a wide variety of controlled stimuli, such as a fearful situation, and to measure and monitor a wide variety of responses made by the user. This flexibility can be used to provide systematic restorative training that optimizes the degree of transfer of training or generalization of learning to the person's real-world environment.
- Finally, IVT systems open the input channel to the full range of human expressions: in rehabilitation it is possible to monitor movements or actions from any body part or many body parts at the same time. On the other hand, with disabled patients, feedbacks and prompts can be translated into alternate and/or multiple senses.

It is interesting to note that this issue of ARCTT reflects this trend. Biosensors, augmented reality, and eye tracking are broadening the typical tools of cybertherapy. The critical challenge, however, is moving from preliminary studies to real-world applications.

In this context it is critical that the pioneers in this field share both information about their experiences and examine the results of the preliminary trials so that suitable development work will speed up. For this reason, the goal of this publication is to provide a forum for presenting and discussing the emerging processes and tools by which cybertherapy applications will contribute to the delivery of state-of-the-art health services. A critical aim of this journal is to stimulate more clinicians and technical professionals to design and test these tools, improving the overall outcome of cybertherapy interventions.

Giuseppe Riva, Ph.D., M.S., M.A.
Co-Editor-in-Chief

Editorials

When planning for CyberTherapy 2006, I set up four goals: (a) increase attendance to the conference and workshops by researchers and students, (b) implement a web-based submission/registration system and database, (c) maintain (or improve if ever possible) the high standards of innovation and quality that have been the hallmark of past CyberTherapy Conferences, and (d) offer all of this at the lowest registration rate possible. I think we achieved these goals, with 131 scientific communications and 174 people registered (58 students) at the time this volume went to pres. The electronic submission/registration and database system is working efficiently and should be very useful for future conferences, despite a few glitches initially encountered when sending reviews back to the authors. These accomplishments were made possible by the financial support of our sponsors.

I hope that you will enjoy the scientific aspects of this year's volume. As you will witness, the field of cybertherapy is evolving at an increasing pace, thanks to the rigorous empirical work of all of our authors.

Stéphane Bouchard, Ph.D.
Co-Editor-in-Chief

Critical Reviews

From SIT to PTSD: Developing a Continuum of Care for the Warfighter

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BACKGROUND

The Virtual Reality Medical Center (VRMC) is currently conducting Stress Inoculation Training (SIT) and Posttraumatic Stress Disorder (PTSD) treatment for the United States Navy and Marine Corps, the combined result being a program that supports a *continuum of care* for troops.

PTSD affects an estimated 5.2 million Americans in any given year (NIH), often resulting in a diminished quality of life and considerable emotional suffering. The current rate of PTSD among Army and Marine Corps combatants returning from duty in Iraq is about 19%. Military experts believe the rate is following historical patterns for sustained ground combat and is still increasing. A continuing upward trend seems especially likely given the unique nature of the Iraq theater. According to recent reports, the number of Iraq War soldiers who will experience PTSD is higher than the Gulf War due to such factors as ground combat and long deployments (Litz, 2004). A recent survey of Soldiers and Marines deployed in Iraq describes a very high level of combat experience, with more than 90% of respondents reporting having been shot at (Hoge et al., 2004).

Clearly, PTSD is a serious health threat for military personnel. Learning to treat—or better still, *prevent*—this disorder is a task of paramount importance. It is our hope that SIT will help prevent or reduce rates of PTSD in returning troops. We at the VRMC have been working for the past 10 years to apply our clinical VR expertise to a full range of troop support, with the goal of providing effective tools for both pre- and post-deployment.

In regard to pre-deployment tools, we have developed stress inoculation training (SIT) and virtual environment tactical training to effectively teach personnel tactical and trauma care skills, enable them to practice stress management techniques, and to improve performance during real-life combat situations. Situations with very high stress and a cognitive load not often encountered in real life can be created in the simulation environment. These scenarios, combined with physiological monitoring, allow military personnel to train themselves to better process stress through techniques such as breath retraining and relaxation. In this way, cognitive skill hardening can be achieved.

For those personnel who require PTSD treatment post-deployment, we are developing and testing VR therapy environments. By placing a patient in a virtual Iraqi war setting, and then having him or her slowly experience that situation in a controlled way, the patient should begin to habituate to his or her specific PTSD symptoms and come to reappraise the situation, allowing emotional processing to fully occur. With the goal of allowing for the earliest possible intervention and treatment of PTSD, we have deployed a VR system to Iraq under a program funded by the United States Army's Telemedicine and Advanced Technology Research Center (TATRC). The sections below describe this and other VRMC projects in line with developing a comprehensive protocol to address an array of needs for military personnel, including SIT training for pre-deployment, tactical training for in-theater support, and follow-up mental health care for affected returning personnel.

PRE-DEPLOYMENT TOOLS: VR FOR SIT AND TACTICAL TRAINING

Stress Inoculation Training (SIT)

SIT is a technique to help "inoculate" individuals to future potentially traumatizing stressors. Deployed personnel must often perform in extremely stressful environments, and optimum performance under such conditions requires the

management of physiological, psychological, and emotional responses to stressful stimuli. An acute stress reaction (ASR) or combat and operational stress reaction (COSR) can occur during exposure to exceptionally stressful events, resulting in extreme sympathetic nervous system arousal and impaired performance. Longer-term reactions can include acute stress disorder, and acute and chronic PTSD. During preventative SIT, military personnel "experience" highly stressful situations in a virtual environment while being physiologically monitored. Repeated exposure enables performers to gradually become desensitized to stimuli that may initially elicit such strong physiologic arousal that performance is impeded (i.e., "freezing in the line of fire") and psychological trauma is more likely.

SIT is intended to help prevent or reduce rates of PTSD in returning troops. There is some existing evidence that SIT can reduce PTSD. A group of 106 male British soldiers preparing for a 6-month tour of duty in Bosnia received a combination of pre-deployment stress training with psychological debriefing. They demonstrated a drastically reduced incidence of PTSD and other psychopathology, approximately 10 times less than figures reported from other military samples (Deahl et al., 2000). In fact, the level was too low to demonstrate any possible debriefing effect.

Besides decreasing stress, SIT for military personnel is designed to improve performance. Training under stressful conditions pre-deployment improves performance by training personnel to recognize and control their stress levels. In our ongoing SIT studies, we train military personnel in virtual environments such as an Iraqi village, a shoot house, and a ship. Simulations can be viewed on desktops, laptops, through a head-mounted display (HMD), or as a 3-wall CAVE (computer automatic virtual environment) projection system, depending on the needs of the specific population to be trained. The training is then transferred to real-world exercises in structures designed specifically for tactical training.

Tactical Training

VR allows stimuli to be presented in a systematic, controlled fashion, and physiology provides objective evidence of when the stimuli are eliciting appropriate responses in the trainee. This enables treatment and training to be individualized, focusing on those specific parts of the experience that cause the individual the most difficulty. By combining such measures as subjective ratings, physiological data, personality type, and self-report questionnaire scores with expert clinical observations, it is possible to further refine and improve clinical and research-based protocols.

By understanding the state of the student during training, the simulated training can then be modified to add or subtract stressors as would be most appropriate to the situation (Wiederhold, Bullinger, & Wiederhold, 2006). For example, quick mastery of a scenario could be supplemented by a more challenging mission, and physiological indicators that the participant is too overwhelmed to learn could be responded to by a "backing-off" of stressors until the trainee is again prepared to move forward.

VRMC's Student State Report was a three-year study (completed in July 2005) sponsored by the Defense Advanced Research Projects Agency (DARPA), which proved the effectiveness of a low-fidelity laptop simulator to train military personnel. The 970 participants were a combination of elite units of the U.S. Navy, U.S. Marine Corps, and U.S. Coast Guard. The objectives of the investigation were to examine the effectiveness of virtual reality training simulators in their ability to teach personnel tactical and trauma care skills, enable them to practice stress management techniques, and to improve performance during real-life combat situations. The test group first received training in a virtual combat scenario while their stress and arousal levels were monitored through non-invasive physiological means. The control group did not receive virtual training. Afterward, all participants were tested in a real-world version of this same combat scenario to determine the effectiveness of training in a virtual environment. Significant transfer of skills from virtual to real world exercises was demonstrated through standard, objective performance measures and after-action analysis of video. The study proved virtual reality training to be an extremely effective and efficient method of preparing military personnel for combat situations.

Currently, the VRMC is conducting a study, funded by the U.S. Army's Telemedicine and Advanced Technology Research Center (TATRC), to test the efficacy of virtual reality video game (VRVG) training in preparing combat medics for real-life combative medical scenarios. The purpose of the VRVG is to provide an inexpensive training tool that will allow medics to experience situations outside of their everyday training. The game will test the medics' knowledge of medicine, combat training skills, and ability to function under the pressure of a battlefield situation. The VRVG will contain virtual scenarios of terrain that the medics are not able to experience in their current real-world training. The game will also allow medics to learn from their mistakes and repeat scenarios until they successfully complete the task.

In addition, the VRMC is currently providing SIT training for the U.S. Army's Aeromedical personnel at Fort Rucker, AL. Data will be collected during the training, and trainees will be tracked after returning from deployment. Uses for the data may include: 1) studying the relationship between physiologic arousal and performance outcomes; 2) evaluating adjunctive training techniques (such as relaxation training) to manage physiologic arousal and enhance performance; and 3) longitudinal tracking of personnel physiological levels during training to determine the fidelity of the relationship between blood pressure/heart rate and combat operational stress reactions (COSRs) and PTSD, which could eventually act as a predictive tool.

POST-DEPLOYMENT TOOLS: VR THERAPY FOR PTSD

Deployment stress is a very serious problem. PTSD has a negative impact upon return to duty rates and health care costs. It is a disabling, often chronic problem, which frequently results in poor treatment outcomes and disability payments to PTSD-diagnosed veterans that may continue for years, if not decades. Front-line antidepressant medications for the disorder—such as selective serotonin reuptake inhibitors—rarely yield better than a 40% reduction in Clinician Administered PTSD Scale (CAPS) scores, and most patients will still meet criteria for PTSD at the end of an adequate treatment trial (Hamner, Robert, & Frueh, 2004). Regarding psychotherapy, only 44% of all those who enter treatment—based on a meta-analysis published early this year—will be classified at the end of the treatment period as improved (Bradley et al., 2005).

The DSM-IV classifies PTSD as a heterogeneous disorder that develops following exposure to traumatic events such as a serious injury or threat of injury or death to the self or others. Symptoms of PTSD, which must persist for at least one month, include increased anxiety or arousal, dissociation, avoidance of stimuli associated with the trauma, numbing of general responsiveness, and flashbacks to the traumatic experience (APA, 2000). Both anxiety-reducing medication as well as cognitive behavioral therapy (CBT) can help in recovery.

Prior to the availability of VR therapy applications, the existing standard of care for PTSD was imaginal exposure therapy, in which patients "relive" the traumatic event in a graded and repeated process (Rizzo et al., 2006). Exposure therapy is based on emotional processing theory (EPT). Applying EPT to PTSD, fear memories are stored as a "fear structure" and include psychological and physiological information about stimuli, meaning, and responses (Foa & Kozak, 1986). Once accessed and emotionally engaged, the structure is open to modification through CBT and, over time, will result in extinction of the fear response.

Although exposure therapy has been shown to be effective (Laor et al., 1998; Wiederhold & Wiederhold, 2004), many patients are unable or unwilling to effectively visualize the traumatic event. Ironically (in terms of exposure therapy), avoiding reminders of the trauma is one of the defining symptoms of the disorder (Difede & Hoffman, 2002). In studies that address treatment non-responders, failure to engage emotionally or visualize well enough to elicit an emotional response are cited as most predictive of non-response, since the fear structure is not accessed and therefore not open to change (Jaycox, Foa, & Morral, 1998; Kosslyn et al., 1984; Van Etten & Taylor, 1998).

This is where virtual reality graded exposure therapy (VRGET) may provide an excellent middle ground. In recent years, VR has been

shown to improve treatment efficacy for PTSD in survivors of motor vehicle accidents (MVA), war veterans, and those involved in the 9/11 World Trade Center attacks, as well as in other areas (Difede & Hoffman, 2002; Rothbaum et al., 1999; Walshe et al., 2003; Wiederhold & Wiederhold, 2000; 2004; Wiederhold et al., 2001; 2002). By placing the patients in a virtual Iraqi setting, or other environment where a trauma has occurred, and then having them slowly experience that situation in a controlled way, the patient may begin to habituate to their PTSD symptoms and come to reappraise the situation, allowing emotional processing to fully occur and thus free them from the past.

VRGET overcomes many of the shortcomings of imaginal exposure by providing external visual and auditory stimuli for the patient, thus eliminating the need for intense imagination skills. And, unlike in vivo therapy, which takes the patient into real-world scenarios (which is not practical or often even possible with war veterans), VR permits the patient to interact with anxiety-inducing scenarios in the safety and confidentiality of the therapy room. The ability of patients to feel they exert some measure of initial control over the situation also seems a safer, more tolerable starting point for many. In addition, the therapist and patient, in their therapeutic alliance, can determine and control the exact "dosage" (in terms of duration and intensity) of the exposure exercise. Multiple exposures can also be done during a single therapy session, making for more efficient time usage (Wiederhold & Wiederhold, 2004). Rizzo et al. suggest that a VR system for PTSD treatment could serve as a component within a reconceptualized approach to how treatment is accessed by veterans returning from combat, especially in regard to hesitancy to seek treatment (Rizzo et al., 2006).

In research funded by the Office of Naval Research (ONR), we are exploring whether exposure therapy for PTSD-diagnosed non-combatants using a cognitive behavioral therapy (CBT) approach is more effective when facilitated by VR tools. VRMC graphic designers and software developers created a Virtual Baghdad environment (see below) as a clinical therapy aid for military personnel with PTSD. This fully immersive environment can be viewed on a laptop computer or with a head-mounted display (HMD) and features a market, a battalion aid station, and houses, all of which can be freely navigated. The environment is comprised of sights and sounds such as Arabic prayer from a temple, helicopters thundering overhead, distant explosions, vehicles burning, terrorists running and firing guns, and the voices of Iraqi civilians. Based on interviews with a population of Marine and Navy personnel recently diagnosed with combat-related PTSD and receiving treatment, these are some of the most salient memories they associate with recurring, intrusive thoughts (Spira, Pyne, & Wiederhold, 2006).

Figure 1. Scenes from VRMC's Virtual Baghdad, an immersive, highly realistic environment comprised of both sight and sound, which is used in combination with CBT to treat PTSD. (The combination is known as virtual reality graded exposure therapy, or VRGET.) Users can freely navigate the environment and its structures and interact with virtual people.

Participants will include 136 US Navy Seabees and medical personnel who have acute PTSD stemming from combat exposure. Outcome measures will focus on the general symptom categories targeted by exposure therapy, such as re-experiencing, avoidance, and arousal. The systems will be tested at Balboa Naval Hospital and Camp Pendleton. Initial pilot testing of the system indicates that VR therapy produces both subjective (self-report) and objective (physiological) arousal in individuals suffering from PTSD. In a second study funded by ONR, Stress Inoculation Training (SIT) protocols are being tested to determine if providing stress-hardening skills prior to deployment can decrease incidence of PTSD.

A separate project, funded by the Telemedicine and Technology Research Center (TATRC), allowed us the opportunity to ship a VR system to Iraq in August 2005. The tool is being used by psychiatrists and psychologists deployed to Iraq, where mental health professionals are now far forward. In-country clinicians appreciate use of the VR PTSD tool as part of an early intervention protocol, and provide VRMC clinicians with valuable feedback on ways to improve the tool. This information from troops in-theater on how the software might need to be adjusted to better meet their needs is crucial for our system. Having the end user in the development loop has been an important attribute we have encouraged over the past decade and provides for quicker iterations in the development cycle and a more useful end product.

CONCLUSION

Decades after the first simulators were used to train fighter pilots, advanced technologies and simulations are now impacting military medicine. The VRMC is committed to developing, testing, validating, and delivering innovative technology integrated with medical science to successfully train, prepare, and provide follow-up care for troops. Over the past decade, we have developed a variety of evaluation and assessment protocols based on both subjective and objective measures in our clinic, particularly by pioneering the use of physiological measures while trainees perform exercises in virtual reality and other simulation environments. We are greatly encouraged and motivated by the promising advances made so far and the new technologies yet to come.

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Virtual Standardized Patients for Training Health Professionals on Chemical and Biological Agent Exposures

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Abstract: *A prototype training system has been developed, implementing experiential learning elements through the use of a Virtual Standardized Patient in order to prepare the medical community to recognize and manage victims of bioterrorism. This training simulation replicates the function of live standardized patients; however, it facilitates repeated use, requires limited resources, can be easily distributed, and provides immediate feedback. This research follows initial studies on training health care professionals to respond to bioterrorist agents through experiential learning methods instead of the traditional didactic approaches used in medical education. Anecdotal evidence indicates that this simulation training is extremely engaging and that the use of highly interactive role-play simulations improves training effectiveness and "boost[s] learning retention rates dramatically" (Boehle, 2005).*

INTRODUCTION

Biological and chemical warfare agents such as smallpox, anthrax, and sarin are candidates for use in terrorist attacks because they have the potential to create widespread panic with serious medical and economic consequences. Since these agents are unlikely to be encountered in events other than terrorist attacks, most health care professionals have had negligible preparation for the diagnosis and treatment of medical conditions caused by such agents. In particular, the last outbreak of smallpox was seen in the United States in Texas in 1949, and the World Health Organization proclaimed the worldwide eradication of the disease in 1980, so few physicians practicing today have ever seen a case, and scant attention has been paid to it in medical training for many years. As a result of an increased awareness and threat of terrorist attacks in recent years, medical education to prepare first responders has rapidly evolved. Of particular importance are experiential training methods that have the capability for widespread distribution.

Simulations involving standardized patients (SPs) are one method of experiential training, and we are aware of two simulation exercises that used trained SPs to portray bioterrorism exposure. Both simulations measured the performance of medical professionals in the initial diagnosis and management of casualties. In the first exercise, staff from the Uniformed Services University National Capital Area Medical Simulation Center (SIMCEN) trained and moulaged SPs to simulate the presentation of smallpox; the exercise was conducted before 9/11/2001 and has not been previously published. Seventy intern-level military physicians in various specialties participated in a simulated Emergency Department (ED) exercise in which they were asked to evaluate a patient with a rash. In the case of simulated smallpox, 32% of the interns failed to take a travel history, 25% failed to wash their hands, 74% failed to use gloves and gowns, 71% failed to discuss the possibility of serious disease with the patient, 52% failed to isolate the patient, and 85% failed to notify public health authorities.

A more recent study (Klein, Atas, & Collins, 2004) evaluated pre-hospital and ED care at 12 hospitals in the care of a total of 13 trained SPs with simulated smallpox. None of the ambulance personnel correctly identified their patients' condition, but emergency department staff correctly identified 7 of the 13 SPs as potentially being infected with a highly contagious agent. While 5 of the 7 were isolated, the other two were recognized before they left the ED. The local health department was notified in two cases, and of the 6 SPs who were not correctly identified, all were inappropriately discharged from the ED. Clearly, there is an indication for educational efforts to improve the ability of health care providers to effectively diagnose patients exposed to bioterrorist agents and to help reduce casualties of bioterrorism.

MEDICAL EDUCATION

Traditionally, medical education has followed a didactic approach, based primarily on lectures and written learning materials. However, such approaches tend to be least effective in promoting retention of knowledge, especially for adults. We previously published a book, *Physicians' Guide to Terrorist Attack* (Roy, 2004), and a series of case-based booklets for Continuing Medical Education, which address a broad spectrum of chemical and biological agents (Benedek, 2005; Durning & Roy, 2005; Omori & Benedek, 2005; Roy, Durning, & Hall, 2005); the former of these training materials is available electronically on an accompanying CD-ROM, and the latter has already been accessed by thousands online. Nevertheless, we suspect that experiential learning would be far more likely to promote durable knowledge retention.

In medicine, the prime method for experiential learning is the live patient; however, opportunities to learn to treat bioterrorism are limited by the fact that bioterrorism agents are rarely encountered clinically. One viable alternative for experiential learning is the evaluation of SPs who are trained to mimic the effects of specific medical conditions. We developed scenarios for educational workshops at national meetings in which we trained SIMCEN SPs to mimic presentation to physicians' offices with smallpox, anthrax, staphylococcal enterotoxin B, and botulism, respectively, as well as a mass casualty exercise involving terrorist use of sarin. Training 25 physicians at one national meeting required 8 hours of training time for 20 SPs, transportation of the SPs to the workshop site, and payment for their time in the workshop. We also needed four physicians to supervise and provide feedback at both the SP training and CME workshop sessions, along with a moulage expert and an administrator to help with logistical issues involving the SPs. While SPs are effective in improving retention of learning objectives, afford the interactivity lacking in a didactic approach, and decrease the requirement for subsequent training with repeated use, significant resources and expenses are associated with this training method, with a relatively high marginal cost. Training with SPs is also limited considerably by the fact that it cannot accommodate a large number of learners, feedback is subjective, and training is constrained by available time and space.

BACKGROUND

Research conducted on simulation training programs previously developed by SIMmersion indicates improvement in skill level and information retention as well as a high level of user interest. In an effort to augment and standardize FBI interview training curriculum for new agents, SIMmersion developed the *Mike Simmen* Criminal Investigation simulation. A study conducted by the FBI on the effectiveness of this simulation found that trainees rapidly improved their scores for identification of clues of deception and truthfulness by 30% and their overall interview scores by 16% between the first and second simulated interviews. Not only did students improve their performance after completing the two required simulation plays, but they also continued to use the simulation during their personal time. The same study found that new agent trainees who were required to conduct only two simulated interviews actually spent their own time conducting an average of five additional interviews with Mike Simmen. In all, over 60% of the time trainees spent interviewing Mike Simmen was voluntary (Olsen et al., 1999).

METHODS

To overcome the limitations of live patients and SPs as experiential learning tools, we developed a training module prototype that facilitates conversations between learners and a virtual standardized patient (VSP); learners include medical students, physicians' assistants, and other ancillary health care personnel. The VSP training was created using simulation technology developed by SIMmersion LLC; the technology has been implemented to create computer-based training modules that can be employed alone or with additional content for training topics such as suicide intervention or substance abuse counseling. This simulation was designed specifically to improve the skill of health care providers in the initial evaluation of a patient presenting in a primary care setting with a rash and accompanying symptoms. In doing so, it provides the opportunity for a health care pro-

fessional to hold a detailed conversation with a patient that may have signs and symptoms of smallpox or another more common medical condition for which smallpox might be mistaken. The simulation was developed as a proof-of-concept for a training system that enables virtually unlimited practice for building skills, increasing learning retention, improving trainee confidence, and changing behavior.

We developed a set of questions that a health care professional might reasonably be expected to ask in the course of taking a medical history, including options with varying degrees of appropriateness; while some questions stay on task and develop rapport, others deviate from the purpose, include personal judgment, use medical jargon, or otherwise damage rapport. The questions were developed in accordance with teaching objectives, in order to provide learners with the opportunity to cover certain topics at particular points in the simulation. During the course of the medical interview, the selection of questions may affect the patient's mood and consequent responses. To make this possible, a variety of responses was scripted to reflect how a patient would react, taking into account the patient's medical condition and mood. Response variations are reflected by content, amount of detail, attitude, and tone. In summary, the simulation enhances both disease-specific skills and overall interviewing skills. The simulation provides immediate feedback on the appropriateness of the learner's questions, while making the scenario both interesting and informative enough to maintain the learner's attention. The engaging quality of the simulation encourages learners to use the simulation repeatedly to maximize learning.

Throughout the development process, we incorporated mechanisms into the script to provide both comprehensive and immediate feedback to simulation learners. Accuracy of the diagnosis made by the learner is provided at the end of the simulation; in addition, a Help Agent can deliver verbal and non-verbal feedback to the learner during their conversation with the VSP. Feedback options are available for every question, based on user preference. For example, learners can choose whether they would like feedback on each question asked or only for those that they request help on. Learners can also select the desired delivery method. The Help Agent, an animated desktop icon, is available to enact feedback using gestures such as clapping or thumbs-down. Verbal feedback explaining why a learner's selection of a particular question is good, bad, or neutral can be spoken by the Help Agent or can, alternately, be read by the learner from a pop-up window.

We link questions and responses using software that relies on non-branching logic, resulting in conversations that are never repeated in exact sequence or with the same content. The realism of our simulated conversations is also attributable to the interactive audio and video components. The simulation has been engineered to enable learners to speak with the VSP using voice-recognition software while viewing movie clips that we filmed of an actor. Since actors are more life-like than computer-generated avatars, and consequently more engaging, we chose to use an actor who was moulaged to exhibit smallpox, as well as easily mistaken conditions such as chicken pox and Rocky Mountain Spotted Fever. The actor we employed had considerable prior experience in medical settings, having served as an SP in the training of medical students learning how to perform medical histories and physical examinations. Learners using the simulation also have on-demand access to pop-up windows displaying physical findings, medical images, and audio recordings such as heart and breathing sounds at appropriate points in the simulation.

To test the smallpox simulation module, we made it available for use by a group of experienced military physician educators. Each physician was asked to engage in a single clinical encounter with the VSP, make a diagnosis, and complete a questionnaire immediately upon using the simulation. The survey consisted of a series of objective questions with responses on a five-point Likert scale: Poor, Fair, Good, Very Good or Excellent. There was also ample room for physicians to make subjective comments.

RESULTS

Fifteen practicing military physicians used a prototype of the smallpox simulation module and were then surveyed to ascertain their opinions and feedback. Eighty-seven percent of the phy-

sicians agreed that the simulation was entertaining and the same percentage agreed that when the conversation was over they were curious to try the simulation again. Of the 9 participants who had experience with SPs, 56% indicated that the experience compared favorably to interacting with a live SP, while the realism of the interaction with the VSP was rated by 47% as Good, by 47% as Very Good, and by 7% as Excellent. Forty-seven percent of the participants clearly indicated that they had not viewed any rash photos; all of these participants recommended that the simulation offer additional physical exam information or increased accessibility to the images. Of the 33% that clearly indicated they had viewed rash photos, all rated the photos as either Very Good or Excellent in both accuracy and in relevancy. Of the one-third of the physicians who made recommendations for additional physical exam information, none of them had viewed any photos. Besides desiring access to physical exam information, participants indicated wanting the opportunity to inquire more about the VSP's past medical and travel history, exposure to those infected with a rash or those who had received a smallpox vaccine, and details of symptoms and onset.

The medical conditions included in the differential diagnosis for smallpox in training physicians how to respond to potential biological threats was assessed as appropriate by 87% of survey participants, with comments from the remaining 13% indicating that that the scope of biological threats is more extensive and that the selection was appropriate for skin manifestations, but was not representative of the whole spectrum of potential biological threats. Two-thirds of the physicians indicated that they would use the simulations in their medical curriculum. When asked how this simulation training should be implemented as a training tool, 85% suggested that its best fit would be as a supplement to existing training on this topic for all skill levels, 67% suggested that its second best fit would be as refresher training or as Continuing Medical Education (CME) for experienced health care providers, and 58% identified the least effective purpose for this simulation as a stand-alone product for training medical students and other physicians. When asked to rate the usability of the simulation, 60% of the physicians rated both the clarity of directions and ease of navigation as Good. Each category had the remaining 40% of respondents split between Fair and Very Good/Excellent ratings, with no Poor ratings.

DISCUSSION

Our smallpox simulation prototype appears to be an effective method for educating physicians and ancillary health care providers to recognize and manage victims of bioterrorism. Our preliminary survey results from a group of physician educators support our hypothesis that VSPs have the potential to be an appealing and effective experiential learning component. By collectively identifying the simulation as engaging and expressing an interest to continue to practice with the VSP, the physicians reinforced the idea that training with VSPs is engaging and affords a high level of realism, both important aspects of experiential learning. The high accuracy and relevancy ratings of the rash photos also contribute to the realism of the simulation. Results suggested the exam functions and findings to be quite important to the surveyed physicians; as a result, we've identified that the need for information currently lacking in didactic learning can be addressed through training with VSPs. While the training was not recommended as a stand-alone product, developing VSP training as a supplement to existing training programs or as refresher training or as CME for experienced health care providers seem to be viable options for product placement. Results also indicate implementation of VSP training into medical curriculum as a prospect. We will be continuing to assess learner satisfaction and efficacy with this simulation, as well as making improvements in response to feedback.

There are some limitations to our initial assessment of clinician satisfaction with the simulation. While we received some useful information that allows us to make improvements to the program, the individuals we surveyed are all physicians in the military, and are all involved in graduate medical education. Thus, their perspectives are perhaps relatively limited and uniform. It is arguably more critical for military physicians to be knowledgeable about bioterrorism because of the potential for the use of biological agents in warfare. Moreover, the military has been vaccinating soldiers against smallpox in recent years, so military physicians' awareness of

smallpox in particular has been heightened. Non-military physicians and ancillary providers might find the simulation even more useful and stimulating. The fact those surveyed were medical educators may make them more knowledgeable about the advantages and disadvantages of various educational methods. While their level of knowledge may improve the validity of their feedback, it probably narrows their perspective and may result in a bias toward more traditional learning methods. For example, the fact that many of the surveyed physicians thought the simulation would be more useful as an adjunct to traditional methods, rather than a stand-alone product, may reflect a bias on their part.

The fact that the product being tested and evaluated by physicians is a prototype simulation directly affected survey responses. While the proof-of-concept demonstrates the idea of VSPs, the depth of character responses and the breadth of topics covered in the simulation are limited. Shortcomings identified by the survey participants can be explained by the limitations of a prototype model and will be addressed in the subsequent development of an expanded training simulation. Expansion of the simulation training will include additional physical exam information, more rash images, the addition of Marburg hemorrhagic fever as a medical condition, an expanded selection of topics to discuss, and a greater variety and detail of character responses. While the simulation content is focused on current bioterrorist agents that present with a rash, the principles of this simulation training can be applied to different scenarios; it is feasible to develop additional systems focused on agents that present with pulmonary conditions.

To evaluate the efficacy of repeated practice of the simulation in enhancing knowledge and management skills beyond those acquired by usual educational experiences, we will recruit a group of 60 clinicians. All 60 will use an electronic learning element of the system, which will, for example, educate them on the key signs and symptoms for differentiating smallpox from chicken pox. However, 30 of the 60 clinicians will be randomized to practice taking an accurate medical history and to implement a patient management plan via the simulation. One month after the training, each of the 60 clinicians will be asked to interview two of four live standardized patients (the four cases will include smallpox, chicken pox, Rocky Mountain spotted fever, and Marburg hemorrhagic fever). The SPs have significant experience in the evaluation of medical students and residents and will be blinded to the training status of the clinician; they will perform blinded assessments of the clinicians' performance. In addition, the sessions with the SPs will be videotaped for additional assessment by independent blinded observers. The performance of the two groups will be compared, both on individual tasks as well as in aggregate, using students' two-tailed t-tests and chi-square. We hypothesize that the interactive learning with the VSP will prove more effective and durable than simple review of the key clinical information.

Ultimately, if the smallpox simulation proves effective and successful, we plan to develop simulations to address other bioterrorism agents, along with more common conditions that would be in their differential diagnoses. For example, a pulmonary presentation could include the bioterrorism agents anthrax, plague, and tularemia, along with influenza, influenza-like illness, and community acquired pneumonia. Another simulation we seek to develop is the initial diagnosis and management of post-traumatic stress disorder (PTSD), which could result from exposure to the aforementioned biological terrorist attacks as well as from war or other trauma. VSPs could be used to improve the ability of primary care physicians or mental health professionals to screen individuals who may be affected by PTSD; consequently health care professionals could use VSPs to practice establishing an initial management plan, whether it involves pharmacotherapy, psychotherapy, or a referral.

CONCLUSION

We have developed and conducted initial testing of a simulation using a virtual standardized patient to improve the knowledge and skills of health care professionals in an area that has traditionally been neglected in medical education. It has the advantages of being relatively low cost, easily accessible, realistic, and engaging. The simulation is a model of experiential learning and distributed learning technologies, which has the potential for a myriad of applications in improving the palatability and efficacy of educa-

tional endeavors for health care providers. If our subsequent studies prove successful, they can open the door to many new research projects with the potential to radically change the way that medical education is delivered.

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Coping with stress using Virtual Reality: a new perspective

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Abstract: *This paper discusses the possible role of VR in stress management research. After analyzing the current research in this area, we propose to use VR for triggering a broad empowerment process within the optimal experience induced by a high sense of presence. Specifically, we intend to use VR for manipulating experience-related self-efficacy and mood following the emotion-focused therapy approach.*

On one side, we use a vivid VR experience – a beautiful island or a green hill landscape – to induce an optimal experience. On the other side, we combine relaxation techniques to cope with a general stressful situation, and cognitive techniques to change the meaning of the event. In this process, emotional status plays a critical role for achieving an optimal experience. So, the protocol includes a specific focus on emotional control based on three phases: emotional awareness, emotion regulation, and transforming emotion.

INTRODUCTION

There is no doubt that stress, anxiety, and depression are now the leading mental health problems in western societies. In addition, major illnesses like cardiovascular disease (Shah et al, 2004) are linked to stress. Stress does not represent a pathology in the Diagnostic and Statistical Manual of Mental Disorders - Fourth Edition (DSM-IV), but high levels of stress can contribute to a pathogenic condition. Indeed, not everyone undergoing trauma or highly stressful periods develops an anxiety disorder, though some authors (Mineka and Zinbarg, 2006) have proposed a link between stress and generalized anxiety disorder (GAD), stating that people with uncontrollable and unpredictable life stress seem to be especially prone to developing GAD.

The aim of this paper is to propose an innovative approach to cope with stress using Virtual Reality (VR). Traditionally VR has been used for exposure therapy, immersing the patient in a synthetic universe in which the anxiety stimulus is introduced in a gradual and controlled way. The new approach examines VR as an experiential means to support coping skills in a learning process without exposure.

With this purpose, we discuss the traditional approaches for coping with stress, followed by a section dedicated to the proposal of using VR to cope with stress. To make this connection we underline the potential of VR as experiential interface focusing on the relevance of presence in VR.

COPING WITH STRESS: THE TRADITIONAL APPROACHES

Stress management (SM), as recently noted in a review (Ong et al., 2004), is a term widely used with a seemingly obvious meaning, but that does not clarify how many different forms exist and how efficacious they are according to the target problem.

Because the way stress is conceptualized partly determines how coping is operationally defined (Singer, 1984), we begin by examining issues related to how stress is conceived. First, we have to consider that stressful events have both objective and subjective features (Sarason, Johnson, & Siegel, 1978). Objective features of such events have consequences that are shared across individuals experiencing a similar event. Often, however, such features of stressors may be less important than the more subjective aspects of such events. Indeed, in line with the Transactional model on the ecology of stress (Lazarus, 1966), in a

stressful situation, it is important to understand how the person perceives incongruence and dissonance between him/herself and any dimensions of the context he/she has to face.

The situational (or transactional) perspective (Lazarus, 1999, 2000; Lazarus & Folkman, 1984) represents the dominant paradigm in the field. The fundamental assumption of this perspective is that coping is a process that involves unfolding interactions between the person and his or her physical and psychosocial environment. The transactional view of coping is highly cognitive and highlights the importance of appraisal processes, or how one views the demands of the situation (primary appraisal), and his or her available personal and interpersonal resources (secondary appraisal). The combined primary and secondary appraisals determine the intensity of stress that one experiences; this in turn influences the choice of coping responses.

Coping researchers have begun to investigate the utility of positive emotions in stressful contexts. A review of recent evidence indicates that positive emotions help buffer against stress (Folkman & Moskowitz, 2000). For instance, positive coping strategies, such as positive reappraisal, problem-focused coping, and infusing ordinary events with positive meaning are related to the occurrence and maintenance of positive affect (Folkman & Moskowitz, 2000) and predict increases in psychological well-being and health (Affleck & Tennen, 1996). These findings suggest that positive emotions are valuable tools for establishing enhanced outcomes in well-being.

The appraisal theory represents a crucial factor to understanding the relations between emotion and cognition. Within this perspective, cognitions and emotions are interwoven. In particular, Scherer (2001), in his component process theory, proposes that the organism makes five types of checks in response to a stimulus: novelty, intrinsic pleasantness, relevance to meeting plans, ability to cope with perceived event, and compatibility of the event with self-concept and social norms. He believes that organisms need the information that such checks afford in order to choose how to respond.

Whereas the range of possible coping responses may be limitless, strategies are generally classified as either problem-focused or emotion-focused (Lazarus & Folkman, 1984). Problem-focused strategies attempt to change or modify the actual conditions that cause the stress, involving gathering more information, goal setting, problem solving, and time-management techniques. Emotion-focused strategies target changing one's emotional response to the stressful event, which involves learning relaxation techniques to cope with a situation that must be endured or cognitive techniques to change the meaning or perceptions of the event.

Based on the initial work by Lazarus and Folkman (1984), a more elaborate theoretical framework (Cox & Ferguson, 1991; Endler & Parker, 1994) proposes two added categories of coping: appraisal-focused or avoidance-focused. Several authors noted the inefficacy of the last one (Mineka, 2004; Zinbarg, Craske, & Barlow, 1994) stating that cognitive avoidance, in which the subject attempts to suppress emotional and physiological responses, or to control worry, may lead to more negative intrusive thoughts and may develop perceptions of uncontrollability over worry. These thoughts are in turn associated with greater stress, leading to a vicious cycle.

Rather than concentrating on toning down or suppressing emotions, people need to guide their emotions toward constructive action or transform them into emotions that are more favourable and more helpful to problem solving. In this sense, people who are experiencing high levels of stress and distress could receive greater help from using emotion-focused strategies (Ptacek & Pierce, 2003.) that do nothing to directly alter the situation causing the stress, but may help the person feel better.

In the clinical context, emotion-focused therapy (Greenberg, 2004) is based on two phases: arriving and leaving. The premise is that one cannot leave a place until one has arrived at it. Emotional support inside therapy is the foundation for therapeutic effectiveness, based on three emotional processing principles: 1) increasing awareness of emotion, 2) enhancing emotion regulation, and 3) transforming emo-

tion. These three principles act as a general guide for working with emotions:

- Emotional awareness helps people understand what they are really feeling at their core by paying attention to their bodies and making contact with sensations. Clients are asked to become aware of and track sensorimotor processes (the sequence of physical sensations and impulses) as they progress through the body (Perls, Hefferline, & Goodman, 1951) and to be mindful of their internal experience (Kabat-Zin, 1993).
- Emotion regulation skills involve such things as identifying and labelling emotions, allowing and tolerating emotions, establishing a working distance, augmenting positive emotions, reducing vulnerability to negative emotions, self-soothing, breathing, and distraction. Another important aspect of regulation is developing patients' abilities to tolerate emotion and to self-soothe. Emotion can be down regulated by developing tolerance and by soothing at different levels. Physiological soothing involves activation of the parasympathetic nervous system to regulate heart rate, breathing, and other sympathetic functions that speed up under stress.
- Transforming emotion is the process of "changing emotion with emotion." This novel principle suggests that a maladaptive emotional state can be transformed best by undoing it with another, more adaptive, emotion. For example, positive imagery is a good strategy of affecting an emotional response. With practice, people can learn how to generate opposing emotions through imagery and use these as an antidote to negative emotions.

From this perspective it seems clear that there is no single approach to coping with stress, but the focus on emotional aspects could represent a valid way to learn internal strategies. Our proposal is to use this emotional focus with an innovative method to generate experience.

THE EXPERIENCE IN VIRTUAL REALITY'

Virtual Reality (VR) is a new technology that alters the way individuals interact with computers. It has been defined as a set of computer technologies that, when combined, provide an interface to a computer-generated world. VR provides such a convincing interface that users believe they are actually present in a three-dimensional world, and navigate and interact with it in real time, where their actions and reactions are experienced in the present moment (Wiederhold & Wiederhold, 2005). It is possible to delineate VR as something that overcomes technology and comes ever closer to the experience. This represents the principal potential of VR and allows us to describe VR as an experiential interface. A virtual experience may evoke the same reactions and emotions as a real one; this emerges mainly from the sense of presence (Riva et al. 2003; Ijsselteijn 2001). Some authors suggest that presence is a neuropsychological phenomenon defined as the "feeling of being in a world that exists outside of the self" (Riva & Waterworth, 2003). According to this vision, presence has a simple but relevant role in our everyday experience: *the control of agency through the unconscious separation of "internal" and "external.*

However, there is not a shared vision about the role and the nature of presence. From a technological point of view, the main determinants of presence are: the use of multiple sensorial channels (particularly vision, hearing and feeling); the immersion (through the exclusion of external stimuli to the ones offered by the virtual environment); the egocentric location (offered specially by the head-mounted display (HMD), which provides images in accordance with the head's location); the possibility of action in the environment, provided by an environment's response to our movements. However, as IJsselsteijn (2003) stated, although the breadth and depth of sensory experience are important in improving the media experience "the basic appeal of media still lies in its content, the storyline, the ideas and emotions that are being communicated." Thus, to allow the participant to feel a sense of presence, it is important to work on the proposed content within the mediated experience. In agreement with Scherer theory (Sander et al., 2005), we retain that the coherence between the content of the experience and the goal of the users is critical: the users may feel more present in a virtual environment (VE) when they consider the mediated experience relevant for their goals. Our proposal is to take advantage of the potential of this

technological tool by enhancing the quality of the experience through the elicitation of the sense of presence.

VR TO COPE WITH STRESS

Formerly, Virtual Reality has been used to deliver graded exposure as an adjunct to cognitive–behavioral therapy (CBT; Wiederhold, 2001; Moore, 2002) to treat pathologies such as phobias, post-traumatic-stress disorder (PTSD), and others related to anxious stimuli management (Botella et al., 2004; Riva, Wiederhold, & Molinari, 1998). Typically, using VR, the therapist controls a repertoire of stimuli to structure graded exposure of relevant arousing stimuli. The principal disadvantage of this approach is that is content-specific: a new virtual environment has to be developed for each particular context. So, it is hardly applicable to some conditions, like stress and generalized anxiety disorder, which are not strongly related to a specific scenario.

Nonetheless, VR could give a strong contribution to stress management research. Recently, some authors observed (Plante et al., 2006; 2003) that individuals who interact in an enriched environment with a variety of positive visual and auditory stimulation report greater improvement in self-efficacy and mood (McAuley, Talbot, & Martinez, 1999; Turner, Rejeski, & Brawley, 1997).

This suggests that it is possible to use VR for manipulating experience-related self-efficacy and mood. Further, the effects are related to the affective, social, and environmental experience associated with the interaction.

Our perspective is to use VR for triggering a broad empowerment process within the optimal experience, induced by a high sense of presence. Within this general approach, our strategy combines relaxation techniques to cope with a general stressful situation and cognitive techniques to change the meaning or perceptions of the event. How can we set up this intervention?

First, we should develop a VE including positive visual and auditory stimulation aimed at producing an optimal experience. A typical relaxing scenario could be a natural environment, like a tropical island or a hilly landscape, which includes different zones corresponding to specific experiences (see Figure 1).

Figure 1. The Dream Island – http://www.thedreamisland.com

Within the environment, it is important to include contextual sensorial cues to enhance the realism and the sense of presence experienced by the participants. An audio narrative supports each phase of the protocol, guiding participants in navigation and helping them in performing the cognitive and relaxation exercises. Within this process, emotions play a critical role for achieving an optimal experience. Following the emotion-focused therapy (Greenberg, 2004), our protocol includes three phases: emotional awareness, emotion regulation, and transforming emotion. Figure 2 better explains the different phases and the role of VR in them.

What are the other advantages of using VR for stress management? Positive imagery represents a powerful strategy of effecting an emotional response. The visual presentation of a calm scenario can facilitate participants' practice and mastering of relaxation and acceptance techniques. Thanks to VR, the experience is more vivid and real than what most subjects can create through their own imagination and memory (Vincelli, 1999).

The possibility of planning "virtual experiences" in which participants have an active role should help them to experience themselves as competent, efficacious, and influential. According to

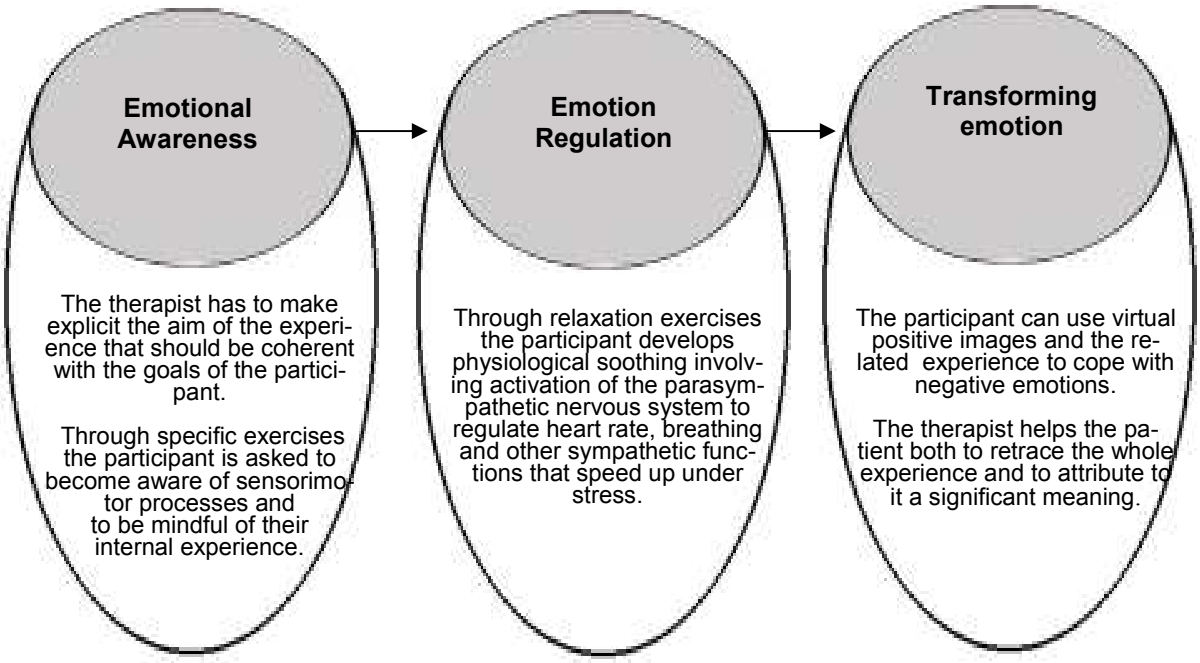

Figure 2. The three phases of the protocol

Bandura's theory (Bandura, 1977), once established, self-efficacy tends to generalize to other situations. Practically, the acquisition of specific skills of stress management during the virtual experience promotes a sense of personal efficacy and prepares the participant to cope with real stressful situations. Indeed, once acquired, these competencies assigned to internal factors become a means to management of stressful situations and they can be transferred and applied to other contexts.

CONCLUSIONS

In this paper, we discussed the possible role of VR in stress management research. The emerging results in this area (Plante et al., 2006; 2003) showed that subjects interacting in an enriched environment report greater improvement in self-efficacy and mood (McAuley, Talbot, & Martinez, 1999; Turner, Rejeski, & Brawley, 1997).

We propose the use of VR for triggering a broad empowerment process within the optimal experience, induced by a high sense of presence. Specifically, we intend to use VR for manipulating experience-related self-efficacy and mood following the emotion-focused therapy (Greenberg, 2004) approach.

On one side, we use a vivid VR experience – a beautiful island or a green hilly landscape – to induce an optimal experience. On the other side, we combine relaxation techniques to cope with a general stressful situation and cognitive techniques to change the meaning of the event. In this process, emotional status plays a critical role for achieving an optimal experience. So, the protocol includes a specific focus on the emotional control based on three phases: emotional awareness, emotion regulation, and transforming emotion.

However, significant efforts are still required to move VR into routine clinical use for stress management. First, building new virtual environments is important to help therapists in investigating how to apply these tools in their day-to-day clinical practice. We need controlled clinical trials to compare the efficacy of the proposed approach with competing methods.

Finally, the importance of presence for inducing optimal experiences requires more studies to explore its link with the different features of a virtual experience.

ACKNOWLEDGEMENTS

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Evaluation Studies

The use of a visible and/or an invisible marker Augmented Reality System for the treatment of phobia to small animals

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Abstract: *Virtual Reality and in vivo exposure have been used extensively for the treatment of several psychological problems, but Augmented Reality (AR) has not been exploited in this field. We have recently presented an Augmented Reality system for treating the fear of cockroaches and spiders that uses visible markers. With this system, we successfully treated ten patients, four with a phobia of spiders and six with a phobia of cockroaches. One important step in the treatment is when the patient must search for an animal that is possibly hidden behind an object. This stimulates patients' anxiety because they do not know which object the animal is hidden behind or if there is a hidden animal at all. When using visible markers it is very easy to know if animal/s is/are going to appear, because at the moment the patient sees the marker, they know an animal will appear. We realized that having visible markers was a negative aspect of our system, and this is why we have developed a Markerless Augmented Reality system. The system works in the same way as the visible marker system, but in this case the markers are not visible. In this paper, we present the markerless system. At present, we are investigating whether the sense of presence and reality judgment in normal users (those without fear) is the same when using the visible marker system as when using invisible marker system.*

INTRODUCTION

Augmented Reality

There are several application areas in which Augmented Reality (AR) is already utilized. Some of the most popular application areas are the following (Azuma et al., 2001; Azuma et al., 1997; Vallino, 1998):

- Medical
- Military
- Education
- Engineering design
- Manufacturing, maintenance and repair
- Entertainment

This list includes some of the areas where AR has been applied, but other areas may be included in this list. Any area where adding virtual information to real world stimulus could help users in their work is a candidate for the use of AR.

In the medical area, AR can offer possibilities to support minimally invasive techniques through image-guided surgery. Surgery planning and surgery training can also be done using AR because of its 3D visualization and interaction capabilities. In psychology, its use for treating patients with phobias is being investigated. Our group has been a pioneer in the use of AR for the treatment of phobias to small animals (cockroaches and spiders; Juan, Alcañiz, et al., 2005; Botella et al., 2005). We have also presented an Augmented Reality System for the treatment of acrophobia using immersive photography (Juan, Pérez, et al., 2005; Juan et al., 2006).

In the military area, AR is used primarily to provide soldiers with real-time information (e.g., maps, occluded buildings, and troop concentrations) in a battle situation. Military training and simulation also benefit from AR.

AR might have the ability to change traditional education methods because it can be used to visualize abstract theories and offers a high degree of interactivity. Geometry and spatial relationships between planets are two examples of cases that have already been investigated.

In engineering design, AR can offer an interactive and collaborative way to construct models. Such virtual models are tangible and can be viewed from different angles. Examples are the construction of the layout of a new city block or the interior design of an apartment.

In manufacturing, maintenance, and repair AR can provide real-time information from instruction manuals to facilitate working processes. This information could be annotations of parts of a machine, instructions for assembly or disassembly, or visualization of hidden inside views.

Entertainment can profit from the interactivity AR offers. AR could change existing gaming concepts, such as board and strategy gaming, and could even make outdoor gaming possible. Interactive story telling is an example of using the application for children.

Marker or Markerless Augmented Reality System?

A marker Augmented Reality System utilizes markers (e.g., a white square with a black border containing symbols or letters). The system recognizes the marker and obtains the position and orientation of the camera with respect to the marker. A markerless Augmented Reality System does not need a marker.

One important step in the treatment of the fear of small animals is that patients have to search for an animal that might be hidden behind an object. This stimulates the anxiety of patients because they do not know which object the animal is hidden behind or whether there is an animal hiding at all. When using visible markers it is very easy to know if animal/s is/are going to appear, because at the moment the patient sees the marker, they know an animal will appear. We realized that having visible markers was a negative aspect of our system, and this is why we have developed a Markerless Augmented Reality system.

The Markerless system works in the same way as the visible marker system, but in this case the markers are not visible. They exist, but they are not visible for users.

CHARACTERISTICS OF THE MARKERLESS SYSTEM

The AR system is video see-through. That is, a color camera captures the image of the real world. This image is then treated by the system. The required information about the position and orientation of the 'invisible marker' is obtained. The virtual elements are overlapped over the desired position in the coordinate system.

Hardware

The video stream is captured using a FireWire camera (color image). We have used a DragonFly Camera (Figure 1). The IR Bullet Camera (715nm IR filter) has been used to obtain the infrared image where the invisible markers are detected (Figure 2). The Daeyang i-Visor(DH-4400VPD) has been used as a visualization system (Figure 3). The IR invisible Ink Writing Pen – 840 nm Peak has been used to draw the invisible markers. This ink is invisible for the color camera, but visible for the infrared camera.

Figure 1. DragonFly Camera

Figure 2. IR Bullet Camera

Figure 3. Daeyang i-Visor(DH-4400VPD) HMD

Description of the system

The infrared and colour cameras are situated in known positions, so the transformation matrix from the position of the infrared camera to the position of the colour camera is easy to obtain. Both cameras capture the image of the real world. The infrared image is analyzed to identify the position and orientation of the marker. Later, using the above-mentioned transformation matrix, the real position where the virtual objects have to appear over the colour image is obtained. The cockroach/spider appears over the invisible marker in the colour image. In this way, the system knows the position where the animals have to appear, but the user cannot see it.

The functionality of the system is the same as the marker system (Juan, Alcañiz, et al. 2005).

RESULTS

This section includes some images taken during the execution of the Augmented Reality system with markers and without markers. Figures 4 and 5 show similar situations. As figure 4 depicts, one participant is using the marker system. In contrast, figure 5 presents the same participant using the markerless system.

Before testing the system with real patients, we are carrying out a study to determine the sense of presence and reality judgement when participants use both systems. We believe that the markerless system will be even more effective than the marker system.

The study is still in progress, and at the moment, includes participants recruited by advertisements on the University campus, all of whom are students, scholars, or employees at the Technical University of Valencia (ages 21 to 40). All participants fill out the Fear and Avoidance to cockroaches and spiders questionnaires, adapted from Szymanski and O'Donohue's Questionnaire (1995). Participants are divided into two groups. The first group uses first the marker system and later the markerless system. The second group uses the markerless system first and later the marker system.

In order to check the sense of presence that participants experience using both systems, they fill out an adapted questionnaire by Slater et al. (1994). For checking the reality judgment that participants experience using both systems, they fill out a questionnaire adapted from the Reality Judgment and Presence questionnaire by Baños et al. (2000).

The study is still in progress, and for the moment we do not have enough participants to extrapolate conclusions. However, in a preliminary analysis of the data, we can say that participants have a greater sense of presence and reality judgment using the markerless system than using the marker system. Moreover, these scores are greater if participants first use the marker system and then the markerless system. We will be able to extrapolate the final conclusions once the study is completed.

CONCLUSIONS

We have presented a Markerless Augmented Reality system, which is an improved version of our marker AR system for the treatment of a phobia of small animals (Juan, Alcañiz, et al., 2005; Botella et al., 2005). The system presented here will be suitable for cases in which user must not see the marker, keeping them unaware of where the virtual elements will appear.

We intend to test the system with real patients. The marker version has proved to be effective

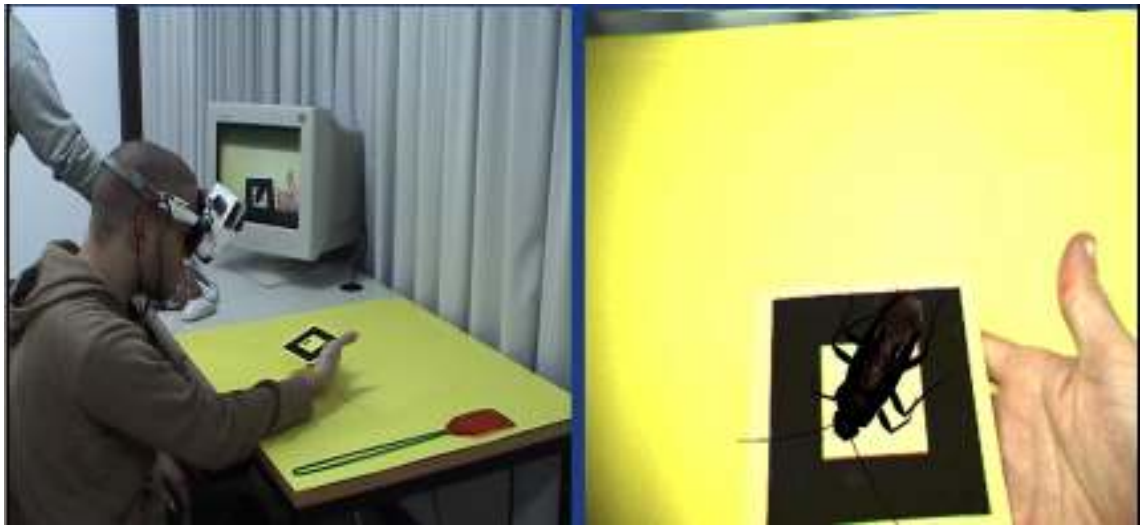

Figure 4. Marker system. a) Participant using the system. b) View of the participant using the system Marker system. a) Participant using the system. b) View of the participant using the system

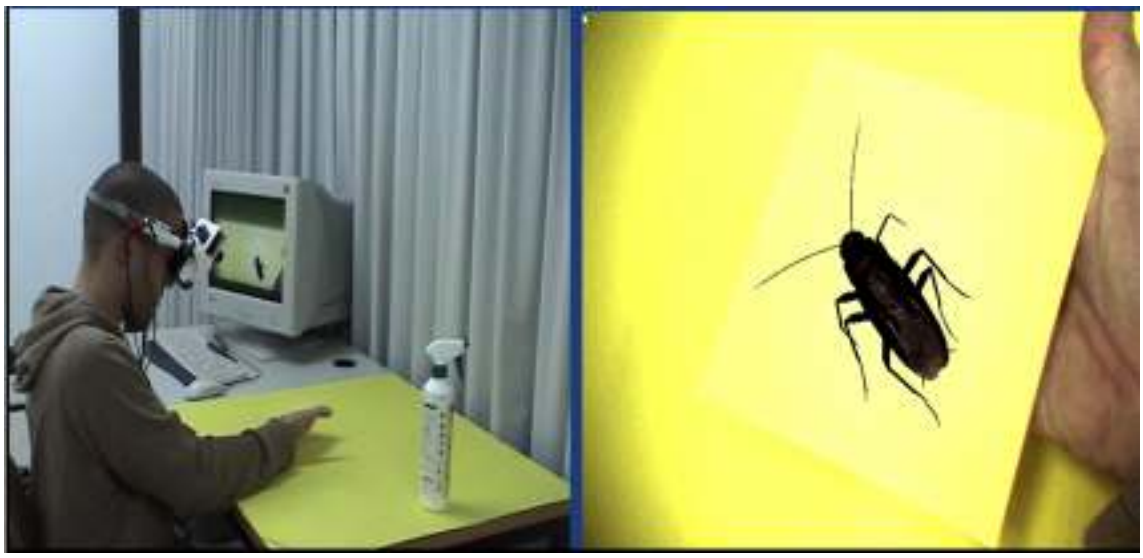

Figure 5. Markerless system. a) Participant using the system. b) View of the participant using the system

in the treatment of real patients. We treated one patient with a phobia of cockroaches (Botella et al., 2005) and five patients with a phobia of cockroaches and four with a phobia of spiders (Juan, Alcañiz, et al. 2005). Before treatment, none of the patients were able to approach or interact with the live animal without fear. In all cases, patients reduced their fear and avoidance of the feared animal in only one session. Moreover, all of them were able to kill the real animal after the treatment.

At present, a study comparing the marker and the markerless systems is being carried out. While we have yet to finish our study, we can say that the participants who have tested the system have a greater sense of presence and reality judgment with the markerless system than with the marker system. The study is still in progress and we will be able to present final conclusions once it is completed.

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Randomized Controlled Trial of CBT with Virtual Reality Exposure Therapy for PTSD

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Abstract:
Background: Posttraumatic stress disorder (PTSD) has frequently been identified in U.S. service members returning from Operation Iraqi Freedom. Untreated or undertreated, PTSD is associated with significant adverse health and life consequences. Unfortunately, PTSD is relatively resistant to therapy, with even first-line treatments failing half the time. Cognitive behavioral therapy (CBT) with exposure therapy is the preferred non-pharmacologic therapy, but it can be difficult to get patients to engage in traditional imaginal exposure. Virtual reality (VR) may overcome this obstacle, enabling therapist-guided exposure to progressively present more intense trauma-associated stimuli. VR exposure therapy (VRET) has shown promise for PTSD treatment in prior small studies. The "Virtual Iraq" environment, adapted from the Microsoft® X-box game Full Spectrum Warrior, is the most realistic and sophisticated ever applied to PTSD treatment; we present plans for blinded controlled comparisons of its performance versus other therapies. Objective: To compare the efficacy of CBT/VRET vs. supportive psychotherapy in conjunction with a relaxation virtual environment, as well as vs. CBT with imaginal exposure, with blinded outcome measures. We hope to establish a feasible control for CBT/VRET, to get an initial measure of the efficacy of CBT/VRET, and to assess the added value of VRET vs. traditional imaginal exposure. Methods and Design: Consenting combat veterans with PTSD will be randomized to CBT/VRET or supportive psychotherapy/relaxation VR in one study, and CBT/imaginal exposure vs. CBT/VRET in a parallel trial. An experienced psychotherapist will train study therapists in CBT, imaginal exposure, and VRET. A blinded, independent investigator will assess response to therapy, using the gold standard Clinician-Administered PTSD Scale (CAPS) to compare outcomes. The study using supportive therapy and relaxation VR as the control will be conducted on outpatients with newly diagnosed PTSD. The trial using imaginal exposure as the control will be in the partial hospitalization program on the psychiatry service at Walter Reed Army Medical Center, where it is expected to have more severe illness with higher rates of comorbidity, so that the more active control arm will be important. Assessment of CBT/VRET in two different populations should enhance the generalizability of the results.

BACKGROUND

Posttraumatic stress disorder (PTSD) was initially codified in the aftermath of the Vietnam War, but the symptoms and associated functional impairment it represents have been well documented for centuries. Perhaps Cain was the first to suffer the torment of this disorder, and Homer certainly depicts its symptoms in his account of Achilles in The Iliad. More recently, hundreds of accounts from the American Civil War, both World Wars, and other national and international conflicts have documented symptoms of distress: myriad physical and psychological symptoms linked to the stress of war that escape efforts to attribute them to environmental factors. PTSD is also frequently seen after terrorism, genocide, and personal assaults such as rape. The current conflict in Iraq, involving snipers and suicide bombings as well as concerns about prisoner mistreatment, is unfortunately a perfect recipe for PTSD, with the first sizeable study of Operation Iraqi Freedom (OIF) veterans finding that 12.9% meet a strict case definition, and 18% a broader definition (Hoge et al., 2004). Untreated or undertreated, PTSD is linked to higher rates of depression and other psychological conditions,

poorer physical health, missed work, impaired function at work and home, and higher health-care costs. In 1998, in the U.S. alone, PTSD and related anxiety disorders were estimated to cost $63 billion (Ullman & Siegel, 1996; Kessler, 2000; Wagner et al., 2000; Walker et al., 2003). Unfortunately, PTSD is also remarkably persistent: 20% of Vietnam veterans still suffered from PTSD many years after the war (Marmar et al., 1994), and PTSD was documented in 12.7% of a cohort of Gulf War veterans several years after that conflict (Roy, Koslowe, Kroenke, & Magruder, 1998). For military personnel, inadequate treatment may lead to separation from the service, greater utilization of medical care in the both the Department of Defense and Veterans Affairs systems, prolonged functional impairment, and loss of Quality Adjusted Life Years (Frueh et al., 2003).

Over the past decade, selective serotonin reuptake inhibitors such as sertraline have been found to be beneficial in the treatment of PTSD, though response rates have been 40-60% at best (Davidson et al., 2001). Cognitive behavioral therapy (CBT) that incorporates exposure therapy is considered first-line therapy (Foa, Davidson, & Frances, 1999; Ballenger et al., 2000). CBT corrects irrational beliefs and thoughts and promotes rational behavioral changes, while imaginal exposure helps individuals to repeatedly confront stimuli associated with their traumatic experience until anxiety decreases. However, it is difficult to get some patients to engage in traditional imaginal exposure, since avoidance of reminders of trauma is one of the cardinal features of PTSD, and imaginal exposure asks them to repeatedly describe it. Virtual reality exposure therapy (VRET) offers an intriguing method for overcoming this obstacle by directly exposing patients to auditory and visual, and even tactile and olfactory, manifestations of their trauma in a safe, therapist-controlled environment. It is only recently that technology has achieved sufficient VR quality to make it realistic enough to employ in this manner. VR has been utilized to successfully help patients overcome phobias (e.g., claustrophobia (Botella et al., 2002), fear of flying (Rothbaum et al., 2000), fear of heights (Emmelkamp, Bruynzeel, Drost, & van der Maast, 2001), fear of spiders (Carlin, Hoffman, & Weghorst, 1997; Garcia-Palacios et al., 2002), and fear of driving after an automobile accident (Walshe et al., 2003)), as well as for anxiety disorders (Rothbaum & Hodges, 1999) and PTSD. Some of our co-investigators documented improvement in an open trial of Vietnam War veterans with PTSD (Rothbaum et al., 2001). More recently, another co-investigator documented significant improvement in World Trade Center workers after 9/11/01, with CBT/VRET compared to waitlist controls (Difede, Hoffman, & Jaysinghe, 2002; Difede & Hoffman, 2002).

We describe our plans to utilize the “Virtual Iraq” environment, adapted from the Microsoft® X-box game *Full Spectrum Warrior,* which is the most realistic and sophisticated ever applied to PTSD treatment. It is being used in an open trial of PTSD at the Naval Medical Center San Diego, but in order to achieve widespread acceptance of this approach, it will be critical to make blinded comparisons in controlled studies.

METHODS

To determine the efficacy of 12 weeks of CBT/VRET, we will conduct two parallel, randomized, controlled trials. In one study, we will compare CBT/VRET with a combination of supportive psychotherapy and exposure to a relaxing virtual environment, with blinded outcome measures. We hope that this design will serve two purposes: first, to establish the virtual relaxation as a feasible control for CBT/VRET, and second, to give us an initial measure of the efficacy of CBT/VRET. We will also conduct a separate study to compare CBT and imaginal exposure therapy with the CBT/VRET combination, to estimate the added value of VRET in comparison to the current standard of care.

We will use the lowest possible threshold on the 4-item PC-PTSD as an initial screen for PTSD in veterans of Operation Iraqi Freedom seen at Malcolm Grow Medical Center, Andrews Air Force Base, MD, and National Naval Medical Center in Bethesda, MD (ambulatory clinics and inpatients). Individuals with at least one positive response will then be asked to complete the PTSD Checklist, Military Version (PCL-M), and those with a score of 44 or higher will be invited to a baseline evaluation to confirm the diagnosis of PTSD and to consider participation in a treatment trial.

The second study will be conducted at Walter Reed Army Medical Center (WRAMC) in Washington, DC, where participants will be enrolled within a psychiatric partial hospitalization program; as such, they are likely to already carry a diagnosis of PTSD, and may already be receiving some form of therapy. In both studies, the Clinician-Administered PTSD Scale (CAPS) will be used to confirm diagnoses. A study psychologist will administer the CAPS and will also conduct a brief clinical assessment to document prior psychiatric history, treatment, psychosis, and suicidal or homicidal ideation. A medical examination will be conducted to rule out serious comorbid medical conditions. The comparison with imaginal exposure will be conducted at WRAMC, where the study population is expected to be more severely ill, an indication for a more proven therapy in the control arm. In the first study, we anticipate enrollment of an average of one participant every two weeks, up to a target number of 26 (13 per arm), based upon the acknowledgement that approximately 3 individuals in each arm may voluntarily discontinue treatment prior to the completion of the study, leaving us with 10 patients having completed each arm, a number our sample size estimates indicate should provide sufficient data for analysis. Participants will be randomized to either CBT/VRET or supportive therapy/relaxation by a coin-flip, until thirteen subjects have been randomized to one arm or the other.

For those randomized to receive CBT/VRET, each of 12 sessions will be approximately 90 minutes in length. The first 3-4 sessions will follow a cognitive behavioral therapy approach, without VR. The initial exposure to the virtual environment, during the 4th or 5th session, will be a relatively innocuous introduction to the "Virtual Iraq" environment, tangentially touching upon the stressor; subsequent sessions at 3- to 10-day intervals (goal of 7-day intervals, but limited flexibility based on schedule availability) will more closely approximate the primary stressor for each individual. The final session will focus on ensuring that the individual is prepared to go forward, with clear follow-up care plans established, and will not include VRET. The VR element will comprise no more than half of each session, with the remainder of the time following a CBT approach. For those randomized to receive ST/relaxation therapy, each of 12 sessions will be 35-40 minutes in length. The VR relaxation environment will be introduced in the 5th session and continued through the 11th session, comprising 15-20 minutes, or approximately half, of each of these visits.

All participants will be re-assessed by phone at 2-week intervals throughout the treatment period, by a mental health professional who is blinded to the treatment status of participants, utilizing the CAPS, IES, PCL, PRIME-MD Today® (Spitzer, Kroenke, & Williams, 1999), and SF-36 (Ware & Sherbourne, 1992). Each telephonic interview is expected to take 20-30 minutes. Phone administration of the CAPS has been previously shown to compare favorably with face-to-face interviews in the diagnosis of PTSD (Aziz & Kenford, 2004).

All participants will be re-assessed at 4-week intervals during a 12 week follow-up period after cessation of therapy, utilizing the CAPS, IES, PCL, PRIME-MD Today®, and SF-36. Each telephonic interview is expected to take 20-30 minutes. Analyses will be performed based upon completers as well as upon intention to treat, comparing baseline scores on PTSD instruments, as well as the PRIME-MD Today® and SF-36, with those for each later time period, and comparing the two arms against each other.

CBT will provide psycho-education about PTSD for individuals about PTSD and its symptoms, and the role that their thoughts and behaviors have in the persistence and disability associated with the condition. It will feature instruction on a variety of exercises and tasks for individuals to engage in between sessions, including breathing exercises, *in vivo exposure*, and cognitive restructuring. The CBT/VRET approach to be employed is adapted from that utilized by Difede for World Trade Center survivors, which in turn draws upon the work by Rothbaum and others in treating Vietnam veterans. However, the environment developed by Rizzo and others at ICT is more advanced and sophisticated than those of prior studies. The "Virtual Vietnam" environment did not include a human element at all—it was a graphic representation of the topography of Vietnam, with rice fields, rivers and riverbanks, viewed from inside a helicopter, with gunfire exchanges. The World Trade Center environment included avatars (computer-generated figures), but consisted of a single sequence of events to be followed in every

case, regardless of the actual experience of the individual being treated. The "Virtual Iraq" environment enables the therapist to individualize the experience to a far greater degree, providing a range of user perspectives, such as from the inside of a building, on urban streets, in a small rural village, on a desert highway, at a vehicle checkpoint, from inside a "HUMVEE" (military human transport vehicle), or from inside a helicopter. Not only are avatars included, but the therapist can also control whether the participant is in the environment alone, with a buddy, or with a patrol. The therapist can introduce intermittent or persistent machine gun fire, mortars, or rocket-propelled grenades. The therapist has the ability to insert the participant at any point in the environment, controls whether it is night or day, and can add rain or a sandstorm. The therapist is able to continually monitor physiologic responses such as skin impedance (a measure of diaphoresis), respiratory rate, heart rate, and blood pressure, integrating these involuntary responses with the participant's subjective units of discomfort (SUDs) score to determine whether to progress to a closer approximation of the individual's trauma, or to remain with the scene currently being presented. The VR exposure will begin with relatively innocuous sequences, gradually approximating the actual trauma experienced by the participant over the course of a number of sessions. The range of visual elements in the virtual environment will be supported by an equally compelling range of stereo-surround sounds (in addition to machine guns and explosions, characteristic features of the Middle Eastern environment will include calls to prayer, Arabic music, and marketplace chatter) and smells (e.g., spices, burning rubber, chordite, and body odor). Olfactory sensations have not been previously utilized in VRET for PTSD, but may have particular relevance due to the close proximity of the olfactory bulb to areas of the brain that are believes to be especially important in the development of PTSD, such as the amygdala.

Participants will wear Emagin Z800 3DHead Mounted Displays (HMDs) with tracking—a visor with goggles and noise-canceling stereo earphones. HMDs feature small visual displays and optics that display computer-generated images to each eye from a computer screen; the HMDs are very lightweight with relatively high-resolution color displays (600 by 800 pixels, and 40 degrees of field view). This provides a highly realistic and intense experience for the participant, while the therapist is able to control sensory stimuli and closely monitor the participant via computer. The headset tracking device will be supplemented by a motion platform to provide tactile stimuli, for example, when there is an explosion, gunfire, or the participant is within a virtual moving vehicle. Tactile elements enhance the sense of immersion in the virtual environment.

Exposure sessions are not strictly timed; rather, they are conducted so that a participant's reactions to material guide the necessity for more exposure. SUDs provide the primary guide and will be tracked by the therapist at 5-minute intervals. Our VR system also enables the therapist to continually monitor a variety of physiological measures such as skin impedance, heart rate, respiratory rate, and blood pressure, which provide valuable additional data in assessing the degree of distress associated with exposures.

Supportive therapy (ST) is the most widely available type of psychotherapy in the community and is presumably more robust than a simple placebo control. However, a recent Cochrane systematic review found that across 29 studies that met their quality criteria, there was no difference between "other" (supportive therapy, non-directive counseling, psychodynamic therapy and hypnotherapy) therapies and wait-list or usual care controls, whereas trauma-focused cognitive behavioral therapy/exposure therapy was significantly better (Bisson & Andrew, 2005). For this arm, the therapist will provide empathy, support, and reflection, encouraging the participant to express their feelings about their symptoms and experiences. Participants' efforts to cope with their symptoms will be supported, but the therapist will not actively try to alter negative or counterproductive thoughts or actions. The approach will be flexible and reflective rather than systematic and direct like CBT. The accompanying VR relaxation environment will feature a Jacobsonian progressive muscle relaxation technique. This will be conducted with the same VR hardware as for the VRET and is designed to teach participants an 8 or 13 muscle group relaxation exercise. The therapist will explain and demonstrate the exercises in the first two sessions. Some subsequent sessions will be guided, but others will be completed at the participant's own pace with

audio input. Virtual scenery available for conducting relaxation exercises includes a river bank, beach, country field, and other relaxing scenarios. The relaxation program is 22 minutes in length.

The second study, using CBT with imaginal exposure as the control, will provide significant additional data, further expanding our knowledge base regarding CBT/VRET. We intend to enroll 20 patients from a partial hospitalization program in each arm, as there are ample numbers in this population, and the comparison with a proven therapy will require greater numbers to assess differences. Since the partial hospitalization program requires greater resources, and includes a more seriously ill population, we will accelerate the therapy process, conducting sessions 2 to 3 times per week rather than once weekly, to try to achieve a significant response in approximately one month's time. This comparison will enable us to assess patient acceptability or satisfaction with VRET vs. imaginal exposure, as well as whether VRET results in a more rapid, or higher rate of, response.

DISCUSSION

Completion of the two parallel studies should have several significant implications. First, by comparing CBT with imaginal exposure to CBT with VRET, we will be able to get an initial estimate of the added value of VRET. There is reason to think that VRET may accelerate and enhance the therapeutic process, facilitating recall of trauma by the patient, increasing its immediacy and impact, and providing avenues for the therapist to be able to help the patient overcome symptoms of avoidance, hypervigilance, and intrusion. While we do not know whether we will have sufficient power to demonstrate a difference, we should at least be able to estimate the effect size to help determine what sample size will need to be included in future studies in order to have the power to show the size of the added benefit. The power to demonstrate an advantage for the CBT/VRET combination over supportive therapy and a relaxation virtual environment should be greater. Supportive therapy has not been shown to be superior to waitlist controls, but it seems more ethical to engage patients with at least this approach than to just follow them without intervention. There is little data on the potential benefit of relaxation, but it seems plausible to think that a relaxation environment might be beneficial with symptoms of hypervigilance and sleep disturbance, for example. Finally, our work will represent the first controlled test of a virtual environment that can be tailored by the therapist to meet the needs of the individual patient, rather than following a predetermined pathway through the virtual environment that is identical for all patients. This has significant theoretical advantages, but remains to be proven.

If the results of our initial studies meet expectations, we then hope to be able to conduct a larger study assessing whether the combination of CBT/VRET and pharmacotherapy have a superior response rate to either therapy alone. Since no monotherapy has thus far been proven to work for more than half of those treated, there remains significant room for improvement, and it seems plausible that the mechanisms of these two approaches are different enough that the combination may prove superior.

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Efficacy of Sensory Integration Treatment based on Virtual Reality - Tangible Interaction for Children with Autism

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Abstract: *Children with autistic spectrum disorders have difficulties integrating motor and sensory experiences. It is important to address therapeutic interventions for these children. However, there are some limitations to sensory integration therapy (SIT) and the application of virtual reality (VR) for autistic children. SIT based on the VR-Tangible Interaction System (VR-TIS) has three components: measurement of coordination ability, social skills training, and sensory integration therapy. These components all originated from sensory integration therapy.*

There are significant differences between autistic children and healthy controls in coordination ability measurements and social skills training. We found that it is possible to apply our system to the assessment of, and therapy for, autistic children.

INTRODUCTION

Children with autistic spectrum disorders have difficulties integrating motor and sensory experiences (Baranek, 2002). These abnormalities in sensory processing affect all aspects of adaptive, cognitive, social, and academic functioning, and correlate with higher levels of stereotypic, rigid, and repetitive behaviors in autism. It may, therefore, be important to address this in therapeutic interventions for children with autistic spectrum disorders (Piek & Dyck, 2004).

Sensory integration therapy (SIT) is based on a theory developed by Ayres (1972), which emphasizes the relationship between sensory experiences, and motor and behavioral performance. SIT is intended to focus directly on the neurological processing of sensory information as a foundation for learning higher-level (motor or academic) skills (Baranek, 2002). There are some advantages of SIT. It is possible that unstructured therapy using role-play situations can provide social skills training through practicing intimacy with friends. However, most sensory integration therapies involve a therapist treating a child. In such instances, the limitations of sensory integration therapy for autistic children are the length and cost of treatment. In addition, there are limitations on the number and variety of places that can be used as experiences for children in therapy, so the therapy may become repetitive.

Several studies have reported on the clinical use of virtual reality (VR) technology for autistic children. Children with autism performed as well as controls on a computerized version of the Wisconsin Card Sorting Task (WCST), but significantly worse than controls on the standard, non-computerized version. Pascualvaca (1998) suggested that social/motivational factors could be responsible for the effect; that is, children with autism might prefer to receive feedback about their performance from a computer rather than an examiner. Virtual environments for social skills training would best be used in collaboration with other people (Murray, 1997). VR technology is an exciting tool that allows children with autism to practice behaviors in role-play situations, while providing a safe environment for rule learning and repetition of tasks (Parsons & Mitchell, 2002).

However, some ethical and technical concerns surround the use of fully immersive VR technology. For example the use of head-mounted displays (HMDs) can elicit 'cyber sickness' in some people (Cobb et al., 1999). Moreover, because HMDs place some limitations on the child's interaction with another person, mixed

and augmented reality is more useful for group interactions and sensory experiences.

The known limitations of preexisting therapeutic intervention methods for autistic children may be reduced through SIT based on the VR – Tangible Interaction System (VR-TIS). VR-TIS is a system that connects the human body, the physical environment, and a computer. It measures human behaviors accurately and makes sense of their behaviors through visual feedback (Hornecker, 2004). In addition, tangible features are designed to make the artificial barrier less apparent and more intuitive by mixing the synthetic virtual environment with the natural physical environment (Lee, 2002).

The purpose of this study was to develop a program of SIT based on VR-TIS for the assessment and treatment of autistic children. We also aimed to verify that the program is an efficacious assessment and treatment for autistic children.

METHODS

Participants

A total of 12 autistic children and 20 healthy controls, all aged between five and six years, participated in this study. All children in the autism group met the DSM-IV criteria for autism and were recruited from the outpatient unit at the Children's Hospital in Seoul. Unrelated healthy children were recruited from the kindergarten belonging to C University, in Seoul.

The mean IQ of the 12 autistic children (2 girls, 10 boys) was 64. The mean social maturity scale (SMS) index was 73, and all were six years old. Of the 12 autistic children, one dropped out of the study.

Instruments

SIT based on VR-TIS (VR-SIT) has three components: coordination ability measurement, social skill training, and sensory integration therapy. These components all originate from sensory integration therapy. Each component was developed through discussion with an expert and a designer, and was tailored to the study purpose.

Our VR–TIS consisted of a Pentium IV PC, a projector, a screen (200 × 150 cm), an infrared reflector, a digital camera, and tangible devices (e.g. a stick, a rotation board, a trampoline).

Visuomotor Coordination Ability Assessment

The Visuomotor Coordination Ability Assessment is a measuring program for visuomotor coordination ability, which does not require the whole scenario, and only measures a specific phase. The therapist can control the levels. The program involves breaking virtual balloons with a real stick, and reinforcements are provided for success.

Social Skills Training

Social skills training was designed to minimize sound effects and background, allowing conversation between participants and the therapist, and allowing the participants to concentrate on the graphic factors.

Sensory Integration Therapy

To measure the functions of sensory integration treatment effectively, images were developed from various rides in an amusement park. It was expected that exposing the client to such a range of vivid stimuli, which would be impractical or unsafe in the real world, would be beneficial. Conditions such as swaying from side to side and backward and forward, stairs, screen rotation, user rotary motion (such as turning four sides or turning the screen), running, and a trampoline were used.

Procedure

Demographic data were collected before the test was started by examining the records of the children and their degree of adaptation to the therapist. We also tested the children's sociability (SMS) and sensory integration, and researched their preferred visual and auditory reinforcements. We then tested the SIT, social skills training, and visuomotor coordination ability in ten sessions. Although we had planned to test sociability and sensory integration again, we decided that administering the test after all ten treatment sessions would be affected by the repetition of the tests. It was also difficult to test the children because of their treatments in other fields. After the ten sessions, we discussed the usefulness of our system with the therapist and assistants.

Data analysis

We measured the reaction time of children in the tasks of stopping the balloon, moving the balloon, and reading the mind, to find the changes in reaction time and the adaptation of children to each task. We also measured the accuracy, the distance the stick was moved, and mean reaction time of coordination ability to find the adaptation and improvement in the adaptation ability exercise in each session. Data were analyzed by repeated measure Analysis of Variance (ANOVA).

RESULTS

Visuomotor Coordination Ability Assessment

We tested the Visuomotor Coordination Ability measurements of reaction accuracy, movement of the stick, and average reaction time by repeated measure ANOVA analysis. As repetition increased, the accuracy of the reaction increased, and the movement of the stick decreased. However, the mean reaction time changed greatly (a = 0.031, R^2 = 0.011).

Movement of The Stick

Movement of the stick was efficient in later sessions. Although the movement was not great, accuracy improved and more space was used as the sessions progressed.

Comparison to Healthy Control Children

Autistic children became more accurate due to their practice. However, there was no significant difference between autistic and healthy control children because the variance of the autistic children was so dramatic (t = 1.803, p = n.s.). Healthy control children showed more movement of the stick (t = 4.962, p < .01) and faster reaction times (t = 3.931, p < .01), indicating that they performed more efficiently than the autistic children.

Social Skills Training

We tested the reaction time of each child to the social skills training, such as stopping the balloon, moving the balloon, and reading the mind. We used repeated measure ANOVA for the ten sessions.

As the number of sessions increased, the mean reaction time gradually decreased, but the variance was very high. Reading the mind (F (1,2) = 0.663, p = n.s.) and moving the balloon (F (2,3) = 10.401, p = 0.08) did not show any significant results.

Sensory Integration Therapy

The low number of sessions (three to eight) and the limitation of the stimuli used for sensory integration training (primarily focused on vestibular organs) made the effects of SIT difficult to measure, as they use the same measurement of sensory profile. Moreover, there are no variables that can be measured that differ from the social skills training and coordination ability measurement. It is possible that to judge the effect of the sensory integration therapy, the overall impression of the effect of the sensory integration test immediately after those of sociability and coordination ability, and indirect observation of the interest of the children who engaged the sensory integration therapy program, could be used.

As in other forms of therapy, boredom had a large effect. The children had time to adapt but became bored easily. On the other hand, preference for unrepeated stimuli such as running, increased as the sessions progressed. Thus, we can assume that the preference for tangible interaction had an effect.

Influence on the social skills program and coordination ability that operated after the sensory integration therapy did not affect the statistics of the sensory integration therapy.

DISCUSSION

Until now, there has been no research on autistic children using VR-TIS. From our research, however, we can see its possibilities. It may be difficult to employ because autistic children have mental disabilities that affect their ability to participate (Luke, 2003). However, all but one of our original participants were able to complete the tasks. There was a significant difference between healthy controls and autistic children. This implies that this program can be used to classify normal and autistic children. Specifically, we found that it is possible to apply our system of, and therapy for, autistic children.

In this study, social skills training and coordination ability measurement had better effects than

sensory integration or the trampoline. This was caused by individual differences in the case of the sensory integration therapy. In addition, the contents of the problem solving and recognition of social training and coordination ability tasks were more interesting to the children than any other tasks. The social skills training program produced more interaction (through conversation with the therapist) than sensory integration therapy (which represented reality).

The social skills training module can elicit various conversations, so it was useful both before and after treatment, while measuring the coordination ability was more useful during the training module. By recognizing these special features of the modules, we can develop the applicability to other therapy programs. The sociable module could be made more interesting by including the transcripts or voices of these conversations.

However, some limitations of our study have to be considered. First, there are differences in the preferences and adaptation levels of participants, even though they have the same symptoms (Parsons & Mitchell, 2002), so the therapy should be individualized (our program was not). Thus, in future trials, the therapy should be individualized to be more effective. The level of contents should also be individualized.

During the ten sessions of the test, many children became bored even though we tried to vary the contents. Also, during the adaptation test, in which the children were able to practice two to four times before the real test, some children tended to concentrate more during practice, and later became bored by the repetition. In future studies, we suggest that the adaptation tests be excluded and that new and more varied materials be developed.

To allow a larger screen projection, we used a wide, dark room. This led to the room being too dark for face-to-face interaction. It is very important to consider the mental aspects for autistic children (Greenspan & Wieder, 1997). The layout of the therapy room was designed to be parallel with the therapist and children, but it was sometimes difficult to see the children. It would be helpful to offer several pieces of furniture so that participants can be comfortable and can complete their exercises without any inconvenience. We should also be careful with the lighting for face-to-face interactions.

Some limitations in this study are apparently due to the use of VR-TIS for assessment of autistic children for the first time. However, we believe that our findings have potential for the clinical field. We will address the identified limitations in future studies. Subsequently, VR-TIS might be a useful tool for assessing and treating those children with autistic and pervasive development disorders.

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The Usefulness of Virtual Reality Stress Inoculation Training for Military Medical Females: A Pilot Study

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Abstract: *Warfighters face stressors such as sleep deprivation, information overload, exposure to injuries/dead bodies, and anxiety for the welfare of fellow Warfighters and family left behind. Consequently, we are continuously losing Warfighters due to psychological stress. Researchers have recently reported that approximately 18% of Warfighters returning from Iraq and 11% returning from Afghanistan (n = 6, 201) screened positive for Post Traumatic Stress Disorder (PTSD). PTSD is a debilitating condition resulting from experiencing trauma, characterized by continuous memories of the traumatic experience. Military medical personnel are not immune to stress since they have a challenging and demanding dual role — that of a Warfighter and a first responder. In fact, it has been reported that many first responders report serious psychological distress, including PTSD. Even though many researchers are studying Warfighters' stress, there is still a gap in the literature on studies with support personnel (i.e., medics) and females. During a recent interview, a researcher reported finding no statistically significant PTSD symptoms difference between males (11%, n = 300) and females (12%, n = 50) in a sample of Warfighters holding violence-prone support jobs (i.e., medics). However, other researchers had previously reported that approximately 20% of females and 8% of males who had been exposed to traumatic events did develop PTSD symptoms. Furthermore, some researchers suggest that females might be less likely to be exposed to adverse stressful events but more likely to develop PTSD if exposed. Thus, an overall increased prevalence of PTSD in females (10% vs. 5% in males) can be accounted for by a significantly greater vulnerability to develop PTSD after exposure. Females also seem to have a longer course of illness than males with a median time to remission being 35 months for females compared to 9 months for males. The purpose of this study is not to identify which gender is more prone to PTSD. However, given the premise that males typically grow-up being exposed to more stressful situations than females (i.e., teasing each other, playing rough sports), and the lack of studies on female Warfighters (especially, in the medical field), we propose to test the effectiveness of Stress Inoculation Training (SIT) for female military medical personnel. SIT proposes that repeated exposure in stressful, but controlled conditions (i.e., via virtual reality) enables individuals to gradually adapt to stressors and learn how to cope. By conducting virtual reality SIT, or "VR-SIT", the stressors can be applied systematically and paced appropriately for each individual. Our VR-SIT pilot study is currently underway and preliminary findings will be presented at the 2006 CyberTherapy Conference in Canada.*

INTRODUCTION

Warfighters face a myriad of stressors when deployed to the battlefield, such as sleep deprivation, information overload, exposure to injuries/dead bodies, and anxiety for the welfare of fellow Warfighters and family left behind (Lukey, Stetz, & Romano, 2005). Hoge et al. (2004) reported that approximately 18% of Warfighters returning from Iraq and 11% returning from Afghanistan (n = 6, 201) screened positive on stress-related measures (i.e., Post Traumatic Stress Disorder (PTSD)). They also reported that 1 in 10 U.S. Iraq veterans suffer some type of stress disorder (Hoge, Auchterloni, & Milliken, 2006). Additionally, Stetz et al. (2006) found that in 2003, 7% (21 out of 282) of medical evacuations in Operation Enduring Freedom and 6% (365 out of 5,389) of those in Operation Iraqi Freedom were due to psychiatric illness. Stetz et al. (2006) also reported that 21% of those evacuated had prior psychiatric histories before deploying to the theater of operations. Most prior histories were either related to stress

(i.e., PTSD, n = 33, 31%) or to depression (n = 72, 66%).

PTSD is a psychiatric disorder that follows traumatic events. It can occur after exposure to extreme traumatic stressors during combat deployment such as coming under fire, suffering injuries that require medical attention, seeing casualties (Nisenbaum, Barrett, Reyes, & Reeves, 2000), or handling human remains (McCarroll, Ursano, & Fullerton, 1993). To be considered PTSD, symptoms must be present for more than one month (to rule out Acute Stress Disorder), and the disturbance must cause clinically significant distress or impairment in social, occupational, or other important areas of functioning. Major symptoms of PTSD consist of a persistent reexperience of the traumatic event, avoidance of stimuli associated with the trauma, numbing of general responsiveness, and increased arousal (i.e., difficulty sleeping, anger, irritability). Danckwerts and Leathem's (2003) PTSD review shows that the severity of PTSD symptomatology is influenced by the extent or gravity of the actual exposure to the stressful event (e.g., the sudden unexpected death of a loved one carries a risk of 14% for triggering PTSD, while combat, bombing, or mass violence has a risk factor as high as 20–40%). Individuals with PTSD report symptoms related to cognitive impairment such as an inability to think, concentrate, or make decisions. They may appear easily distracted or complain of memory difficulties (Amer. Psych. Assoc., 2002).

In addition to deployment and battlefield stress, Warfighters experience job-related stressors such as work overload, time demands, uncertainty, and poor leadership that can decompensate in sub-clinical emotional states of anxiety and fear. For example, under conditions of high workload, individuals tend to experience anxiety because of an inability to cope with work requirements (Bliese & Stetz, in press) and individual performance declines. Unpredictability at work has also been shown to lead to low performance. Warfighters tend to report higher performance and well-being when predictability/ certainty at work is high (Fleming, O'Keeffe, & Baum, 1991). Organizational constraints (i.e., lack of equipment) have also been associated with lower satisfaction (Spector & Jex, 1998; Stetz, Stetz, & Castro, in press), lower well-being, and decreased reenlistment intentions.

VIRTUAL REALITY'S ROLE IN STRESS DETECTION, MEASUREMENT, TREATMENT, AND PREVENTION

There are many ways to measure stress. For example, researchers can administer paper-and-pencil or computerized surveys, such as the Clinician-Administered PTSD Scale, to determine individuals' psychological states. Stress can also be measured via physiological apparatuses that capture stress markers such as breathing rate, heart rate, and skin temperature. Luckily, some battlefield stressors can be treated with non-invasive measures. For example, sleep loss, a typical byproduct of the quick tempo in the battlefield, can be monitored using a wrist-mounted actigraph and treated with hypnotics, phase delay light therapy, or strategic naps. Increased physical activity is also recommended for everyone aiming to feel better. Leduc, Caldwell, and Ruyak (2000) found that while the alerting effects of exercise were short lived, short but vigorous bouts of exercise placed during the circadian ebbs actually helped the participants "get over the hump." However, treating extreme stress (i.e., PTSD) is not that easy. Research shows that only 44% of those individuals who enter psychotherapy "significantly improve" (Bradley, Greene, Russ, et al., 2005). Psychological debriefing (PD), designed to mitigate acute distress and prevent long-term psychopathology, is undergoing intense scrutiny. Some critics question its efficacy (McNally, Bryant, & Ehlers, 2003), while others claim it may increase the risk of developing long-term psychological symptoms following traumatic events (McFarlane, 1986). Critical incident stress debriefing (CISD) is also used to help Warfighters manage stress upon returning home or immediately after a traumatic exposure, but has received mixed empirical support (Kavanagh, 2006). While most recipients of psychological debriefings report feeling better or that the debriefing was helpful, there is not a clear or robust relationship to either mitigation of psychological symptoms or functional outcomes. Ironically, this approach is currently used extensively in the military, law enforcement, fire fighting, emergency rescue, and airline industries. Drugs, or antidepressant medi-

Figure 1-4. Photos of Data Collections During Virtual Reality- Stress Inoculation Training: (1) Male Participant and Researcher in Lab Setting; (2) Male Participant and Researcher in Afghanistan; (3) Female (Stetz) Participant and Researcher in the VRMC; and (4) Medical Female in USAARL's B-HIVE (Battlefield Highly Immersive Environment).

cations (i.e. selective serotonin reuptake inhibitors), rarely yield better than a 40% reduction in the Clinician-Administered PTSD Scale scores, and most patients will still meet criteria for PTSD at the end of their treatment trial (Hamner, Robert, & Frueh, 2004).

It is often said, "An ounce of prevention is worth a pound of cure." This saying rings true with regard to stress casualties. The Department of Defense (DoD) is earnestly looking for ways to prevent and treat Warfighters' mental health problems like PTSD. DoD asks all units to complete health questionnaires before (DD Form 2795) and after (DD Form 2796) deployments. However, both of these surveys only ask a few questions concerning mental health. Furthermore, most questions are asked upon redeployment back home. Therefore, there is limited pre-deployment screening effect. Moreover, units do not tend to follow the same process as prescribed by DoD (Centers for Disease Control). Stress Inoculation [exposure] Training (SIT) is a prevention strategy that aims to mitigate the negative effects of psychological stressors in healthy individuals. Its foundation dates back to Wolpe's work on cognitive/ behavioral stress-coping training in the early 1970's. The cognitive-behavioral preventive approach, which is central to SIT, has been implemented in military, medical, and other settings. SIT attempts to immunize an individual from reacting negatively to stress exposure (Abramson, Metalsky, & Alloy, 1989). The individual and the stressful condition must be identified *a priori* (Adams, 2005). Gradual and repeated stress exposure desensitizes individuals to stimuli that may impede performance and produce psychological trauma (Wiederhold, Bullinger, & Wiederhold, 2006), decreasing the probability of future negative responses (Driskell & Johnston, 1998). That is, through successive approximations, individuals build a sense of expectancy that is integrated into positive cognitive appraisal, providing a greater sense of mastery and

confidence or "self-efficacy." The rationale for stress-reduction is based on the premise that the availability of information or pre-exposure to the stress reduces the novelty of stressful tasks. SIT, therefore, increases the likelihood of a positive expectation and greater sense of predictability and control with a consequent reduction in both physiological and emotional reactivity.

Saunders et al. (1996) offer the following findings regarding the effectiveness of SIT (Abramson, Metalsky, & Alloy, 1989): the greater the number of training sessions the better (Adams, 2005); there is no difference in effect for laboratory and field (not necessarily battlefield) interventions; SIT is more effective for state anxiety if used with small groups while more effective for performance anxiety if used with larger groups; and finally, (Banderet & Russo, 2005) SIT programs using imagery components are more effective at reducing performance anxiety than those that do not use imagery, unless the latter uses behavioral practice in coping. Meichenbaum (1985) states that SIT's success is also dependent upon employing stress-coping training-features and instructional design. Adaptive coping strategies and their associated appraisals could act as a moderating buffer against stress-induced impairment. Coping skills, such as combat breathing, can first be taught in a safe environment. After the basic skill is taught, the individual can be asked to perform the skill in a more vivid environment. Vividness is an important component of the SIT approach and it must be controlled, allowing individuals to gradually adapt to stressors and learn how to cope.

With recent advances in virtual reality (VR), the technology leads itself quite well to be used in SIT. Stressors can be systematically added and vividness can be increased as the individual habituates. Military personnel can train in virtual environments (i.e., an Iraqi village, a shoot house, or a ship) where simulations can be viewed on desktops, laptops, through a head-mounted display, or as a one- or three-wall CAVE projection system. The training is then transferred to real-world exercises in structures designed specifically for tactical training. VR-SIT is consistent with a current emphasis on embedding training in Warfighters' systems. There is some evidence that SIT can reduce PTSD. A group of 106 male British soldiers preparing for a 6-month tour of duty in Bosnia received a combination of pre-deployment stress training and PD. The study demonstrated a drastically reduced incidence of PTSD and other psychopathology, approximately 10 times less than figures reported from other military samples (Deahl, Srinivasan, Jones, et al., 2000). Saunders et al. (1996) conducted a meta-analysis of SIT studies to determine the effect of such training on subjective (anxiety) and objective (performance) measures. They found a strong overall effect for SIT to reduce performance anxiety (anxiety resulting from engaging in a task). They also found a moderate effect for reducing state anxiety (anxiety that is not necessarily task-related) and increasing performance. Their results are similar to Driskell and Johnston, (1998) who studied overlearning. Stahl (2004) notes that both SIT and stress management approaches have been studied extensively, and overall, these two appear to have a positive effect on subjective measures of stress and anxiety prior to and during performance.

BATTLEFIELD STRESS, VR, AND PERSONAL CHARACTERISTICS

Even though battlefields are very stressful, some Warfighters decompensate more than others. For example, Killgore, Stetz, and others (2006) compared Soldiers who had been deployed (to either OEF or OIF) with those who had not been deployed. They found that (in consonance with theories of stress reaction, repression, and somatic amplification) combat-experienced Soldiers reported limited affective complaints, but greater somatic complaints than Soldiers without combat experience. Also, in regards to gender, during a recent interview by Elias (2005), a researcher reported finding no statistically significant PTSD symptoms difference between males (11%, n = 300) and females (12%, n = 50) in a sample of Warfighters holding violence-prone support jobs (medics, mechanics, and drivers). Interestingly, Foa et al. (1999) had previously reported that approximately 20% of females and 8% of males who had been exposed to traumatic events did develop PTSD symptoms. Some researchers suggest that females might be less likely to be exposed to adverse stressful events but more

likely to develop PTSD, if exposed. Thus, an overall greater prevalence of PTSD in females (10% vs. 5% in males; Kessler et al., 1995) can be accounted for by a significantly greater vulnerability to develop PTSD after exposure. Females also seem to have a longer course of illness than males with a median time to remission being 35 months for females compared to 9 months for males (Breslau, Davis, Andreski, & Peterson, 1997). It is widely known that in the developmental stages of childhood, male children are often encouraged not to show their feelings, while females are encouraged to do the opposite. It is possible that women may not be experiencing PTSD more often than men, they are just more likely to come forward and seek help. Moreover, animal models show no difference in stress reactions between sexes. Incidentally, Campbell and Elison (2005), claim their studies on coping reported that Long-Evans' rats, when exposed to stressful situations, showed no significant difference between genders. Specifically, they found that the main difference between genders was that female rats had higher recovery cortisol levels than males.

Participant's characteristics are also important factors to consider when analyzing stress data in VR studies. MacCluskie (1998) suggests that eye movement desensitization and reprocessing may elicit differential treatment effects based on client variables that have yet to be identified. Furthermore, Cheung (2002-2003) found from a study of male and female reactions to stress in a VR setting that there is no significant difference in subjective symptoms rating and blood flow measurements between the sexes. It was found, however, that data suggested that females may be more inclined to admit discomfort, as indicated by their responses to a survey of motion sickness history prior to the experiment. Park and Hu (1999) also found that while women reported a higher incidence of motion sickness history, the severity of symptoms of motion sickness while viewing a rotating optokinetic drum were not significantly different. Klosterhalfen et al. (2005) suggest that susceptibility to motion sickness is affected by not only gender but also ethnic origin. Also, Grantcharov et al. (2003) compared the impact of hand-dominance, gender, and experience with computer games on performance in virtual reality laparoscopy. They found that men usually completed the tasks in less time than women, but there was no statistical difference between the genders in the number of errors and unnecessary movements. They also found that subjects with a right hand dominance made fewer errors, fewer unnecessary movements, and had an overall trend of better results in terms of time and errors overall. Subjects who reported use of computer games made fewer errors than nonusers. Finally, age is another important demographical variable to consider. Schultz and Schultz (2003) studied the affects of age on stress levels as they relate to overall performance and found that age did not directly affect stress levels of the subjects during an evaluation. Montoya et al. (2003) studied the characteristics of drug users who were diagnosed with PTSD. They studied age, race, gender,and income as the independent variables and found that people with a higher income were more likely to develop PTSD. Additionally, they found that young females were in a higher risk of PTSD than older females.

CONCLUSION

The above review shows that there is some research suggesting demographical differences when studying stress and using VR. The purpose of the present paper is to share with readers that The United States Army Aeromedical Research Laboratory (USAARL) is conducting a pilot study on genders' vulnerability to stress, and "VR-SIT" usefulness. Given the premise that males typically grow-up being exposed to more stressful situations than females (Bridget, 1999), and the reported difference when using VR technology (courtesy of the Virtual Reality Medical Center), we predict that females will yield higher stress markers than males. We will capture stress-related data by using the Multiple Affect Adjective Check List-Revised (MAACL-R) survey (courtesy of the Army Research Laboratory (ARL)), a physiological apparatus to capture heart rate, and an amylase test created by the Northwestern University in collaboration with ARL—all measures that provide immediate on-site data. This stress data will be collected before, during, and after the participants navigate VR scenarios. We also predict that females will respond faster to the coping strategies than males, and that males will be looking for those scenarios where they can more actively participate (i.e., shoot the enemy).

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The virtual classroom: An ecological version of the continuous performance test – A pilot study

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INTRODUCTION

Attention Deficit Hyperactivity Disorder (ADHD) is one of the most common psychiatric disorders of childhood (NIH, 1998). Teacher and parent rating scales are often used to assess ADHD symptoms (Barkley, 1991). Yet there is a trend in the increased use of cognitive measures as an adjunct to subjective rating scales to enhance diagnostic decision-making (Barkley, 1991; Berlin, Bohlin, Nyberg, & Janols, 2004). Research on ADHD suggests that assessment should be accomplished through a multi-method procedure (Barkley, 1998; Guay, Parent, & Lageix, in press).

The Continuous Performance Test (CPT) is one of the most frequently used tasks in the clinical assessment of ADHD (Rapport, Chung, Shore, Denney et al., 2000). There are several versions of the test. Generally, the child is asked to sustain his attention and react to the presence of targets while ignoring distracters. A large multi-site study compared the performance of 498 children presenting with ADHD according to gender and type of comorbidity on a CPT and ratings scales (Newcorn, Halperin, Jensen, Abikoff et al., 2001). It was found that inattention and impulsivity errors on the CPT were high in all ADHD subgroups, but dominant error type on the CPT and ratings differed with respect to comorbidity and gender. Children with ADHD and conduct disorder were more impulsive on both types of measures. Children with ADHD and anxiety disorders appeared more inattentive on ratings only. Girls' performance was less impaired than boys' performance on most ratings and on several CPT indices, particularly impulsivity. Girls with ADHD and anxiety made fewer impulsivity errors than girls with ADHD only. It was concluded that the CPT is a sensitive and valid measure for the assessment of ADHD with or without the presence of comorbidity, but lacks specificity. Börger & van der Meere (2000) noted that, during CPT performance, children with ADHD tend to look away from the monitor; this relevant behaviour is typically lost in the assessment process using flatscreen stimulus delivery.

It was demonstrated that most current laboratory methods for assessing ADHD symptoms have a low to moderate degree of ecological validity, with some proving to be clearly unsatisfactory (Barkley, 1991). Ecological validity refers to the degree to which measurement results represent the actual target behaviours as they occur in real life settings (Barkley, 1991). Direct observations of behaviour in its natural setting would represent a highly ecologically valid measure. In contrast, weak ecological validity is represented by a measure of behavior that is unlikely to be encountered in a real life setting, as is exemplified by traditional CPTs (Barkley, 1991). The closer the measure is to direct observation in a natural setting, the more ecologically valid its results should be.

Since direct observation of behaviour is time consuming, expensive, and prone to the influence of subjective judgment, an alternate means of assessing behaviour is desirable. Virtual reality (VR) offers an elegant solution. Attention abilities have been addressed using VR (Wann, Rushton, Smyth & Jones, 1997; Rizzo, Buckwalter, Neumann, Chua, et al., 1999), and has shown promising results in the assessment of ADHD symptoms in children (Rizzo, Bowerly, Buckwalter, Klimchuk, et al., 2006), in the assessment of driving abilities of teenagers and

adults presenting with ADHD (Barkley, 2004), and in the treatment of ADHD symptoms (Cho, Ku, Jang, Kim, et al., 2002). VR offers the clear advantage of placing the participant in a realistic environment. Yet, it remains a test and, to some extent, carries the limitation, in terms of ecological validity, of being more attractive and playful than corresponding real-life situations for many children.

In using VR for the assessment of ADHD symptoms, research results (Rizzo et al., 2006) indicate that children with ADHD, compared with normal controls, have slower correct hit reaction times (RT), higher RT variability, and more omission and commission errors. While effect sizes (d) for variables derived from traditional CPT and other psychological tests seldom exceed 1.0 (Frazier, Demaree & Youngstrom, 2004), these effect sizes from the VR CPT ranged from 1.05 to 2.07, the highest one being obtained on the number of omissions. The task used by these researchers consisted of a CPT presented on a chalkboard within a virtual classroom environment. Two conditions were used, with and without distracters, and results were equally or more significant in the distraction condition. Such impressive effect sizes certainly justify further studies. Currently, large effect sizes are only obtained from questionnaires, with d values ranging from 1.3 to 3.7, depending on the questionnaire (Green, Wong, Atkins, Taylor et al., 1999). This, however, is partly tautological since the diagnosis of ADHD is explicitly based on testimonies from parents and teachers concerning specific behaviours also investigated by the questionnaires.

The VR Classroom is a computer-based program that uses a head mounted display (HMD) to deliver both visual and auditory stimuli within a simulated classroom virtual environment. Within the VR Classroom, a CPT designed to test attention in school-aged children is administered. The child is immersed in a 360-degree classroom environment and presented with a standard A-K CPT on a chalkboard at the front of the class. This task requires children to hit a response button whenever they see an A-K sequence of letters appear over a six minute period. During the assessment, visual and auditory distracters are presented (i.e. ambient classroom and hall noise, movement of virtual classmates, activity occurring outside the window, etc.). Attention performance in the VR Classroom, like for other CPT measures, is quantified in terms of reaction times and its standard error and of commission and omission errors. While the task is performed, a head tracking device monitors movements, documenting to what extent the child turns away from the stimulus delivery location.

Objectives of this pilot study

1. Compare performance from children diagnosed with ADHD and children in a control group on the VR Classroom test, including head movement measures.
2. Determine if the cognitive profile of children with ADHD outlined by the traditional CPT corresponds to the one outlined by the VR Classroom (ecological CPT).
3. Compare performance on the VR Classroom to a standard neuropsychological battery on variables of commission and omission errors, reaction time (RT) and its standard error and determine ecological validity according to Barkley's criteria (1991).

RESEARCH METHODOLOGY

Participants: Twenty-two participants (15 boys with ADHD and 7 boys in a comparison group) all aged between 9 and 13. Boys with ADHD were recruited from the Montreal area through various health agencies and Rivière-des-Prairies Hospital. Boys in the comparison group were unaffected siblings of participants with ADHD. Both groups were tested with the VR Classroom, standard neuropsychological tests, and parent ratings on behavioural questionnaires. ADHD-diagnosed participants were tested prior to taking their daily medication and tests were not repeated if recent administration results were already available in medical chart (less than six months).

VR Classroom procedure: Participants sat on a standard "school chair," wearing the HMD displaying the interior of a classroom. The scenario consisted of a standard rectangular classroom environment containing four rows of desks, a teacher's desk at the front, a chalkboard across the front wall, a female virtual teacher between the desk and chalkboard, nine virtual children seated at desks around the participant, a large window on the left side wall looking out onto a street with moving vehicles, and a pair of door-

ways, one at each end of the wall facing the window, through which activity occurred. The technician then instructed the participant to spend a minute looking around the room and naming various objects observed. The participant was provided with a one-minute practice of the virtual task before actual testing started. The virtual teacher then warned the participant that the testing proper was about to start and instructed him to view a series of letters appearing on the chalkboard and to hit the left mouse button only after he viewed the letter "K" preceded by an "A" (successive discrimination task) and withhold their response to any other stimulus letter. This A-K version of the CPT consists of the letters A, B, C, F, G, H, I, J, K, L, S, T, U, V, X, Y and Z. The letters are white on a green background (virtual chalkboard) presented at a fixed position directly in front of the child. The stimuli remained on the screen for 150ms, with a fixed 1200ms stimulus onset asynchrony. Three hundred stimuli were presented in the six minutes task. The target letter K (correct hit stimulus) and the letter K without the A (incorrect hit stimulus) each appeared with equal probability of 10%. The letters A and H both appeared with a frequency of 20%. The remaining fourteen letters occurred with equal probability. Stimuli occurred in the presence of mixed 3D immersive audio and visual distracters. Distracters consisted of (a) pure auditory: constant ambient classroom sounds (i.e., whispering, pencils dropping, chairs moving, etc.), (b) pure visual: paper airplane flying directly across the participant's field of view (occurring three times throughout the 6-minute task), (c) mixed audio and visual: cars and school buses "rumbling by" outside the window on the left (occurring three times each), and a virtual person coming in and out of doors on the right side of the classroom, with sounds of the door "creaking open," footsteps, and hallway activity (occurring once). Reaction time, response variability, and commission and omission errors were used as performance measures, while the tracking device on the HMD was used to monitor head movement.

VR performance was also compared with results from standard neuropsychological tests: Color-word interference Test (Stroop; DKEFS, 2001) conditions 3-inhibition and 4-flexibility, on total errors variables; CPT-II (CPT; Conners, 2000; lasts 15 minutes; task is to inhibit response to letter X) on RT, RT standard error, omission and commission errors variables; d2 (Brickenkamp & Zillmer, 1998) on omission and commission errors variables; Strength Difficulties Questionnaire (SDQ; Goodman, 1997) ADHD and total problems subscales, ADHD Rating Scale-IV (DuPaul et al., 1998) total problem subscale and Achenbach System of Empirically Based Assessment (CBCL; Achenbach & Rescorla, 2001) ADHD and total problems subscales. VR-CPT was administered at the end of the 40-minute assessment period.

RESULTS

Side effects

No significant side effects were observed in either group, based on post VR testing using a cybersickness questionnaire (Laboratoire de Cyberpsychologie, 2002).

VR Classroom performance

- Independent samples one-tailed t-tests (with 20 degrees of freedom) were done to compare performance of both groups on various variables of the VR Classroom. It was found that:
- Participants with ADHD made significantly more omissions than participants in the comparison group (mean raw: 27 omissions versus 8; $t=3.426$, $p=0.0015$; after log transform to correct positively skewed distributions: $t=2.968$, $p= 0.011$, $d= 1.36$).
- RT variability (standard error) was significantly higher for children with ADHD (182ms versus 135; $t=1.758$, $p<0.05$; after log transform to correct negatively skewed distributions: $t=1.986$, $p=0.031$, $d=0.91$).
- The ADHD group had slower RT (568ms versus 544ms) and made more commissions errors than the comparison group but these differences were not significant.

Traditional CPT

Independent samples one-tailed t-tests were done to compare the performance of the ADHD and comparison groups on the Conner's CPT on equivalent variables reported for the VR Classroom:

- Children with ADHD presented significantly more omission errors than children without ADHD (mean: 41 omissions versus 7; $t=3.844$, $p=0.0005$, $d=1.76$; no transformation required).
- The ADHD group had significantly longer RT (518ms versus 356ms; $t=4.406$,

p=0.00013, d=2.02).

- The RT had significantly higher standard error of the mean in the ADHD group (26ms versus 8; t=5.767, p=0.000006; after log transform to correct positively skewed distributions: t= 6.164, p=<0.0001, d=2.82).
- Commission errors were exactly the same for both groups (26 commissions).

VR Classroom head movements

Independent samples one-tailed t-tests were done to compare head movement of both groups during the VR Classroom:

- The amplitude of head movement from side to side (Yaw: farthest left to farthest right) of participants from the ADHD group was significantly higher than in controls (Yaw: 154 degrees versus 42; t=4.462, p=0.0005, d=2.04).
- Amplitude of head movement up and down (Pitch: farthest position looking up to farthest down) in the ADHD group was significantly higher than in the comparison group (Pitch total absolute amplitude: 74.96 degrees versus 28.5; t=3.752, p=0.001; after log transform to correct positively skewed distributions: t= 3.547, p= 0.001, d=1.62).

VR Classroom and CPT

Univariate analyses of covariance (with degrees of freedom 1 and 19) were done, after verifying that the slopes were homogeneous across groups, to assess the unique contribution of equivalent variables from both tests to discriminate between the two groups. A significant group difference remaining once the corresponding variable from the other test is taken into account indicates that the test reveals information relevant to group difference that is not already provided by the other test.

- When possible shared variance between both variables was removed, the RV omission variable still significantly distinguished the two groups (F=10.253, p=0.005), but the CPT omission variable no longer distinguished them (F=2.761, p=0.113).
- When possible shared variance was removed, the earlier significant variable on t-test, CPT RT still distinguished the two groups (F=18.507, p<0.0005).
- Finally, when possible shared variance was removed, the earlier significant variable on t-test, RV RT standard error, could no longer distinguish the groups (F=0.360, p=0.555) but the CPT RT standard error variable still did (F=27.895, p<0.0005).

VR Classroom and neuropsychological tests

Univariate analyses of covariance were also done to compare equivalent variables of VR Classroom and neuropsychological tests, after verifying that slopes were homogeneous.

- When possible shared variance between d2 and VR Classroom omissions was removed, the earlier significant variable, the RV omission, still significantly distinguished the two groups (F=15.628, p=0.001) but the d2 omission variable no longer distinguished them (F=0.009, p=0.927).
- Similarly with the Stroop total errors on the inhibition condition, when possible shared variance was removed, the RV omission variable still significantly distinguished the two groups (F=14.282, p=0.001) but not the other variable (F=0.154, p=0.699).
- VR omission variable and total errors on flexibility condition of the Stroop test had significantly different slopes in the two groups. Analysis of covariance was therefore not done.
- VR commission compared to d2 commission and total errors of the Stroop test did not significantly distinguish the two groups, once the shared variance was removed.

VR Classroom and parent ratings

Bivariate one-tailed Pearson correlations on various behavioural ratings filled by parent and significant RV variables (as determined by t-tests) were obtained for the ADHD group only (since boys of the comparison group obtained scores near 0 on all three ratings). Significant correlations (based on 13 degrees of freedom) were observed:

- Between VR Classroom omission errors and both SDQ scales (ADHD scale, r=0.69, p=0.002; Total problems scale, r=0.602, p=0.009).
- Total absolute Pitch amplitude of head movement with the SDQ ADHD scale (r=0.602, p=0.009) and CBCL ADHD (DSM) scale (r=0.508, p=0.027).
- Total absolute Yaw amplitude of head movement and SDQ ADHD scale (r=0.460, p=0.042).

DISCUSSION

The first objective of the pilot study was to compare performance from children diagnosed with ADHD and from children in a control group on the VR Classroom test, including head movement measures. The study partly replicates results obtained with a previous form of the VR Classroom (Rizzo et al., 2006) on the omission and RT variability scores (children with ADHD made significantly more omission errors and their RT varied more over the test than children without ADHD). Results for head movements were not reported previously (children with ADHD have wider amplitude of head movement either up and down or from side to side). This study, however, did not replicate the group difference in mean RT and in commission errors. The previous version lasted for a total of 20 minutes compared to 6 minutes for the present version. The 20-minute version is evidently more strenuous in terms of sustained attention compared to the 6-minute version. The difference in duration might explain the generally larger effect sizes obtained with the first version of VR Classroom (Rizzo et al., 2006).

The second objective of the study was to determine if the cognitive profile of children with ADHD outlined by the traditional CPT and VR Classroom (ecological CPT) differed or not. It seems that the VR Classroom is efficient in distinguishing boys with ADHD from those without on a few traditional variables of continuous performance tasks (omission and variability of RT). Traditional CPT appears more efficient in distinguishing both groups if compared on similar variables. Since the standard CPT results, taken from the patient records, contributed to a positive diagnosis of ADHD, the CPT effect sizes are likely biased positively. For that reason, the contribution of one test to discriminate the groups beyond what the other test contributes is more relevant to appreciate the respective merits of the two tests. It turns out that the VR Classroom more often contributes new information than does the traditional CPT.

The final objective of the study was to compare the VR Classroom performance to neuropsychological tests and determine ecological validity. To establish ecological validity, Barkley (1991) recommends four sources of evidence.

1. Difference between ADHD and control groups: The present study included a group of non-ADHD boys. Larger studies need to include several clinical comparison groups.
2. Correlation with assessments that have previously established ecological validity: Few neuropsychological tests meet the criteria. To do so, performance on such measures ought to be correlated with observation in similar real life settings. An experimental measure of a spelling test in a simulated real life classroom was done with boys of the ADHD group but results are yet to be compiled and analysed. Results obtained on VR Classroom did correlate with traditional neuropsychological tests on equivalent omission variable and added new information regarding the variable, as outlined in the covariance analyses.
3. The assessment shows similar directional changes as that of the ecological criterion when exposed to experimental manipulations known to affect the criterion, such as medication: This condition was not included in the present study.
4. Correlations between the assessment and ecological criterion such as caregiver ratings: Results of the VR Classroom were compared with various parent ratings for which ecological validity have been established in previous studies. High correlations were found between some VR variables (omission errors and pitch and yaw total amplitude of head movement) and some SDQ and CBCL subscales (parent ratings).

This being a pilot study, there are limitations to take into account for future studies. First, the traditional CPT used does not assess the same skills as the VR CPT, as determined by covariance analyses. Conners' CPT is a measure of the ability to inhibit a response and to adjust in a changing rhythm in answering. On this respect, the VR CPT is closer to the Gordon Diagnostic System (GDS; Gordon, 1983), which measures the ability to react to a specific stimulus when stimuli are presented at a fixed rate. Also, the VR Classroom used here is shorter in duration (6 minutes) than most traditional CPT (around 15 minutes). Performing longer tasks demands further mental effort from the participant. Duration might have an effect on the effect sizes (d values) obtained since the longer version of the VR Classroom (version 1) obtained higher effect sizes. Future versions of the test should take this observation into consideration.

The number of participants in both groups was limited. Only two types of participants were compared, those with ADHD and the comparison group without ADHD. It would have been relevant to measure the specificity of the VR Classroom relative to traditional CPT's, knowing that they lack the ability to discriminate between various clinical groups (Berlin et al., 2004; McGee, Clark & Symons, 2000; Riccio & Reynolds, 2001). The particular combination of head movement tracking and distraction offered in the VR environment might contribute to enhance the specificity of continuous performance tasks. Proper ways to process this information, i.e. relating movement or performance levels to distraction events, must be devised.

Only boys were included in the pilot study. Girls and boys perform differently on neuropsychological assessments, and these differences need to be addressed in future research on the VR Classroom. Finally, future studies ought to verify the relevance of age and intelligence on VR performance. It has been found that intelligence (Halperin, Newcorn, Sharma, Healey et al., 1990) correlates with performance on CPT whereas age does not (McGee et al., 2000), since norms take age, but not IQ, into account.

CONCLUSION

The VR Classroom contributes information on ADHD status not provided by Conners' CPT. By automatically monitoring head movements, it provides information that still needs characterisation but contributes positively to distinguish children with and without ADHD. It is still uncertain to what extent this reflects hyperactivity, distractibility, or loss of focus on the task. Even for variables also available in the standard CPT, the VR Classroom yields information not captured in Conners' CPT. Further work is needed to assess to what extent this reflects the difference in tasks (press for K following A vs. for all letters but X) or the better ecological validity of VR Classroom.

Concerning ecological validity, most of the suggested sources of evidence were addressed in the pilot study, albeit to a limited extent, and positive preliminary results were obtained. The actual research was not able to determine or rule out ecological validity for the VR Classroom, but showed promising results, especially with the inclusion of head movement tracking.

The virtual classroom is in its second version and early in its development. Future changes should consider returning to a longer duration, and possibly embedding other attention tasks. The VR CPT sensitivity, specificity, and ecological validity in discriminating ADHD participants from non-ADHD have yet to be established in larger scale research

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A study of Active Navigation and Object Recognition in Virtual Environments

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Abstract: *We investigated the importance and efficiency of active and passive exploration on the recognition of objects in a variety of virtual environments (VEs). In this study, 54 participants (19 males and 35 females) were randomly allocated into one of two navigation conditions (active and passive navigation). The 3D visual display was presented through HMD and participants used keyboard to navigate VEs in active navigation condition. The VEs consisted of exploring four rooms (library, office, lounge, and conference room), each of which had 15 objects. 'Active navigation' was performed by allowing participants to self-pace and control their own navigation within a predetermined time limitation for each room. 'Passive navigation' was conducted by forced navigation of the four rooms in random order. Total navigation duration and objects for both navigations were identical. After navigating VEs, participants were asked to recognize the objects that had been in the four rooms. Recognition for objects was measured by response time and the percentage of hit, miss, correct rejection, and false alarm responses. Those in the active navigation condition had a significantly higher percentage of hit responses ($t(52) = 4.000$ $p < 0.01$), and a significantly lower percentage of miss responses ($t(52) = -3.763$, $p < 0.01$) in object recognition than those in the passive condition. These results suggest that active navigation plays an important role in spatial cognition as well as providing a better explanation about the efficiency of learning in a 3D-based program.*

INTRODUCTION

In recent years, 3D-based simulated programs that people can interact with and explore in real time are popularly referred to as virtual reality or virtual environments (Willson, 1992). Their potential benefits as training media for optimizing environment–human behavior interactions have been accepted for many years: for example, in flight simulation (Kalawsky, 1993), battle-field training (Johnson & Wightman, 1995) and training for disabled children and adults (Wilson, Foreman, & Tlauka, 1996;1997). Specifically, there has been growth in the interest in VEs as tools for acquiring spatial knowledge of a novel environment (Peruch & Gauthier, 1998); these interaction systems appear to have significant potential as aids to human learning. For example, exposure to VEs was effective in training people to find their way along a specific route through a large office block (Witmer, Bailey, Knerr, & Parasons, 1996) and firefighters could apply route knowledge learned in a VE to a mock rescue in the real world(Bliss, Tidwell, & Guest, 1997). Evidence from these results clearly shows that VEs offer advantages to training with actual equipment and environments, and have ecological validity for acquiring spatial knowledge. In general, the visual information that can be used to memorize and to recognize, which is essential for learning in virtual environments, can be acquired in a variety of ways; it can be obtained both in the course of active navigation of an environment and during passive one. In addition, one factor that may promote learning in both real and virtual environments is the user's type of navigation (Wilson, 1999). Evidence from real world experiments generally suggests that active navigation is necessary for effective orientation and wayfinding (Appleyard, 1970; Hazen, 1982; Cohen & Cohen, 1985). The demonstration of spatial competence in experimental settings seems to occur most efficiently when the subject has freely navigated the testing environment. Thus, as suggested in previous studies, self-produced, voluntary movement in space may be necessary for the construction and use of spatial representations (Bertenthal & Campos, 1987; Larish & Andersen, 1995). In addition to the findings on active versus passive navigation in experimental settings, evidence from real world experiments suggests that active navigation is necessary for good orientation. For ex-

ample, a study of hundreds of city inhabitants using different types of navigation in an urban area found that car passengers learned less than automobile drivers about the layout of a town route (Appleyard, 1970). There was also a small but significant advantage in wayfinding ability following active navigation of a VE compared with a condition in which participants passively watched a prerecorded route through the environment (Peruch, Vercher, & Gauthier, 1995). These results imply that active navigation plays an important role in determining how vision is used to assist spatial knowledge and learning. However, not all studies have shown superiority of activity over passivity (Ito & Matsunaga, 1990; Gaunet, Vidal, Kemeny, & Berthoz, 2001). There has been a failure to find a beneficial effect of active exploration on orientation in VEs. Moreover, a recent study compared experimental conditions which were active, passive, and snapshot, in directing exploration using a driving simulator (Gaunet et al., 2001). The active and passive exploration conditions led to similar performances for path memory but the snapshot exploration condition resulted in lower performance. There were no differences in performance between the active and passive exploration, although continuous visual stimulation was essential for the acquisition of spatial abilities. These inconsistent results suggest that factors such as the amount of attention directed to the task and the kinds of information available may influence the active-passive navigation (Flach, 1990). In other words, these studies have failed to show a superiority of active navigation in VEs; the driving simulator environment was limited in its ability to test exact spatial abilities and the amount of attention in active and passive conditions were not identical (e.g., only the participants in the active navigation condition were limited to the visual and tactile simulated apparatus). In the present study, therefore, we examine the role of active navigation in the efficient acquisition of spatial knowledge, and further investigate the relative effectiveness of active navigation and passive navigation by controlling for the previously mentioned limitations.

MATERIALS AND METHODS

Participants

Participants were 54 adults in the range of 19–29 years of age (*M* = 22.72, *SD* = 2.5) who were recruited at K University in Korea. Nineteen (35.2%) were males and 37 (64.8%) were females; mean ages were 24 years (*SD* = 2.13) and 22 years (*SD* = 2.45) respectively. All participants gave written consent.

Instruments and measures

The virtual environments were created using the Direct X, Pentium IV PC, with an Open CL Accelerator VGA card. The 3D visual display was presented through an Olympus FMD-250W Head Mounted Display (HMD) with resolution of 800 x 600 pixels. The virtual environments consisted of four rooms (library, office, lounge, and conference room). Participants were required to complete a demographic form and a Simulator Sickness Questionnaire (Kennedy, Lane, Berbaum, & Lillienthal, 1993) designed to measure the incidence of simulator sickness symptoms in a variety of task performance environments.

Procedure

Before the experiment, participants were asked to complete and return their demographic questionnaire. Participants were randomly divided into one of two VE navigation conditions; 22 were in the active navigation group and 32 were in the passive navigation group. The VE consisted of four rooms (library, office, lounge, and conference room), and each room had 15 objects (total of 60 objects). The rooms were identical in size. The participants in the active navigation group were shown how to move around the virtual environment using the HMD and keyboard and asked to explore at their own pace within the predetermined time limitation for each room. Participants in the passive navigation group passively explored the four rooms in random order. During the passive navigation, each target object was presented for 2000 ms without motion, and the Inter-Stimulus Interval (ISI) between objects was 5000 ms. The total duration of navigation was limited to 125 s and objects presented in both conditions were identical. After navigation, all participants were asked to complete the recognition task with 60 old items, which had previously been shown during the navigation, and 60 new items, which had not been presented before. The familiarity, emotional valence and arousal dominance items were matched on two categories (old and new objects) in a previous survey. Before the recognition task, participants were instructed to com-

plete the Simulator Sickness Questionnaire (SSQ). During the recognition task, stimuli were presented for 500 ms with 2000, 3000 or 4000 ms inter-trial intervals. Participants were asked to use a keypad of two response buttons to indicate if they had seen the stimulus during the previous navigation

Data analysis

In the object recognition task, we conducted *t*-tests to compare the response times and the response percentages of the active navigation group with those of the passive navigation group. The response times and percentages were measured by several scales including hit, miss, correct rejection, and false alarm response.

RESULTS

The response times of recognition

The mean response times for correctly identifying old objects and new ones were 734 ms (*SD* = 154) for active navigation and 721 ms (*SD* = 163) for passive navigation. The mean response times for missing old objects were 821 ms (*SD* = 214) and 749 ms (*SD* = 196) for active and passive navigation conditions respectively. The active navigation group had longer overall reaction times than passive navigation group, though this difference was not significant.

The response percentages of recognition

The mean percentage of correct rejection was 87.50 (*SD* = 6.68) for the active navigation group and 88.70 (*SD* = 7.72) for the passive group. The mean percentage of false alarm was 12.27 (*SD* = 6.80) and 10.36 (*SD* = 6.84) for the active and passive groups, respectively. In this analysis, we failed to find a difference between the groups.

The mean percentage of hit responses that correctly identified old objects by active navigation was 70.61 (*SD* = 10.97); by passive navigation it was 56.15 (*SD* = 14.30). The mean percentage of miss responses in which participants failed to correctly recognize old objects was 29.02 (*SD* = 11.19) for the active navigation group, and 42.76 (*SD* = 14.38) for the passive group. The analysis revealed a significant difference between the conditions in hit and miss response percentages for object recognition. The active navigation group made significantly more hit responses (t (52) = 4.000, $p < 0.01$) and fewer miss responses (t (52) = –3.763, $p < 0.01$) than did passive condition.

DISCUSSION

The most important finding in this experiment was the difference in object recognition between the individuals who navigated actively and those who navigated passively. The study was designed by controlling for the limitations mentioned in the introduction, and the results are consistent with those of previous studies (Appleyard, 1970; Cohen & Cohen, 1985) that found active navigation of VEs allows more accurate recognition of spatial objects than does passive navigation. Although we expected the active navigation group to outperform the passive group on the recognition task, only a significant difference in response percentages of recognition was found. In particular, differences between conditions were shown in hit and miss response percentages which represent the most accurate responses among several response measurements. This implies that active navigation promotes higher memory performance and more efficient spatial learning than when individual was passively navigated. However, there was no difference in the response times of recognition between the two navigation conditions. There are a number of reasons why this may have occurred. One possibility is that the emphasis of current study was on testing response accuracy than response times in memory ability through a recognition task. The present results appear to be of some theoretical interest in relation to neurobiological models of spatial cognition and mapping. In influential theory (O'Keefe & Nadel, 1978), self-initiated movement plays a crucial role in the establishment of cognitive spatial maps by means of processes occurring within the forebrain hippocampus. The theory emphasizes the need for the integration of successively encountered environmental cues into more global spatial representations in the hippocampus, to allow predictions to be made about the consequences of self-initiated movement. The time base for these sequential processes is thought to be the theta rhythm, a sinusoidal waveform prominent in the hippocampal EEG and notably coincident with so-called voluntary behaviors, such as exploratory movements

(Vanderwolf, 1971). The results of the present study may support the assertion that self-initiated movement is vital for generating hippocampal cognitive maps and is closely associated with memory ability. Our results also have implications for the use of 3D-based programs for spatial learning. Although most research has been done using paper and pencil, and computerized tasks, virtual environments provide a new tool for cognitive research (Gamberini, 2000; Mania & Chalmers, 2001). Present results suggest that active navigation is generally useful in promoting spatial awareness: walking around a building or city is probably the best way to learn to recognize the environmental stimuli as well as learn its spatial layout. It may used for the benefit of disabled individuals who are unable to establish efficient cognitive maps, and individuals who are less able to utilize spatial concepts, due to damage or disease. In conclusion, we found evidence that active navigation provided a significant advantage over passive navigation under conditions that actually tested spatial abilities, and controlled confounding variables. Active navigation promoted spatial learning. Finally, it is possible to study the extent to which active navigation is beneficial in other kind of VE tasks. Spatial encoding and the memory mechanism underlying active navigation remain to be investigated.

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Original Research

Optic Flow With a Stereoscopic Display: Sustained Influence on Speed of Locomotion

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Abstract: *Previous studies have shown that walking speeds can be modulated over short timescales by varying the rate of optic flow. This study investigated whether the modulating effect of optic flow on treadmill walking speed could be sustained for the longer time periods necessary for rehabilitation. An animated moving walkway was created in 3D Studio Max and rendered into a stereoscopic movie using Virtalis StereoWorks. The movie was projected (moving toward the subjects) onto a 5m wide screen in front of a self-paced treadmill. The movie was projected at three different speed conditions (0.75m/s, 1.5m/s and 3.0m/s) in counterbalanced order. Nine participants were instructed to maintain 'comfortable walking speed' throughout the 5-minute duration of each speed condition. A significant difference was found between the mean walking speeds of the participants at different animation speeds (ANOVA p<0.01); with lower animation speed associated with faster walking speeds and vice versa. This modulating effect was sustained for the duration of each 5-minute test, which suggests that it does have potential for use in rehabilitation and training. This study used healthy subjects, and further work is proposed to investigate the extent of this modulating effect on clinical groups.*

INTRODUCTION

Pain and motor slowing in rehabilitation

Generalized psychomotor slowing and persistent slowing of movements are frequent consequences of injury, illness, pain, and aging, giving rise to an inability to function effectively in the community (Ada, Dean, Hall, Bampton, & Crompton, 2003). Slow movements are also associated with the fear of falling (Chamberlin, Fulwider, Sanders, & Medeiros, 2005). This adds to the physical burden, because slow movements are relatively inefficient both in terms of time taken and energy required (Simmonds, Goubert, Moseley, & Verbunt, 2006).

A study using regular ambulation on a treadmill without the use of Virtual Reality showed promising results, with significant increases in walking speed and walking capacity (Ada et al 2003). Moreover, Sullivan, Knowlton, & Dobkin (2002) found that post-stroke individuals achieved the greatest improvement in overground walking velocity (OWV) when trained at speeds above the patient's typical OWV. This is supported by the findings of Lamontagne and Fung (2004), who also found that fast walking improved the overall walking pattern of stroke subjects.

Although rehabilitation approaches have targeted movement speed, an ongoing challenge is the need to engage and motivate patients to actively participate in their rehabilitation. Virtual Reality displays, as a tool for rehabilitation, have been demonstrated to help engage patients (Rizzo & Kim, 2005) and also improve movement (Merians et al., 2002). Boian, Burdea, Deutsch and Winter (2004) noted that most individuals do not fully recover their walking ability after stroke and proposed a system of training using Virtual Reality to enrich the rehabilitation environment. In addition, Hoffman et al. (2004) demonstrated that pain responses in the human brain can be significantly reduced by using Virtual Reality as a distraction. If this pain-reducing phenomenon can be combined with an environment which improves movement speed, and perhaps reduces the fear of falling, patients may be able to engage in rehabilitation at a higher functional level, leading to increased long-term gains in mobility.

Optic flow and movement

The image of an object on the retina enlarges as it comes nearer and shrinks as it moves

away, and this optic flow phenomenon is used as a visual cue to assess both speed of movement and direction (Harris, 2002). Although the visual system can be used to determine the relative movement of different objects, in order to discriminate between movement of objects in the environment, and movement of self (egomotion), optic flow alone is insufficient, particularly when there is relatively little visual detail or richness.

A study by Prokop, Schubert, and Berger (1997) suggested that the rate of optic flow has a modulating effect on walking speed, demonstrating an inverse linear relationship between optic flow and walking velocity. This agreed with the findings of Pailhous, Ferrandez, Fluckiger, and Baumberger (1990), in which modulating the rate and direction of optic flow gave rise to modulations in stride length, cadence and velocity. Moreover, Durgin, Gigone, and Scott (2005) compared the perception of optic flow speed with and without the influence of self-motion and found that the rate of optic flow was perceived to be lower while walking, suggesting an internal calibration between locomotion and visual perception.

Thus, in addition to the visual stimuli, the brain receives regular information updating awareness of body position and movement, and this sensorimotor feedback is processed in combination with the optic flow to differentiate egomotion from object motion. However, it would seem that the interaction between these two systems is complex, and discrepancies between expected and actual rate of optic flow appear to stimulate a recalibration of the motion perception system. A study to determine visual-vestibular cortical interaction during visually-induced circular vection (illusory self-rotation) found that visual motion stimulation with circular vection not only activates the visual area of the cortex, but simultaneously deactivates the vestibular area of the cortex, suggesting that inhibitory visual-vestibular interaction may be a mechanism to protect visual perception of self-motion from vestibular mismatches (Brandt, Bartenstein, Janek, & Dieterich, 1998). Although this study used circular vection, it is conceivable that a similar mechanism may be brought into play during a mismatch between vestibular activation and linear optic flow, influencing the perception of the walking speed of the subject to be closer to that of the optic flow rather than physical speed. Indeed, a study investigating the effects of optic flow in a Virtual Environment found that a mismatch between walking speed and optic flow stimulated recalibration of visually directed motion in the real world (Mohler et al., 2004). This study also found that the speed at which the walk/run gait transition occurred was modulated by the speed of optic flow of the virtual environment, supporting the idea that visual information tends to dominate the calibration of human movement. Thus systematic manipulation of optic flow within a Virtual Environment could enable these modulating effects on locomotion to be applied to the rehabilitation domain.

Studies of this phenomenon to date have concentrated on modulations over short time scales, typically of a few seconds in duration. However, if there is to be a practical application for rehabilitation or training, then the effect needs to be sustained for longer time periods. The objective of this study was to investigate whether the manipulation of optic flow via a large-screen stereoscopic display could be used to sustain the modulating effect of optic flow on walking speed over several minutes, or whether the sensorimotor feedback would override any short-term effects.

MATERIALS AND METHODS

Participants

Nine healthy volunteers (5 men and 4 women) between the ages of 33 and 57 (mean age 45.6) participated in this study. Participants were from the University of Portsmouth staff, and all gave their informed consent prior to inclusion in the study.

Apparatus

The experimental system included a self-driven treadmill in front of a 5m x 2.5m stereoscopic display screen. To minimize visual distractions, the experimental room was dark, with the main light source being the display screen itself (Figure 1A).

Two equidistant reflective markers were placed on the treadmill belt (104 cm apart). Each test was recorded using a small video camera mounted behind the treadmill, with a local light

Figure 1. (A) Subjects walked on a self-driven treadmill in front of a 5m wide display. (B) The Virtual Environment simulated a moving walkway between vertical columns.

source focussed on the treadmill belt to highlight the reflective markers. The footage was recorded at a rate of 25 frames per second, and by noting the frame number each time a marker appeared it was possible to accurately calculate the speed of the treadmill belt and thus the walking speed of the participants.

The animation was created using 3D Studio Max and rendered into a stereoscopic format using Virtalis StereoWorks. It consisted of two parallel rows of vertical columns on either side of a walkway (Figure 1B). A rolling ball was added in the middle distance to focus the participant's attention on the screen.

The animation was designed to run at three different speeds, all approaching the subject. Condition B was set at 1.5m/s, which is the average overground walking speed for the general population under 65 years of age (Knoblauch, Pietrucha, & Nitzburg, 1996). In Knoblauch's study, the walking speeds were found to be tightly clustered around the mean, suggesting that fixed animation condition speeds would be appropriate for all subjects. Condition A was half the speed of B, and condition C twice the speed, to provide high and low optic flow conditions. A fourth condition (D) was added as a control, and this involved a static display with no optic flow.

Procedure

Prior to the task, all participants were given the experimental instructions and spent a few minutes familiarizing themselves with the equipment and walking on the treadmill. They each participated in all four conditions in counterbalanced order. Each test required the participants to walk on the treadmill for five minutes at a self-selected comfortable pace, with a five-minute rest between each test. Participants were instructed to attempt to maintain the same pace throughout all the tests. During each test, participants wore earplugs to minimise the influence of external noise such as the treadmill belt. They also wore lightweight 3-D glasses to enable stereoscopic viewing.

RESULTS

An analysis of variance (ANOVA) was performed on the average walking speeds, and a significant difference between optic flow conditions was found ($F(3,24)=7.22$, $p<0.01$). Post-Hoc tests revealed that the walking speed in condition A was significantly faster than that in condition B ($p<0.05$), condition C ($p<0.01$), and condition D ($p<0.05$). In addition, the walking speed in condition B was significantly faster than that in condition C ($p<0.01$). There was little difference between the control condition (D) and the optic flow of 1.5m/s (B). The faster (C) and slower (A) conditions demonstrated a significant effect on the walking speed, such that walking speed was lower with a faster optic flow and higher with a slower optic flow (Figure 2).

The significant difference in walking speeds between the optic flow conditions was sustained

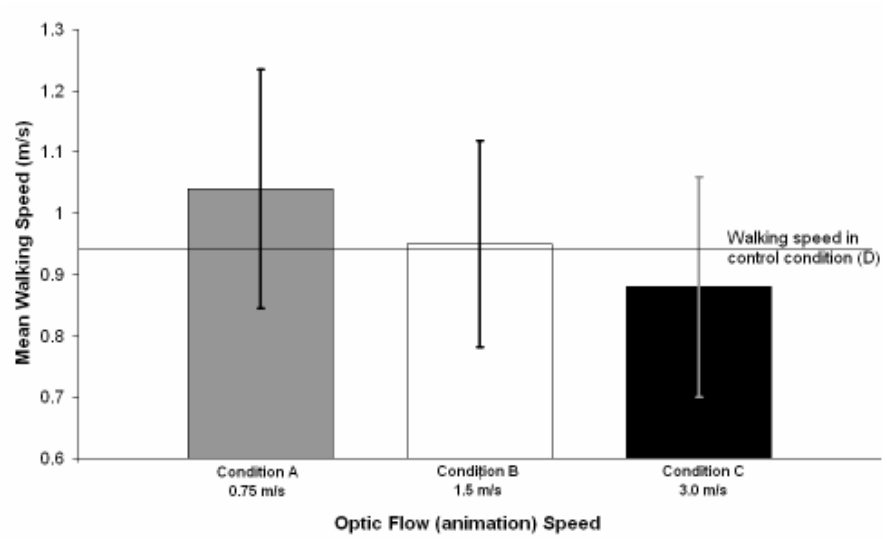

Figure 2. Effect of Optic flow on mean walking speeds of participant group (n=9)

throughout the full five minutes (Min1 $F(3,24)=3.10$, $p<0.05$; Min2 $F(3,24)=4.77$, $p<0.01$; Min3 $F(3,24)=7.17$, $p<0.01$; Min4 $F(3,24)=6.91$, $p<0.01$; Min5 $F(3,24)=5.98$, $p<0.01$). Post-Hoc analysis of the minute-by-minute results confirmed that the pair-wise differences between the conditions were consistent throughout the 5-minute tests (Table 1).

DISCUSSION

The results of this study confirmed that treadmill walking-speed can be influenced by the speed of optic flow on a large-screen stereoscopic display, and demonstrated that the effect can be sustained over several minutes.

Although the experimental design based the optic flow speeds on multiples of the 'normal' overground walking speed of 1.5m/s, the subjects in this study walked on the treadmill at an average speed of 0.95 m/s (SD 0.21), which is similar to the steady treadmill walking speeds in Varraine, Bonnard, & Pailhous (2002). This might suggest a need for a slower optic flow (around 1m/s) for the matched condition (B), but previous studies have suggested that optic flow needs to be increased by as much as 50% to seem normal to subjects walking on a treadmill (Banton, Steve, Durgin, & Proffitt, 2000). The close matching of average walking speed in conditions B and D reported here confirms the previous finding. Thus the selected simulation speeds were appropriate to provide the desired high and low optic flow rates.

The decrease in walking speed with higher optic flow rates supports Durgin et al. (2005) who suggested that there may be a predetermined expectation of the visual effects associated with a particular walking speed.

If the actual rate of optic flow is different from the expected rate, the participants appear to adjust their rate of locomotion in an attempt to correct the optic flow rate to that expected (i.e. when the optic flow is too high, the speed of locomotion is reduced as this would reduce optic flow in normal circumstances, and vice versa). It appears that the visual information is overriding the other sensory input that would normally help to regulate the locomotor speed. This supports the findings of Brandt et al. (1998) of vestibular deactivation by visual stimulus. The modulation in walking speed was maintained for the full five minutes of each test, suggesting a recalibration of locomotion as observed by Mohler et al. (2004). Although this study was carried out on healthy participants and further work is needed to assess the extent of the effect on clinical groups, these preliminary results suggest that decreasing the rate of optic flow during treadmill walking may cause a significant increase in walking speed. Incorporating this effect into a Virtual Environment, where optic flow is geared up or down via a treadmill-to-environment interface, could enhance gait rehabilitation.

Table 1: Analysis of Variance and Post-Hoc analysis of mean participant walking speeds for each minute of the four optic flow conditions

Minute		Walking speed m/s		Post-Hoc analysis - pairwise comparison of walking speeds in the four optic flow conditions
		Mean	SD	
1	A	0.99	0.21	walking speed in A > walking speed in C $p < 0.01$ walking speed in A > walking speed in D $p < 0.05$
	B	0.93	0.19	
	C	0.89	0.21	
	D	0.90	0.22	
2	A	1.08	0.22	walking speed in A > walking speed in C $p < 0.01$ walking speed in A > walking speed in D $p < 0.05$ walking speed in B > walking speed in C $p < 0.05$
	B	0.99	0.19	
	C	0.94	0.20	
	D	0.97	0.25	
3	A	1.11	0.20	walking speed in A > walking speed in B $p < 0.05$ walking speed in A > walking speed in C $p < 0.01$ walking speed in A > walking speed in D $p < 0.05$ walking speed in B > walking speed in C $p < 0.01$
	B	1.02	0.18	
	C	0.96	0.19	
	D	0.99	0.26	
4	A	1.14	0.22	walking speed in A > walking speed in C $p < 0.01$ walking speed in A > walking speed in D $p < 0.05$ walking speed in B > walking speed in C $p < 0.01$
	B	1.04	0.19	
	C	0.98	0.19	
	D	1.02	0.25	
5	A	1.16	0.23	walking speed in A > walking speed in B $p < 0.05$ walking speed in A > walking speed in C $p < 0.01$ walking speed in B > walking speed in C $p < 0.01$
	B	1.07	0.18	
	C	1.01	0.19	
	D	1.05	0.26	

CONCLUSION

The findings of this study extend the work of Pailhous et al. (1990) and Prokop et al. (1997) by demonstrating that the modulating effect of optic flow on locomotion can be sustained for several minutes. This may be attributable to the suppression of the vestibular information by the visual cortex together with dominance of the visual input over the sensorimotor information in the recalibration of visual-motor feedback.

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Simulation-based training of communication and emotional competence for the improvement of physician-patient relationship

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Abstract: *Recent research has determined that the training of health-care professionals in communication and emotional skills management is related to patients' satisfaction and compliance towards medical treatments. Moreover, good communicative and emotional competence enhances the physician's sensitivity to the psychosocial aspects conveyed by patients, and it may also help the physician to cope with his/her own emotions, thus reducing burn-out. Training in such capacities has traditionally been conducted via didactic learning. However, recent work in computer-based simulation offers a viable and promising alternative.*

The present work, as part of the EU-funded project "MySelf: Multimodal e-learning System based on Simulations, Role-Playing, Automatic Coaching and Voice Recognition interaction for Affective Profiling" (www.myself-proj.it), aims to describe the potential of computer-based interactive simulations for enhancing communication and emotional competence training in the physician-patient relationship. In particular, this work is focused on the translation of typical interactive medical situations into 3D simulations with animated characters; this offers the possibility for physicians to train their communicative and emotional skills (e.g. empathy, emotional coping, non-verbal communication, etc.) in critical settings through interactive scenarios that improve the user's identification and experience in a virtual context.

INTRODUCTION

Recent research has determined that the training of health-care professionals in communication and emotional skills management is related to patients' satisfaction and compliance with medical treatments. Moreover, communicative and emotional competence enhances the physician's sensitivity to the psychosocial aspects conveyed by patients (van Dulmen & van Weert, 2001) and it may also help the physician to cope with his/her own emotions, then subsequently reducing burn-out (Fallowfield & Jenkis, 2004).

These capabilities are learned primarily through experience, since they require a number of cues that are managed *hic et nunc,* in the flow of the communicative exchange. Therefore communication competence has been traditionally considered as a typical face-to-face/ classroom learning topic. However, recent work on computer-based interactive simulations and autonomous agents (Aldrich, 2003; Marsella, 2000; Paiva et al., 2004) offers new opportunities for the training of communication and emotional competence in different professional contexts, including health care.

Simulation can be defined as a learning method designed to replicate a real-life situation as closely as possible, to give the user the opportunity to experience this situation in a realistic but non threatening context (Schank, 1997). The efficacy of simulation in soft skills training has been explored in several projects. For example, the IDEAS project (Marsella, 2000) aims to improve problem solving skills in mothers of paediatric cancer patients. Learning is based on interactive stories where two virtual agents, Carmen and Gina, play the role of the mother of a seriously ill child and of a clinical counsellor, respectively. Through identification with the characters, the user can improve his or her problem solving abilities. In addition, Aldrich's

Virtual Leader (Aldrich, 2003) works to improve leadership skills with a training program based on simulations that show several different managerial and business scenarios.

The present work, as part of the EU-funded "MYSELF-project-*Multimodal e*-learning System based on *Simulations*, Role-Playing, Automatic Coaching and Voice Recognition interaction for Affective Profiling" (www.myself-proj.it), aims to investigate the potential benefits of computer-based interactive simulations for enhancing communication and emotional competence training in physician-patient relationship. After an introductory section describing the specific characteristics of communicative and emotional competence training in health-care, this contribution will focus on the rationale for the use of computer-based simulations for physicians' training in various relational skills. Some critical elements related to the design and development of interactive simulations will be presented and discussed, with particular reference to the goal of eliciting a sense of presence in the simulation's user/trainee in order to foster learning transfer to actual professional contexts.

COMMUNICATIVE AND EMOTIONAL COMPETENCE TRAINING IN MEDICINE

The medical encounter represents a complex communicative situation, deeply pervadee with emotional elements. Consequently, good management of communicative and emotional skills by the physician is a key element for an effective relationship with the patient (Fallowfield & Jenkis, 2004).

Even if the training of these abilities can be considered a basic element of medical education, some clinical scenarios invariably make the physician's emotional control particularly difficult. For example, in the oncologic field, the physician is repeatedly faced with serious diseases, and consequently with death. Other medical specialties, like paediatrics, gynaecology, obstetrics, cardiology and emergency medicine also are frequently confronted with stressful communicative situations. Giving bad news and facing possible therapeutic failures involves an emotional distress in medical professionals that may be particularly significant, as some physicians have reported (Orlander, Fincke, Hermanns & Johnson, 2002; Hammond, Franche, Black & Gaudette, 1999; Baile, Lenzi, Parker, Buckman & Cohen, 2002). Specific training focused on the communicative and emotional skills needed to cope with these circumstances can diminish their psychological impact on the physician, reducing the risk of burn-out (Libert et al., 2001; Farrell, Ryan & Langrick, 2001; Rosenbaum & Kreiter, 2002). A general survey on the communicative and emotional traits that characterize the medical encounter can help the comprehension of the role of relational skills training in this field.

The medical encounter can be defined as a non-symmetrical interaction, where the physician's position is higher than the patient's with respect to many variables, including professional competence, and often social status. It can be a non-voluntary relationship (for example in case of emergency) and always requires close cooperation between physician and patient. In this respect, many studies have underlined that good and effective communication by the physician plays a critical role in the patient's compliance with therapy and consequently in the achievement of a good therapeutic outcome (Siminoff & Fetting, 1991; Ley, 1988).

The communicative elements that characterize physician-patient interaction can be schematized as instrumental and affective behaviors. The instrumental communicative behaviors are task focused; that is, they are related to the physician's medical expertise and to the technical skills that enable him to analyze and solve the patient's problem (Hall, Roter, & Katz, 1987). These elements can be also defined as *cure oriented* (Ong, de Haes, Hoos, & Lammes, 1995) and are identifiable in the dialogue parts focused on the medical problem, both by the physician and the patient. On the other hand, affective communicative behaviors can be defined as *care oriented* (Ong, de Haes, Hoos, & Lammes, 1995), since they are related to the socio-emotional aspects of the disease. They include, among other elements, giving the patient reassurance and encouragement, showing empathy and approval, and asking information about the patient's social and family context (Roter, 1991).

In light of the emotional connotation of the medical encounter, the affective aspects should prevail over the instrumental ones, but the communicative scenario is quite different.

Experimental studies focused on the verbal aspects of the physician-patient interaction have revealed that the instrumental elements are quantitatively more frequent than the affective ones (Weston, Brown & Stuart, 1989). Moreover, other studies reported that the communicative exchange is mainly managed by the physician, as his contribution to the dialogue, in terms of speaking time, is higher than the patient's one (Roter, Hall, & Katz, 1988). These results seem to outline a communicative scenario in which the emotional aspects related to the situation are scarcely managed and encouraged.

In this respect, helping physicians to improve their communicative and emotional competence in their relationship with patients can be considered a primary learning objective.

In 1999, the American Council of Graduate Medical Education (ACGME) certified and approved some communicative skills that should be considered a fundamental aspect of medical education. In particular, the capability to recognize and respect the patient's emotional state and also the socio-demographic variables (patient's age, culture, gender, nationality) that can influence his relationship with the disease and the medical setting, are considered elements of basic competence for health workers.

In general, the learning of these abilities is usually rooted in real experience, since they require a number of cues that are managed *hic et nunc,* in the flow of the communicative exchange. In spite of the importance of such competence, communicative training in the medical field is fragmentary, and often accidental. One of the current modalities is the observation of a peer or a supervisor facing a difficult communicative situation, like a diagnosis of incurable cancer or the announcement of the patient's death to his relatives (Vaidya et al., 1999). This training can be useful, but not systematic and is necessarily limited to the colleague's communicative competence.

In medical training courses, one of the most frequently used learning devices in the classroom setting is role-playing (Petrusa, 2002). It is based on the simulation of real interactive situations that physicians often deal with in their daily relationships with patients. Traditional role-playing implies the presence of so-called *standardized patients*, individuals who are specifically trained to realistically interpret the patients' role, and consequently display the physical and psychological behaviors related to different pathological syndromes.

Though improvement of the physician's communicative competence through the use of role-playing has been acknowledged (Boehle, 2005; Barrows, 1993; Wallace, 1997; Fincher & Lewis, 2002), some critical aspects related to this traditional learning device have been recently highlighted (Olsen & Sticha, 2006).

First, role-playing demands a classroom setting and quite a long amount of time. Second, the learning efficacy depends to a great degree on the actors' competence: qualified role-players may be difficult to find and a small amount of subjectivity is always present, even in an expert standardized patient. Furthermore, even if role-play based simulations can be considered realistic, actors are usually healthy individuals who are trained to act "as if" they were patients; they are not actually patients. Finally another critical aspect can be identified in the lack of repetition: repeated practice of the same learning experiences is not possible. On the whole, such limitations can produce a decrease of the ecological validity of the role-playing based methodology. In order to overcome some of these drawbacks, interesting opportunities might be offered by the use of computer-based interactive simulations designed to improve the realism and the objectivity of the learning situation.

COMPUTER-BASED SIMULATIONS FOR PHYSICIAN'S LEARNING OF COMMUNICATION SKILLS

In medical education, Virtual Reality environments and interactive simulations have been increasingly used for the training of clinical and surgical skills. For example, the training of clinical competence has been endowed with virtual

reality based learning devices (Satava & Jones, 1997), in order to make the learning experience as objective as possible. In this perspective, the medical examination of a prototype based on augmented reality has been used to expand the range of potential physical abnormalities related to specific pathologies available for training (McKenzie et al., 2006). The prototype, a realistic human-like mannequin, allows the medical practitioner to listen to physiological or abnormal pre-recorded heartbeats and lung sounds. A preliminary experimental study of this device was carried out during the annual Observed Structure Clinical Examination (OSCE), and the results confirmed this tool's validity for the clinical diagnosis of a circulatory pathology.

When moving from the training of surgical and clinical skills to the training of communicative and emotional ones, the learning objective shifts to the comprehension of the relational environment that characterizes the physician-patient interaction and a realistic representation of it through the simulation. Therefore, a computer-based simulation as a learning device for communicative and emotional skills should depict the social dynamics and the typical conversational patterns of such an interactive situation. This type of experiential training holds great potential in helping the physician to cope with difficult patients in relational contexts that require specific communicative strategies and emotional control (Schank, 1997; Olsen & Sticha, 2006).

In a computer-based simulation, the medical practitioner generally takes the physician's role and manages the interaction with a virtual patient and/or with her relatives. Her character can be described by definite personality traits, which are depicted in the character's profile at the beginning of the simulation. In this way, the user has to act according to these variables and to the relational process that is gradually displayed during the learning experience. Moreover, the physician could also play the patient's role, experiencing the same situation from a different perspective. When compared with traditional role-play, a computer-based simulation provides the user with the possibility of potentially infinite standard replications of the learning process. In this way, the physician can think over her communicative choices and their related outcomes and can modify these outcomes through the repetition of the simulation experience. Furthermore, the simulation provides the user with an immediate feedback about her learning performance.

Within this framework, the development of computer-based simulations for physicians' training of communicative and emotional skills is a main goal of the EU-funded MYSELF-project (www.myself-proj.it). These simulations are focused on specific communicative situations that emerged as particularly emotional involving, according to medical professionals' evaluation. In order to maximize the realism of the learning experience, the simulations are experienced in 3D virtual environments with virtual characters playing the physician and patient role. Characters were modelled and animated with Poser 5 and particular attention was paid to their non-verbal modalities: characters' appearance, gestures, posture, and tone of voice were studied to try to mirror the real physician-patient relationship within a coherent environmental setting. In this respect, the trainee has the opportunity to verify his communicative and emotional skills while managing the conversation with the virtual patient within the simulation's path. The skills that have been identified as learning goals are multiple and include empathy, emotional coping, non verbal communication management, reassurance, focusing on the patient's needs, personal commitment, etc.

The system is endowed with speech-recognition capabilities, so that conversational interaction in the simulation is mainly voice-based, as in a real physician-patient relationship. A screenshot from one of the simulations is represented in Figure 1.

The figure represents the character playing the physician role, which is animated according to the communicative options chosen by the user during the virtual interaction with the patient. A similar scenario is used for the character playing the patient role.

The process of developing training simulations necessitates the analysis of certain key features, in order to guarantee learning efficacy. These elements are strictly related to the elicitation of the user's sense of presence, which is a fundamental element in virtual learning (Mantovani & Castelnuovo, 2003). Such key

Figure 1. A screen-shot from MYSELF project simulations, showing the physician from the patient's perspective.

features are represented by the simulation architecture and rationale definition, the dialogue scripting, and the simulation's character animation. The simulation's architecture building includes the identification of the learning targets, and consequently, of the communicative and emotional skills related to the physician-patient interaction.

To this end, the expertise of medical professionals is required in order to identify involving interactive situations with highly demanding patients whose management calls for communication strategies and emotional control by the medical practitioner. Such professional expertise has to be integrated with expertise in training communication skills. This expertise makes the identification of learning targets possible, beginning with the professionals' evaluations, the operationalization of the communicative and emotional skills, and the building up of a coherent learning path, designed and structured to reach the predetermined learning objectives. In this way, the communication expert should integrate the information coming from the healthcare professional with the mental model of the targeted situation. This mental model can also be defined as a script (Schank, 1986), i.e. a cognitive representation of the structure and organization of an event. Scripts are socially and culturally influenced and acquired; they help individuals to give stability to the real world, as a contribution to the psychological process of meaning attribution.

The simulation's architecture thus obtained generally follows a branching narrative approach, with which the complexity of the real situation can be preserved. At many points in the virtual conversation with the patient, the physician has to choose between different conversational strategies, and then experience different patient reactions as a consequence of their choice. Therefore, good dialogue scripting is essential for an effective simulation, since dialogues must be able to draw the trainee into the scenario and be emotionally and intellectually involving at the same time.

In the same way, character animation is a fundamental trait of the simulation's visible output, and together with the previous elements, plays a critical role in the elicitation of the user's sense of presence. The simulation's animation demands technological and computer graphics expertise to reproduce the simulation rationale in actual implementation. In this respect, virtual patients have to be designed and animated to be believable: their personalities, appearance and clothing, general attitudes, nonverbal be-

haviors and conversational interventions must be compatible with the medical problems they represent. In medical e-learning, in particular, the characters' nonverbal modalities should be carefully implemented, as they are strictly connected with the communication of emotion.

As seen in the analysis of these key elements, in a simulation's building process it is necessary to consider the situation's realism as a basic element to elicit the trainee's sense of presence in the simulation.

CONCLUSIONS

The present contribution has illustrated the opportunities that computer-based simulations can offer in the improvement of the physician-patient relationship through the training of the specific communicative and emotional skills that characterize the medical encounter. As compared to typical classroom role-playing, interactive 3D simulations offer a training environment characterized by several potential benefits: in particular, training situations can be carefully scripted and standardized, there are advantages in terms of logistic constraints, and there is an opportunity for systematic repetition of the learning experience. Due to these aspects, computer simulations hold the potential both for enhancing the training and the assessment of communication and emotional competence in health-care professionals.

After a general illustration of the simulation's constitutive elements, the key features for effective simulation building have been discussed. Particular importance has to be ascribed to the elicitation of the user's sense of presence and identification with the simulation's characters, in order to achieve a real transfer of knowledge through the learning experience. In particular, building effective simulations implies facing a number of issues: translating the real interactive situations into animated actions, scripting dialogues capable of eliciting trainees' involvement in the simulation, providing multiple paths throughout the simulations, developing an adequate model of the complex real-world social dynamics with which the user interacts, as well as designing and animating believable and multimodal characters. Effective implementation of all these aspects can be considered a fundamental challenge that requires a user-centered design approach and a serious and systematic evaluation and validation process.

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Sexual presence as determined by fractal oculomotor dynamics

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Abstract: *This paper presents a tentative model of sexual presence. Using linear stepwise regression analyses, indices of eye movements' fractal dynamics are shown to be more effective than standard computations of eye movements in predicting sexual presence.*

INTRODUCTION

"Presence is a psychological state or subjective perception in which even though part or all of an individual's current experience is generated by and/or filtered through human-made technology, part or all of the individual's perception fails to accurately acknowledge the role of the technology in the experience" (ISPR, 2006). By extension, feeling of sexual presence refers to the illusion of being in a real encounter situation of a sexual or potentially sexual nature, engendered by a technical montage conducive to sensory immersion (Renaud, 2004; Renaud, Rouleau, Granger, Barsetti & Bouchard, 2002; Renaud et al., 2006). As a theoretical and psychometric construct, sexual presence may be very helpful in fields that would be using virtual sexual stimuli for research or clinical purposes (experimental and forensic psychology and sexology, for instance).

SEXUAL RESPONSE

As a multidimensional process, sexual response cannot be reduced solely to sexual arousal. It comprises at least three components: esthetic interest, sexual attraction, and sexual arousal (Kalmus & Beech, 2005; Singer, 1984). Moreover, distinct levels of perceptual and cognitive processing can probably differentially interact with subjective and physiologic outputs of the sexual response (Janssen, Everaerd, Spiering & Janssen, 2000; Spiering, Everaerd & Laan, 2004). In this perspective, perceptual extraction of sexual visual information plays an essential role in the interplay between sexual arousal and the subjective state of sexual awareness.

EYE-MOVEMENTS

Eye movements are dependent upon the coordination of six extra-ocular muscles, the four recti and the two obliques, which are organized in agonist-antagonist dynamics, allowing control over the direction in which the eyes turn (horizontal, vertical and rotational). *Foveation* involves movements initiated to align visual stimuli with the fovea and to keep this alignment stable. Fixations, which are the steady gazes holding over stationary objects, range in time from 150 ms to 600 ms with an average of 300 ms (Stern & Dunham, 1990; Viviani, 1990). Saccades are rapid movements of the eye to search a visual scene, they are usually greater than 1.2 degrees and take between 100 and 300 ms to initiate.

FRACTAL DYNAMICS

Classic Euclidian geometry cannot easily encompass the intricate details of naturally occurring objects and events, especially for behavior and limb coordination. For this reason, fractal geometry was developed to describe the potentially infinite similitudes that exist across differing scales of observation (Mandelbrot, 1975). A

fractal process generates a time series with fluctuations organized in a self-similar manner at multiple time scales, and as such, can be considered a scale-free phenomenon. Fractal dynamics have been found in various physiological (Buldyrev et al., 1993; Haussdorf, Peng, Ladin, Wei & Goldberger, 1995; Haussdorf et al., 1996; Peng, Havlin, Stanley, & Goldberger, 1995) and behavioral phenomena (Abraham, Abraham, & Shaw, 1990; Heath, 2000; Shaw & Kinsella-Shaw, 1988; Treffner & Kelso, 1995; Aks, Zelinsky, & Sprott, 2002; Renaud, Décarie, Gourd, Paquin, & Bouchard, 2003). They have also been observed in eye-head coordination phenomena (Renaud et al., 2003; Renaud et al., 2006; Shelhamer, 1997). Moreover, it was demonstrated that head-tracking behavior during virtual immersion can exhibit fluctuations organized in long-range correlations with scale invariance (Renaud, Bouchard, & Proulx, 2002; Renaud, Singer, & Proulx, 2000). These fractal patterns found in head-tracking dynamics were indeed modulated by the constaints imposed by the tasks, and they were correlated with affective state and presence.

PERCEPTUAL INVARIANCE EXTRACTION

The extraction of *invariant information* in the ambiant optic array is the main purpose of the visual perceptual system's coordination; by extracting these invariances, the beholder is perceiving what his surroundings can afford him for action. According to Gibson (1966, 1979), the *affordances* of an object, event, or environment are the opportunities for action that the object, event, or environment offers the observer. Affordances are thus tightly linked to goals and organismic states, as they instantiate at the perception-action level the coupling between an organism and its environment (Renaud et al., 2002; Renaud et al. 2000). It is most probably through this coupling that the feeling of being present in a particular sexual context or object might emerge by specifying how important or how salient environmental features are according to one's adaptive objectives (Renaud et al., 2003; Flach & Holden, 1998).

METHODS AND HYPOTHESIS

In this section the method that we used to assess the significance of oculomotor dynamics in the emergence of the subjective feeling of sexual presence is described.

Participants

Fifteen heterosexual male participants aged between 20 and 57 ($\bar{X}$ = 36.9, SD = 12.8) were recruited for our study. Seven of them were diagnosed as paraphiliacs and were attending therapy at the Forensic Program of the Royal Ottawa Hospital.

Apparatus

Our experiment was running on a Pentium IV computer (1000 MHz). 3D animations were presented on a computer monitor. The eye-tracking device was a pan-tilt ASL pupil/corneal reflection tracking system sitting at the bottom of the computer monitor. This system relies on the corneal reflection of an infra-red source that is measured relative to the pupil center location. These particular corneal reflections, known as the first Purkinje images (Duchowski & Vertegaal, 2000) can be located with video-based eye trackers collecting infrared reflections. A single eye tracker returns 2 DOF, i.e. variations in an *x* and *y* plane with an accuracy of 0.5 degree.

Penile responses were recorded from a Limestone Tech penile plethysmograph. This device uses a circumferential transducer, i.e. a mercury-in-rubber strain gauge that is placed around the shaft of the subject's penis to measure his sexual arousal (Freund, 1963; Simon & Schouten, 1991). Sexual arousal is measured by the maximum gauge stretching value.

Procedure and stimuli

Subjects were seated and asked to relax while looking at 3D animations. First, a sexually neutral animation was presented for a 3-minute period. Then, after a break of 2 minutes, a sexual animation was presented, also for a 3-minute period (see Figures 1a and 1b). Neutral and sexual animated characters were displaying the same sequence of movements. A soft white noise was delivered through headphones to isolate subjects from surrounding noises.

At the outset of the experiment, subjects had to answer the Immersive tendency questionnaire whose total score is made up of three factors: involvement, focus, and gaming (Witmer &

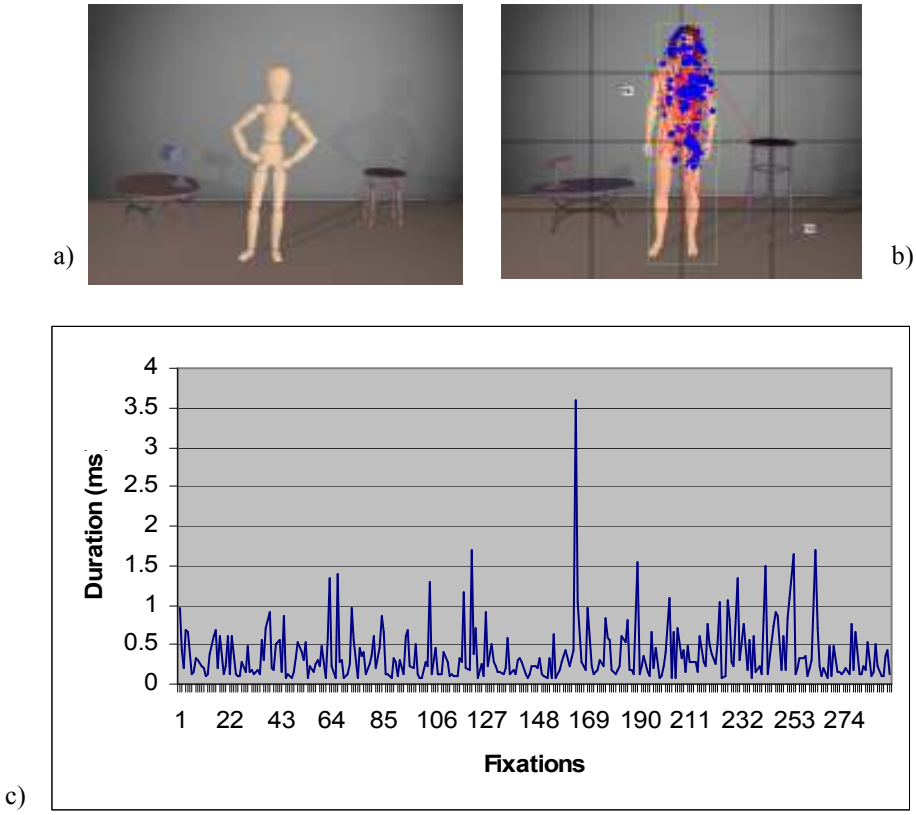

Figure 1. a) Snapshot of the neutral character b) snapshot of the sexual 3D animation depicting a naked adult female with fixations (blue dots) and saccades (red lines) superimposed; dots' size are proportional to fixation duration c) transposition of fixation duration in time series.

Singer, 1998). Then, after exposure to the 3D animations they had to answer the following two questions: 1) *To what extent did you consider this character realistic?* and 2) *To what extent did you consider this character sexually attractive?* Subjects answered using a 7-point Likert scale ranging from Not at all to Completely. Sexual presence was obtained by adding these two scores.

Data analysis

In addition to the total immersive tendency score, nine variables were computed to be included as independent variables in a stepwise linear multiple regression. The dependent variable to be predicted was the score of sexual presence (Tabachnik & Fidell, 2001). Those variables were:

1) Classification of normal (1) or paraphiliac (2) subjects was entered in the regression to control for a possible group effect.

2) The total number of current sex partners (steady or occasional) was taken as an index of the level of sexual activity.

3) The maximum penile gauge stretching value (log-transformed) was taken as an index of sexual arousal.

4) Standard eye movement computations provided the total number of fixations, the average fixation duration (expressed in ms), the average length of saccades (expressed in degree), the average pupil diameter, and the pupil diameter standard deviation (SD) for each subject.

5) The α exponent stemming from the Detrended Fluctuation Analysis (DFA) was taken as an index of oculomotor dynamics (Buldyrev et al., 1993; Hausdorff et al., 1995; 1996). DFA was performed on fixation duration data transformed into time series in which each data point corresponded to an individual fixation duration datum (see Figure 1c).

Determination of Long-Range Correlations: Mainly used with physiological time series, DFA is a modified random-walk analysis relying on the possibility of mapping a long-range correlated time series to a self-similar process by integration (Haussdorf et al., 1995; Haussdorf et al., 1996; Heath, 2000). A time series is thus first integrated into an accumulated sum, and fluctuations [*F*(n)] are then calculated at different observation windows with the objective of finding a power-law scaling relationship between *F*(*n*) and window size. The average at a given window size is computed as the standard deviation (SD) of the residues of a linear regression fit to the integrated time series at each observation window of size *n*. DFA subtracts a locally best fit line before performing the fluctuations analysis and as such is fairly immune to nonstationarity. Generally, *F*(*n*) increases with *n* and if a linear relationship is found on a double-log graph, it can be said that *F*(*n*) corresponds to *n* to the power of α, where α is obtained by calculating the slope of the line relating log of *F*(*n*) to log of *n*. This exponent, α, was used here to ascertain fractal long-range correlations and self-similarity in fixation duration time series.

Persistent long-range fractal correlations are detected if $0.5 < \alpha \leq 1.0$. An $\alpha < 0.5$ indicates anti-persistence, i.e. a negative correlation between past and present data points; in this case a value larger than the mean tends to be followed by a value smaller than the mean. Otherwise, white noise (completely uncorrelated time series), gives an $\alpha = 0.5$. 1/*f* noise is at the limit between stationarity ($\alpha < 1.0$) and nonstationarity ($\alpha > 1.0$). Finally, brown noise (integrated white noise), is non-stationary and shows an α of 1.5. Besides the self-similarity aspect, α gives information about the "roughness" of the original time series. The larger its value, the smoother the time series.

In addition to looking at the exponent's value, a surrogate data method introduced by Theiler and colleagues (1992) and adapted by Hausdorff and colleagues (1995, 1996) was used to statistically differentiate each original computed α from α s coming from random processes. For each fixation duration time series, 20 surrogate time series were generated by performing a Fourier transform of the original data (the phase of each Fourier component was set to a random value between 0 and 2π) while preserving their power spectrum and correlation function (Sprott, 2003; Sprott & Rowlands, 1995). The mean ($\bar{X}$) of the 20 surrogate α s were then computed and compared to the original α to determine statistical significance for each subject using one sample t-tests.

RESULTS

<u>DFA α exponents</u>

DFA α s ranged from .357 to .710 (see Table 1). Correlation coefficients associated with α exponents indicated a linear relationship (ranging from .98 to .99) between fixation duration fluctuations [*F*(*n*)] and windows' size (*n*). Surrogate data tests showed that 11 out of the 15 original α s were statistically different from random uncorrelated noise ($p = .005$ to $p < .0001$), i.e. they were presenting long-range correlations with fractal self-similarity.

<u>Multiple linear regression</u>

Table 1 gives a summary of the variables, including sexual presence. All these variables entered a stepwise linear multiple regression as independent variables to predict sexual presence.

As shown in Table 2, data entered in the multiple regression analysis have led the stepwise procedure to a significant prediction model ($R = .88, F(2,11) = 18.82, p < .001$), keeping only two independent variables of the nine initially introduced, namely the DFA fractal index of fixation duration and the number of sexual partners. This model applies only for the sexual stimulus. No significant regression models came out with the neutral stimulus (which was tested with and without the question, "*To what extent did you consider this character sexually attractive?"* for obvious reasons).

Table 1
Summary of the variables
Descriptive Statistics: Sexual stimulus

	Minimum	Maximum	Mean	Std. Deviation
Sexual presence	2.00	12.00	7.2667	3.63449
DFA fixation duration alpha	.357	.710	.57600	.084134
Nb of fixations	158.22	458.54	285.4682	93.75318
Avg fixation duration	.23	.72	.4259	.14856
Avg length of saccades	1.39	3.95	2.5929	.63624
Avg pupil dilation	22.70	39.87	29.5335	4.50913
Pupil dilation SD	1.80	3.49	2.7089	.48157
Immersive tendency	29	95	68.57	19.937
Sexual arousal	-.44	1.74	.5020	.64081
Nb of female sexual partners	0	1	.67	.488

Table 2
Multiple stepwise regression

	Unstandardized Coefficients		Standardized Coefficients		
	B	Std. Error	Beta	t	Sig.
(Constant)	23.493	3.550		6.618	.000
DFA fixation duration alpha	-33.129	6.181	-.784	-5.360	.000
Nb of sexual partners	4.220	1.063	.580	3.969	.002

Table 3

Correlations

		Sexual presence	DFA fixation uration alph	Immersive tendency	Nb of sexual partners	Sexual arousal
Pearson Correl	Sexual presence	1.000	-.671	.352	.428	.320
	DFA fixation duratic alpha	-.671	1.000	-.531	.195	-.495
	Immersive tendenc	.352	-.531	1.000	-.032	.226
	Nb of sexual partne	.428	.195	-.032	1.000	-.215
	Sexual arousal	.320	-.495	.226	-.215	1.000
Sig. (1-tailed)	Sexual presence	.	.004	.108	.064	.132
	DFA fixation duratic alpha	.004	.	.025	.253	.036
	Immersive tendenc	.108	.025	.	.457	.219
	Nb of sexual partne	.064	.253	.457	.	.230
	Sexual arousal	.132	.036	.219	.230	.

According to the adjusted R^2, this model could explain 73% of the sexual presence score's variance. The DFA fractal index of fixation duration could answer for about 59% of this variance ($sr^2 = .769, t(14) = 5.360, p < .001$), and the number of sexual partners for 32% ($sr^2 = .569, t(14) = 3.969, p < .01$). Table 3 presents bivariate correlations on a subset of the variables. DFA α correlates negatively with the immersive tendency as well as with

sexual arousal. The number of sexual partners (sexual activity) does not correlate with oculomotor dynamics.

These data are subsumed in the causal diagram shown in Figure 5. According to this model, oculomotor dynamics play a pivotal role in the emergence of the subjective feeling of sexual presence. Indeed, DFA α appears to be inversely related to sexual presence, as if a specific mode or regime of oculomotor control would be associated with the emergent subjective state of sexual presence (see Figure 6). Rougher DFA α exponents are more clearly associated with a high subjective feeling of sexual presence, antipersistence α exponents (α < .5) being even more presence inducing. It is as though fixation durations have to be punctuated in a particular way (short fixation durations followed by long fixation durations) to produce high sexual presence. This rhythmic pattern also appears in the negative correlation found between oculomotor dynamics and sexual arousal, the latter (sexual arousal) being indirectly linked to sexual presence (Table 3).

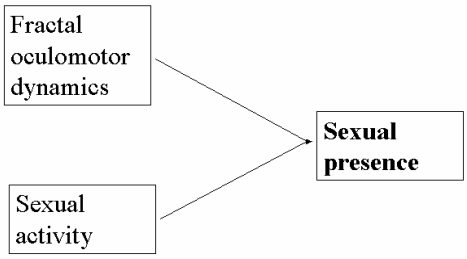

Figure 2. Diagram of the causal relationships between variables.

In the same way, immersive tendency seems to be a trait modulating oculomotor activity involved in visual information extraction taking place with sexual stimuli.

Finally, sexual activity, i.e. the number of sexual partners, seems to be a factor distinct from perceptual dynamics, but which is much less significant in the establishment of sexual presence. Indeed, when DFA α is taken off the regression model, sexual activity is no more statistically significant in predicting sexual presence.

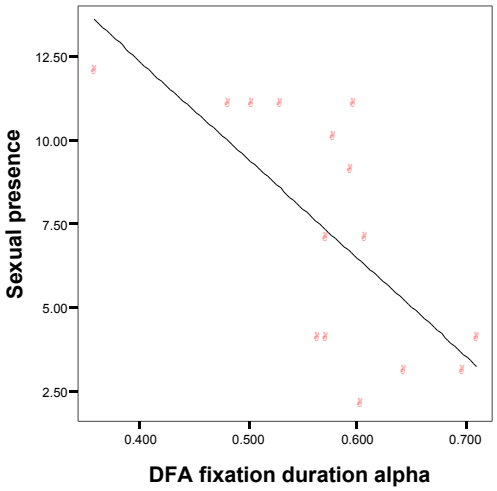

Figure 3. Sexual presence as a function of DFA fixation duration α

CONCLUSION

To conclude this tentative exploration of the interplay between perceptual-motor dynamics and sexual presence, we first have to note that standard computations of eye movements do not correlate with sexual presence. Only the fractal oculomotor dynamics index α turned out to be a significant oculomotor predictor of sexual presence. This result is most probably attributable to the fact that this fractal index of visual scanning tells us how perceptual invariance extraction operates in a dynamic way at different temporal scales of the process (Buldyrev et al., 1993; Haussdorf et al., 1995, 1996; Heath, 2000; Sprott & Rowlands, 1995). In doing so, this index brings out the essential role of perceptual-motor pacing in getting into a sexual state at the physiologic arousal level as well as at the subjective phenomenological level. In fact, it seems that this fractal pacing acts as a keystone in the priming of the automatic instinctual processes involved in sexual arousal and in the emergence of sexual presence (Janssen et al.,

2000; Spiering et al., 2004).

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Physiological and Momentary Assessment for Identifying Tobacco Use Patterns

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Abstract: *Cigarette smoking is the leading cause of morbidity and mortality in the United States. Approximately 70% of smokers report that they want to quit but only about 4% of smokers who try to quit smoking each year succeed. Nicotine is a highly addictive, psychoactive drug that induces physiologic and psychological effects that clearly reinforce the continued use of tobacco products (Smith, 2003). Research with sensor technologies supports the utility of biosensors for the detection and prediction of arousal associated patterns of tobacco use. Sensors have the ability to capture data that can be used to create algorithms for the identification and prediction of arousal patterns associated with cravings and addiction. If we can identify physiologic patterns associated with craving, it may be possible to intervene prior to the onset of an addiction-behavior spiral. The primary objective of this ongoing three-phase study is to detect the physiological antecedents that prompt smokers to use tobacco through the analysis of biometric and behavioral data. For Phase 1, nine smokers completed baseline questionnaires about smoking history, self-efficacy to quit smoking, decisional balance, and readiness to change. Participants wore non-invasive armband sensors continuously for seven days at baseline and for four days at three-month follow-up. Participants pressed an "event button" on the armband each time they lit a cigarette. This article will present the methodology and analyses that are being used for the development and testing of predictive algorithms, and will discuss implications and future applications of these findings. Biometric and psychological data are currently being analyzed. The goal of data analysis during Phase 2 is to generate statistical algorithms, based on individual baseline patterns of craving and tobacco use. The goal of Phase 3 is to then use the follow-up data to test the predictive validity and specificity of the algorithms created in Phase 2. This research lays a foundation for developing innovative treatment approaches by integrating contemporary advances in technology with emergent findings related to the biological substrates and behavioral mechanisms of cravings and addictions. The information gained from this pilot research is a requisite step for the development of innovative behavioral health interventions that will endow consumers with greater control over maintaining their health. New interventions are envisioned that will be tailored to individual biometrics and daily routines, delivered at optimal moments for effective intervention.*

INTRODUCTION

Cigarette smoking is the leading cause of preventable disease, disability, and death in the United States, contributing to the deaths of more than 430,000 people each year (Centers for Disease Control and Prevention [CDC], 2005b). Currently, approximately 21% of U.S. adults are smokers (CDC, 2005b). Smoking is associated with a broad range of serious illnesses, chronic disease, reproductive effects, and increased risk for certain types of cancers. Smoking cigarettes causes over 85% of lung cancers and 30% of all cancer deaths (CDC, 2005b). Approximately 70% of all smokers report that they would like to quit (CDC, 2002). While a number of evidence-based pharmacological and behavioral interventions have proven to be effective in smoking cessation, 70-80% of smokers relapse after a single quit attempt and require several serious attempts before becoming smoke free (Schacter, 1992; Schwartz, 1987).

Emerging technologies offer new opportunities for delivering behavioral interventions (Walters, Wright, & Shegog, 2006). Electronic modes of delivery are well suited for tailoring interventions to the individual, a strategy that has proved to be more successful than non-tailored or no interventions (Strecher, Wang, Derry, Wil-

denhaus, & Johnson, 2002). Tailored behavioral interventions have typically been based on self-report assessments, the results of which are matched to a specific characteristic of the individual (e.g., gender, stage of change, nicotine dependence), or a combination of two or more psychosocial variables (e.g., self-efficacy, perceived barriers, attitude, social support, etc.); however, these types of expert systems are based on static variables and delivered at a time not usually controlled by the researcher. New technologies offer unique opportunities for the translational scientist to advance treatment programs by building on contemporary understandings of the biological substrates and behavioral mechanisms of nicotine and tobacco addiction.

Recent investigations using biosensors suggest that the physiologic arousal associated with specific behavioral events can be accurately detected and predicted (Adam, 2005; Doser et al., 2003; Lang, 1995). Sensor technologies for human behavior have been used for this purpose, to determine whole body and specific behavioral measurement related to sports, entertainment, and medical care (Kanasugi, 2005). Furthermore, autonomous agents are currently being utilized to create adaptive responses to dynamic environments. Researchers at the MIT Media Lab are developing a wearable system with sensors that can continuously monitor the user's vital signs, motor activity, social interactions, sleep patterns, and other health indicators (Pentland, 2004). These wearable systems amass objective data to improve diagnoses and provide early warning of an impending health crisis.

Cravings are critical factors associated with smoking behaviors and relapse (Kelly, Barrett, Pihl, & Dagher, 2004). Most smokers experience cravings and withdrawal symptoms within a few hours of abstaining from nicotine (Smith, 2003). Even a partially abstinent smoker can be regarded as being in a chronic state of withdrawal (U.S. Department of Health, Education and Welfare, 1979). Cravings for cigarettes and other addictive substances are both physiologic and behavioral events that lend themselves to measurement and pattern detection. Decreases in heart rate and diastolic blood pressure, as well as a decrease in metabolic changes, are observed as early as six hours after cessation (U.S. Department of Health, Education and Welfare, 1979). These physiologic aspects associated with craving are predictable and measurable.

While physiologic patterns associated with cravings have not been a previous research focus, the relationship between tobacco smoking and stress has long been an area of interest (Smith, 2003). Kecklund and Åkerstedt (2004) concluded that there are many well-established physiological markers for the measurement of stress. This research provides good evidence for the arousal patterns that appear related to cravings. Individual stress responses are quite consistent, even when the stressor differs (Levine, 1986); however, individual variations in baseline levels and reactivity patterns are large, making it difficult to establish normative values or cut-offs. Fortunately, individual variance can be mitigated by strategies that measure several parameters simultaneously and examine the fluctuations over time (Kecklund & Åkerstedt, 2004). It is not the overall level of a single physiological marker that discriminates between low and high stress situations; rather, it is the profiles over time that reflect the differences. This is the basis upon which the current research builds.

Participants in the current study wore non-invasive sensors to collect continuous biometric data including motion, heat flux, skin temperature, and galvanic skin response. Each time participants lit up a cigarette, they pressed an “event stamp” that recorded their tobacco use as a specific behavioral event in the raw physiologic data. It is our hypothesis that biometric data can be used to create statistical algorithms to identify and predict the arousal patterns associated with craving and/or tobacco use behavior. To facilitate the predictive modeling, algorithms utilizing both deep knowledge and surface knowledge (Velicer & Prochaska, 1999) are being used in order to create individually tailored responses that will adapt based on an incoming stream of physiological data. This research seeks to develop a conceptual model that, in our long-range vision, establishes the foundation for developing new approaches to smoking cessation interventions, which will be tailored to individual physiological and psychological patterns of behavior.

The technical framework on which the project is based is artificial intelligence research that has matured to the point where it can be applied to commercially available products and informed by theoretically sound therapies, such as cognitive behavioral therapy, social learning theory, and the transtheoretical model. Through these methodologies, we seek to develop tailored interventions that will adapt according to individual styles, patterns, and readiness for change.

There are three phases to this study. Phase 1 consisted of continuous biometric data collection from nine cigarette smokers. Baseline data were collected via non-invasive biosensor armbands that participants wore 24 hours a day for a period of seven days. Three-month follow-up data were collected for four days' duration. We are currently completing Phase 2 of the study, which is focused on the exploration of the Phase 1 data to identify physiological arousal patterns that are associated with smoking. This data will be used to develop statistical algorithms for the accurate prediction of individual patterns of tobacco use and smoking behavior. We have also commenced with Phase 3 of the project wherein data is being collected from eight of the nine Phase 1 smokers. The aim of Phase 3 of the study is to verify the strength and predictive ability of the algorithms created in Phase 2. Given the ongoing nature of this research and data analysis, this paper will address the theoretical basis for the study, the methods, and the anticipated findings and implications of this project.

METHOD

Participants

Human subjects approvals were obtained by the University of Hawai`i's Institutional Review Board and the U.S. Army and Materiel Command's HSSRB. Recruitment was conducted primarily at the university campus between October 2005 and February 2006 using flyers, handbills, public service announcements, e-mail and classroom presentations. Inclusion criteria for the study required participants to be current smokers between the ages of 18 and 54, English-speaking, in good health, and demonstrate the ability to read, understand, and complete all self-report questionnaires. Prospective participants were considered ineligible if they were undergoing Nicotine Replacement Therapy for smoking cessation, reported any smoking-related health conditions, and/or required prescription medication that may affect the normative data collected by the biosensor (e.g., asthma, hypertension, low cardiorespiratory fitness, etc.). All participants were required to wear an armband biosensor for 24-hours per day for a one-week period. Informed consent was obtained from all participants following a 30-minute orientation to the study and the equipment involved, and prior to their completion of baseline questionnaires. A total of 11 participants were recruited to the baseline Phase 1 portion of this study; however two individuals were unable to complete the seven-day baseline citing personal reasons (n=9). All participants were contacted to participate in a three-month follow-up for an additional four-day trial. Eight of the 9 participants agreed to participate in the follow-up phase, which was completed in May 2006. The ninth participant was no longer eligible to participate, having quit smoking approximately one week after Phase 1 was complete.

Measures

Self-report questionnaires

Immediately following informed consent procedures and orientation, participants completed the following baseline measures.

Smoking History and Behavior (BCC-LM): The Behavior Change Consortium's (BCC) Tobacco Dependence Workgroup (TDW) recommends a combination of validated smoking behavior questionnaires (Williams, McGregor, Borrelli, Jordan, & Strecher, 2005). The BCC-LM includes the Fagerstrom Tolerance Questionnaire (Fagerstrom & Schneider, 1989), a stage of change assessment (DiClemente et al., 1991), and single-item assessments of seven-day point prevalence, confidence to quit, motivation to quit, habit, and smoking environment.

Situational Self-Efficacy (Temptations): This nine-item measure determines each participant's situational temptation to smoke (Velicer, DiClemente, Rossi, & Prochaska, 1990). The measures support three-item subscales: 1) positive affect/social situations; 2) negative affect; and 3) habit/craving. Respondents were asked to rate their own temptation to smoke on

a five-point Likert scale, ranging from "not at all tempted" (1) to "extremely tempted" (5). Lower self-efficacy scores have been shown to be a predictor of increased smoking behavior, increased risk for relapse (Yates & Thain, 1985), and perceived severity of addiction (Rothman, 2000). Low self-efficacy is also associated with poor coping response to stress (Gerin, Litt, Deich, & Pickering, 1996).

Pros and Cons (short form): This six-item measure will be used to assess changes in decisional balance (Velicer, DiClemente, Prochaska, & Brandenburg, 1985). Respondents were asked to rate the importance of each item in their decision to smoke on a five-point Likert scale, ranging from "not important at all" (1) to "extremely important" (5). Pros and cons are associated with smoking cessation (Bane, Ruggiero, Dryfoos, & Rossi, 1999). Furthermore, the magnitude of shifts in decisional balance is indicative of an individual's readiness to change behavior (Prochaska, 1994).

Physiological Measures

BodyMedia SenseWear® Pro$_2$ armband: It has already been established that cigarette smoking and the arousal associated with withdrawal generates a number of physiological and metabolic changes, affecting heart rate, skin temperature, and skin conductance. Many of these same data channels were collected by the armband sensor: *heat flux*—the rate of heat exchanged between the wearer's arm and the outside environment; *skin temperature*—temperature of the skin under the armband; reflective of the body's core temperature, although it is several degrees cooler; *ambient temperature*—the air temperature immediately around the arm; *galvanic skin conductance*—has been found to correlate positively with novel stimuli, intensity, and/or emotional content, and may also show increased levels during stress (Andreassi, 2000; Fichera & Andreassi, 1998); *movement*—longitudinal and transverse accelerometers track forward and lateral movement.

Procedure

During the first phase of the study, participants wore the armband continuously for seven days as a means of collecting baseline data. Participants were instructed to press an "event button" on the armband each time they lit up a cigarette. The event button recorded a timestamp (or "annotation") on the raw data, so smoking could be correlated with a physiological antecedent. The researchers made no attempt to control extraneous variables and the participants' were instructed to carry on with their normal daily routines.

Data Analysis Plan

Biometric data collected by the armbands were downloaded directly using InnerView™ Research Software v4.0, developed by BodyMedia specifically for the device. Data were exported into Microsoft® Excel and MATLAB for analysis. Data from the self-report questionnaires were input, managed, and analyzed with SPSS 14.0.

Gaussian smoothing filters have been applied to the physiologic data as a means of partitioning five-minute averages for sequential data points. This form of data reduction will provide a more manageable data set. Data analysis will include the statistical analysis of physiological (sensor) and self-report data collected from participants to detect associations between tobacco use and variance in the physiological data.

Hierarchical Linear Regression

A collection of bivariate and multivariate analyses will be used to create algorithms from the best linear combination of all physiological and psychological variables. Specifically, the algorithms will be developed from the physiological data collected by the participants' armband data, participants' smoking events, and self-report questionnaire data.

A series of multivariate regression analyses will be utilized in the initial steps of algorithm development. Algorithms created from the derived functions will utilize a split-half subset of the data. These will be tested against the balance of the collected observations. In the next stage of analysis, a search algorithm will be run in an attempt to identify a subset of data that produces accurate descriptors. After a subset of data has been identified to be an accurate predictor, cross-validation will be used to randomly divide the data in an attempt to validate the algorithm (Reunener, 2003). Hierarchical linear regression will be used to explore combinations of both physiologic and psychological constructs in order to reduce the

variable set to a minimum set of predictors (Raudenbush & Bryk, 2002).

Algorithm Development
Response algorithms will be designed utilizing an autonomous agent framework. This algorithm architecture was selected because of its ability to adapt responses to subsequent data. Sequential Forward Floating Selection (SFFS) will be applied to determine best fit for the constraints imposed by the data collection method and sample size of the study. SFFS in combination with Fisher Projections also result in robust predictive models having an accuracy rate of as much as 81% (Nasoz, Alvarez, Lisetti, & Finkelstein, 2003). Back propagation neural networks have also demonstrated an ability to predict behaviors from large sets of data that don't easily correlate to results.

Initially, normative data will be given greater weight in the prediction of smoking events. As supplementary individualized data is processed, individualized predictive models will be derived for each subject. The modeling algorithms will slowly shift reliance from normative data to individualized tobacco use indicators over time. After a substantial accumulation of individualized data is collected to accurately predict patterns associated with tobacco use, the reliance on normative data as a predictive tool will be gradually eliminated from the calculations. The strength and predictive ability of these algorithms will be examined in a later phase of the study.

RESULTS

Descriptives
Descriptive statistics were tabulated for the sample (*n*=9). Participants were predominantly male (63.6%), with a mean age of 32.9 (*SD*=10.3), college educated (mean years of education=15.3, *SD*=2.8), unmarried (55.6%), and in very good health (55.6%). Most participants identified their ethnicity as White (77.8%), Samoan (11.1%), or Chinese (11.1%), with 22.2% claiming Hispanic origins.

Smoking History
Overall participants began smoking in adolescence (mean age=16.4, *SD*=3.6), have smoked an average of 15.3 years (*SD*=11.9), and smoke an average of 25.9 cigarettes per day (*SD*=26.8). Participants reported little readiness to change, and self-selected into either the pre-contemplation (77.8%) or contemplation (22.2%) stage of change for smoking cessation. Participants in this study rated a moderate to high level of nicotine dependence, with a mean nicotine dependence score of 4.6 at baseline (*SD*=2.5; *range*=0-7). According to the Fagerstrom Nicotine Tolerance Questionnaire (FNTQ; Fagerstrom & Schneider, 1989), individuals who score between 7-10 demonstrate a high level of addiction (*n*=1), scores between 4-6 indicate a medium level of addiction (*n*=5), and scores below 4 correspond to low levels of addiction (*n*=2).

Baseline and Follow-up Comparisons
Phase 1 participants wore the armband over a seven-day period for an average of 9,314 minutes (*SD*=1558.1; *range*=6,808 - 12,526). During Phase 1, participants smoked an average of 108.78 cigarettes in total (*SD*=92.2 *range*=36-330), an average of 0.7 cigarettes per hour (*SD*=.6; *range*=0.23-2.03). At baseline, most participants reported being in the pre-contemplation stage for smoking cessation (77.8%; *n*=9). Baseline participants also reported a mean decisional balance (cons of quitting minus pros of quitting) value of -3.0 (*SD*=13.7).

Participants in the follow-up phase wore the armband for a period of approximately four days for an average of 4,675.4 minutes (SD=1,628.0; *range*=1,765-6,737). During the follow-up phase, participants smoked an average of 63.3 cigarettes in total (*SD*=59.6; *range*=9-180), an average of 0.7 cigarettes per hour (*SD*=.6; *range*=0.15-1.88). Follow-up participants had a mean FNTQ score of 5.9 (*SD*=2.8; *range*=2-10). These participants also reported a slight shift in stage of change distribution with 62.5% (*n*=6) at pre-contemplation, and 25% (*n*=2) at preparation. Average decisional balance scores at follow-up were positively skewed at 4.38 (*SD*=11.5)

DISCUSSION

Nicotine is a highly addictive, psychoactive drug that induces physiologic effects to reinforce the continued use of tobacco (Smith, 2003). Distinct patterns of withdrawal symptomatology have

been specified in the DSM-IV (American Psychiatric Association, 1994), and include depressed mood, insomnia, irritability, anxiety, difficulty concentrating, restlessness, and increased appetite. Definitive physiological changes are found to occur with cigarette deprivation, including decreases in heart rate, decreases in cortical arousal associated with drowsiness and decreased vigilance, hypersensitive visual stimuli, reduction in auditory evoked response, decreases in blood pressure and respiratory rate, and increases in skin temperature (CDC, 1988). These physiologic parameters are observable and measurable across time and therefore predictable at an individual level.

In recent years, the capacity of sensor technology has increased and portability has improved. Non-invasive, wearable wireless sensors offer new opportunities for research and intervention for a broad range of psychophysiological research. Specifically, research using sensor technologies supports their utility for the detection and prediction of arousal associated with addictions. Because of high relapse rates, researchers now characterize tobacco dependence as a chronic condition that requires repeated intervention (Paul & Lucas, 2005). Autonomous agents have been successfully used to create adaptive responses to dynamic environments. This means that individually tailored, early intervention methodologies are possible to assist in treating addiction in more timely and meaningful ways. Interventions will be useful for treating addictions of all kinds, including those who are resistant to change, those already in treatment, and those who need help preventing relapse.

Sensors have the ability to dynamically capture physiological data. The current research seeks to demonstrate the capability of developing statistical algorithms to accurately identify and predict arousal patterns associated with individual cravings and/or tobacco use behaviors. The algorithms are being developed from physiological data collected by wearable sensors with timestamps and subjective data provided by participants. The algorithms developed in Phase 2 of the current study will be used with participants' follow-up data in Phase 3 as part of a beta testing trial to assess the predictive validity and reliability of the algorithms with a view toward determining the optimal timeframe for delivery of a cessation or relapse prevention message.

As data from this project is analyzed, a larger project is envisioned that will expand on the pilot project in three ways: the sample size will be increased; a more robust research design has been constructed; and the project will be augmented with the addition of a controlled laboratory condition. The project will be carried out in order to provide definitive evidence that patterns of physiological arousal associated with tobacco craving can be identified in smokers through statistical algorithms; to differentiate between psychological craving and physiological arousal in smokers; and, to identify robust algorithms that can be used for intervening in tobacco use behaviors.

It is possible that each individual's cravings demonstrate a unique physiologic pattern that is identifiable by immediate changes in one physiologic channel (e.g., heart rate, skin temperature). It is also possible that the gateway channel may be different for each individual. This program of research seeks to understand these patterns and develop a conceptual model for developing new approaches to smoking interventions. Tailored and portable intervention applications are envisioned for a variety of addictions. Identifying individual patterns of craving and tobacco use may provide a window for the earliest possible intervention, before a spiral of behavior begins. Interventions that are designed to be delivered 'just-in-time,' offer critical opportunities for optimal effectiveness.

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Implicit Learning of an Embedded Regularity in Older Adults using a SRT Reaching Task in a Virtual Reality Medium

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INTRODUCTION

Motor learning in rehabilitation can be facilitated by different forms of knowledge (Strangman, Heindel, Anderson, & Sutton (2005). To do so appropriately, it is important to understand how different tasks may facilitate or inhibit these different forms of knowledge. Learning any task involves at least two forms of learning: explicit and implicit. Explicit learning is characterized as learning within conscious awareness and is under intentional or voluntary control of the performer (Gentile, 2001). In contrast, implicit learning is described as operating outside one's conscious awareness and is under automatic control of the performer (Gentile, 2001). In general, declarative and metacognitive processes are the equivalent of explicit knowledge. Procedural knowledge, on the other hand, relates more strongly to implicit knowledge (Dienes & Perner, 2002). Traditional theories of motor learning generally propose that the earliest phase of motor skill acquisition is acquired explicitly and, as learning progresses, skill performance becomes more implicit (Gentile, 2001; Maxwell, Masters, Kerr, & Weedon, 2001). Recent research has challenged this assumption (Maxwell et al., 2001). Evidence suggests that many skills are learned without ever encoding verbal rules or acquiring conscious knowledge regarding underlying rules or regularities (Goschke, 1998). More recently, researchers have argued that initial representations acquired during learning can take either explicit or implicit forms, and with practice, each can be transfigured from one form to the other (Maybery, Taylor, & O'Brien-Malone, 1995; Park & Shea, 2005).

Past investigations of implicit and explicit learning have focused on two different issues: the learning of a specific task and the learning of embedded regularities (i.e., a regularly occurring predictive pattern), and our research focus was on the latter. The ability to note recurrent regularity in the physical or social environment is necessary to be able to adapt to a changing world. Researchers exploring the learning of regularities have investigated whether implicit learning of an embedded regularity can occur. Traditionally, serial response time (SRT) tasks have been employed that require a finger key press in response to a visual stimulus (Goschke, 1998). A predictive sequence (regularity) is embedded throughout the visual stimuli presentations and the standard result is that the response times for the embedded pattern are faster than for random sequences, despite the participants not demonstrating conscious awareness of that regularity (Meulemans, Van der Linden, & Perruchet, 1998).

In the literature, age has been shown to affect the acquisition of tasks requiring conscious processing; whereas tasks that can be learned without conscious awareness are not influenced by the effects of age (Durkin, Prescott, Furchtgott, Cantor, & Powell, 1995; Willingham, 1998). The SRT task is said to have a motor component (Goschke, 1998; Willingham, 1999). It is well known that older subjects demonstrate slower motor responses (Willingham, 1998). Regardless of this motor slowness, similar degrees of implicit learning of a simple, or low, order SRT repeated pattern by both older and younger adults have been shown, with older adults performing more poorly on a test of explicit knowledge of the repeated sequence (Howard & Howard, 1989; Howard & Howard, 1992). However, when using sequences that required more complex or higher-order learning, older adults were able to implicitly learn some second order associations, but demon-

strated poorer implicit learning of more complex sequences (Curran, 1997; Howard & Howard, 1997; Howard, Dennis, Yankovich, & Vaidya, 2004). In their study of spatial and spatiotemporal context learning, Howard et al. (2004) found dissociation between older and younger adults using a higher order visuospatial sequence (i.e., an alternating structure serial reaction time-ASRT) task, but such dissociation was not found for their contextual cuing task that did not entail motor sequencing. So they proposed that differences found in the ASRT task may be attributed to age-related impairments in motor sequencing and that these deficits only become apparent when higher order sequences are used.

The SRT tasks used in these earlier studies, however, employed similar simple movement response that is not reflective of the kind of complex processing required for most daily activities. This is a serious limitation of the previous research in this field. Indeed, Wulf and Shea (2002) claim that findings from studies that use simple skills do not readily transfer to the learning of more complex skills. Thus, to understand different forms of learning processes, more complex skills need to be used in motor learning research. For some tasks, complexity can be influenced by factors such as movement time or degrees of freedom (Wulf & Shea, 2002). The present study used a dynamic, whole body movement task that required both spatial and temporal precision demands. Specifically a gross motor reaching task was used in a virtual reality environment. For this study, SRT will refer to serial response time, as in Willingham (1999), as this was the actual measure obtained during the reaching task.

The purpose of the present study was to determine whether older adults learn an embedded regularity in a gross motor serial response time (SRT) reaching task in a virtual reality environment. In addition, we hoped to determine whether they learned the pattern implicitly and/or explicitly.

METHOD

Participants

Ten female and seven male (n = 17) healthy older adults recruited from local community centers in the Ottawa region served as participants. The participants had a mean age of 68.8 years (range = 63-80 years). Participants were excluded if they presented with any of the following self-reported conditions: physical limitations in upper extremity range of motion, balance problems, or poor standing tolerance. Due to technical difficulties with the virtual reality system, the data from six of the participants were dropped, leaving the data of 11 participants for analysis.

Experimental task

A novel virtual reality (VR) SRT task was used. A digital camera captured the participants' image in real-time allowing the participants to see themselves on a television monitor within the virtual environment. A tripod was placed in front of each participant at the level of the home position as a consistent point of reference for initiation of movement. Participants placed their preferred hand on the tripod and reached out to contact balls as quickly as possible as they appeared at one of the four quadrants of the screen. They returned their hand to the home position (response) after each reach as this activated the appearance of the next ball (stimulus). The response-stimulus interval was set at 0ms as it was demonstrated that such an interval facilitates implicit learning (Destrebecqz & Cleeremans, 2001). The time that it took for participants to move their hand from the tripod to each of the blue balls (response time) was recorded by the system.

Studies that have used an SRT task to determine implicit learning of a repeated pattern used a high number of trials. For example, Shanks, Rowland and Ranger (2005) used 100 trials over nine blocks and Destrebecqz and Cleeremans (2001) used 96 trials over 15 blocks. The present study employed a task requiring gross motor movement that is more susceptible to fatigue than a simple motor task such as key presses. A high number of trials would have therefore been excessively tiring and may have affected ability to detect learning. Thus, for the SRT task during the acquisition phase of this study, the same second order conditional (SOC) pattern as in Meulemans et al.'s (1998) study was used. Despite its smaller number of trials (5 blocks of 84 trials), the results of Meulemans et al.'s (1998) study demonstrated implicit learning of the repeated pat-

tern in both children and young adults. The repeated sequence of ball appearance and trajectory was, 0, 3, 2, 0, 1, 3, 0, 2, 3, 1 with each number representing a quadrant in which the ball appeared. For example, the 0 represented the ball appearing in the lower left quadrant. Three phases were implemented: an acquisition phase to evaluate learning of the sequence; a retention phase to evaluate if learning of the sequence was maintained; and a recognition phase to evaluate the form of learning.

PROCEDURE

Acquisition phase. This phase consisted of five blocks of 84 trials (a trial was equivalent to one ball). Each block started with 4 random trials (random sequence) followed in series by 10 repeating trials (repeating sequence), 6 random trials, 10 repeating trials, until 84 trials were complete. This mixing of repeating and random sequences was expected to make it less probable that participants became aware of the pattern (Curran, 1997; Meulemans et al., 1998). The participants were instructed to reach with their preferred hand to contact the ball as quickly and as accurately as possible. At the end of each block, participants were informed of their total time to complete the block and were encouraged to obtain an even faster time on the next block.

Retention phase. This phase followed after a 30 min filled delay interval. To avoid learning of the sequence within the retention phase, the participants were asked to complete a series of 16 balls, composed of a random sequence (6 balls) and the same repeated sequence (10 balls) that had been presented in the acquisition phase.

Recognition phase. Following the retention phase, the recognition phase involved three tasks: the interview, the process dissociation procedure (PDP), and the recognition task.

The interview consisted of a questionnaire that was verbally administered following the retention phase to determine whether or not there was evidence of explicit learning of the pattern. Questions began very generally and then became more specific. They were: “Did you notice anything about this game?” “Did you notice anything during the game?” “Did you notice any pattern during the game?” “Did you notice any pattern in the way balls appeared during the game?” and “Do you think there was any pattern repeated during the game?” The purpose of the specific questioning was to determine how much prompting was needed before a participant could identify that they had recognized the presence of a pattern, if at all. If the participant was able to state that they were aware of a pattern early on in the interview, it was hypothesized that a level of explicit learning had occurred. Conversely, if the participant required continued questioning to verbalize awareness of the pattern, it is then hypothesized that learning was more implicit than explicit on the continuum of implicit to explicit learning. Such questioning to determine pattern awareness has been used in previous SRT studies (Howard & Howard, 1997; Howard et al., 2004). However, Shanks and Johnstone (1999) argue that the interview taps into reportable knowledge, so it is not exhaustive and may not completely reflect *conscious* knowledge. Therefore, two additional methods of determining explicit knowledge have been implemented.

After the interview, participants were told that there was in fact a pattern present during the task. The purpose of the PDP was to dissociate implicit learning from explicit learning (Destrebecqz & Cleeremans, 2001). The PDP consisted of two conditions, one being the inclusion condition and the second being the exclusion condition. In the inclusion condition, participants were asked to reproduce the pattern that was in the acquisition phase. In the exclusion condition, participants were asked to avoid producing the patterned sequence. If participants were able to reproduce the pattern in the inclusion condition and were able to avoid producing the pattern in the exclusion condition, it was assumed that the pattern was learned explicitly because they were able to manipulate their knowledge. If participants nevertheless reproduced the pattern in the exclusion condition, this demonstrated that they learned it implicitly as they were unable to manipulate their knowledge and so could not avoid reproducing it (Curran, 2001; Destrebecqz & Cleeremans, 2001).

For the recognition task, participants were presented with 16 sequences of four balls. Half of the sequences presented were “old”, being part

of the repeated sequence whereas the other half of the sequences presented were "new" and had never been seen by participants before. For each of the 16 sequences, they were to answer "yes" or "no" to whether the pattern that the four balls appeared in looked like any part of the pattern that was in the acquisition phase. Once again, this allowed us to determine whether participants had explicitly learned the pattern. If so, they would have been able to correctly recognize it. Such a forced-choice recognition task has been recognized as a valid test of explicit sequence knowledge (Destrebecqz & Cleeremans, 2001; Goschke, 1998; Shanks & Johnstone, 1999). Also, Tunney and Shanks (2003) have found that the binary technique described above is more sensitive than continuous scales.

RESULTS

Acquisition

Anticipation toward the wrong ball, that is movement toward a ball that did not actually appear in that particular corner of the screen, was considered an error. These errors were identified using a freeware computer program (accessed at http://www.health.uottawa.ca/biomech/csb/software/) that allowed for graphical representation of the participants' movements. The mean number of errors per block for the repeated sequence was 2.31 and for the random sequence was 2.29. There were no significant differences in the number of errors between repeated and random sequences. It is important to note that the response times recorded during these mistakes would no longer be representative of the overall time it took to respond to the stimulus. Therefore, trials corresponding to wrong directions were initially omitted from all calculations of mean response times. However, a repeated measure ANOVA was completed using mean times for repeated blocks with and without errors. The results indicated that the difference in mean times was not significant, F (1,10) = 4.755, $p < .054$. For this reason, mean response times with errors included were analyzed.

Further, a technical difficulty with using the virtual reality system was that it did not always record the first touch, so participants sometimes had to reach for a ball twice before the stimulus disappeared. The mean number of these double touches per block for the repeated sequence was 1.2 and for the random sequence was 1.6. The initial response time to the stimulus and corrected times were used in our analysis.

To determine whether there was learning of the repeated pattern, the mean response times for both the repeated and the random sequences were examined using a 2 (pattern) X 5 (block) analysis of variance (ANOVA), with repeated measures on the last factor. Results showed that there was a significant improvement across blocks for both the repeated and random patterns, F (4,40) = 20.233, $p < .000$. More importantly, response times were significantly faster for the repeated sequence than for the random sequence, F (1,10) = 9.981, $p < .010$, thus demonstrating that learning of the repeated pattern had occurred (Forkstam & Petersson, 2005). Upon closer analysis of the graph, it seems as though the repeated pattern was initially faster than the random pattern in block one. This may be interpreted as a potential confound, with the possibility that the repeated sequence was just an easier movement sequence to perform. To examine this more closely, a comparison of mean repeated and random response times across the 5 random and repeated sequence trials within block one was done. This was examined using a 2 (pattern) X 5 (sequence trial) analysis of variance (ANOVA), with repeated measures on the last factor. We found that the difference in response times between patterns was not significant, F (1,10) = .000, $p < .996$, indicating that the mean response times of both sequences were equivalent from the start.

Retention

The retention phase allowed us to determine whether learning of the pattern was maintained. The difference in mean response times between block 5 and retention were examined by using a paired sample t-test. It was found that the mean retention response time was slower than in block 5 (see Figure 2), but that the difference was not significant (t = -1.425, $p < .185$). The difference between repeated and random mean times in the retention phase was also examined. It was found that the repeated sequence continued to be significantly faster than the random sequence (t = -2.412, $p < .037$). These results indicate that learning of the pattern was maintained.

Recognition
This phase of the study was designed to determine whether or not there was evidence of explicit learning. Explicit learning of the repeated pattern was measured via three different tasks. If subjects were unable to demonstrate the learning of the repeated pattern through these tasks, it was assumed that the learning that had occurred was implicit (Curran, 1997).

Interview. All participants except for one demonstrated some level of awareness of a pattern at some point of the interview. Seventy three percent (8/11) of the participants reported awareness of a pattern by the second interview question. Though none of the participants were able to explicitly convey what the repeated pattern was, most appear to have had some awareness of the existence of a pattern.

PDP. Since a SOC sequence was used, the number of three-element chunks that were part of the repeated pattern were calculated for both inclusion and exclusion condition. It is possible that participants produced these sets by chance; however, if participants were able to produce patterns above chance, some level of explicit learning of the pattern can be presumed (Destrebecqz & Cleeremans, 2001). As per Destrebecqz and Cleeremans (2001), chance level was calculated to be 0.33 for this sequence. In examining the PDP results, it was found that 73% of participants (8 out of 11) were able to produce patterns above chance level, possibly indicating the presence of explicit learning. Further examination of the results showed that the beginning and end chunks of the repeated pattern were more frequently recalled. This may be indicative of a serial list position effect, i.e., that it is easier to recall the first and last items on a list (Darley & Glass, 1975). A similar effect has been noted with lists of movements (Wilberg, 1990).

The second condition of the PDP task was the exclusion condition. Unfortunately, results were inadmissible, as all but four individuals produced a pattern that was artificial (e.g., selecting balls in a clockwise direction until the task was completed). Also, one participant failed to follow directions and touched balls twice in a row. Of the three participants analyzed, only one reproduced sets above chance level. This suggests that this participant learned the pattern implicitly and was unable to avoid producing it in the exclusion condition; this same participant also replicated the most sets of threes from the repeated pattern in the inclusion condition.

Sequence recognition task. A one-way ANOVA, with response as the dependent variable and sequence as the factor, was done to determine whether or not participants were able to consistently identify the old and new sequences. Results indicated no significant number of correctly identified sequences (correct identification = no response to new sequences and yes response to old sequences), F (1, 74) = 1.367, $p < .244$. This concludes that participants could not discriminate between the old and new sequences.

DISCUSSION

The results of the acquisition phase of the present study indicated learning of the repeated pattern during a gross motor task. Despite the gross motor nature of the task used in this study, the results replicated those of similar SRT studies that have utilized simple motor tasks. Both Howard and Howard's (1989; 1992) and Cherry and Stadler's (1995) results using the traditional key press task showed significantly faster reaction times for across blocks for the repeated pattern. It is therefore plausible that implicit learning during a gross motor task occurs in much the same manner as in a simple motor task. Interestingly, the participants in this study appeared to be cautious in their performance, as they made few errors in both the random and repeated conditions. Such cautiousness was also noted by Howard & Howard (1997) in their elderly participants.

The results of the present study also demonstrated that learning of the repeated pattern was maintained after a 30-minute interval. These findings are similar to those produced by Cherry and Stadler (1995). Meulemans et al. (1998) also included a retention task that was completed one week following the acquisition phase and showed that the mean reaction times were similar in both sessions.

During the interview, many of the older participants verbalized a level of awareness of the pattern being present; however, none were able to report it. This is typical of traditional SRT

studies (Howard & Howard, 1989; 1992). Some level of explicit learning was also demonstrated during the PDP task. Eight out of eleven participants recalled an above-chance number of chunks from the repeated pattern during the inclusion condition, and two out of the three participants analyzed for the exclusion condition were successful in avoiding chunks from the repeated pattern. These findings are contrary to those of Howard and Howard (1989; 1992), where the older adults showed little pattern learning (below chance level) compared to the younger adults. Both older and younger adults reported noticing a pattern; however, the older adult performed more poorly than younger adults when it came to identifying the actual pattern or parts of it (Howard & Howard, 1989). Harrington and Haaland (1992) used a task where participants learned a pattern of different hand postures in response to lights being used as cues. Unlike previous pattern-detection studies, the elderly in their study demonstrated equivalent impairment in both implicit and explicit learning of the cognitive-motor sequence. The processing speed theory predicts that older subjects will be less likely to spontaneously notice and explicitly memorize the sequence. This hypothesis was considered by the study's authors, but was not found to be valid in explaining the results (Willingham, 1998).

As with the present study, not only did most participants in the hand posturing study report awareness of a pattern, but recall in the free recall test exceeded chance level, indicating explicit learning. However, unlike the Harrington and Haaland (1992) study, the older adults in the present study showed some evidence of implicit learning of the sequence (as noted in the recognition test and the exclusion condition of the PDP task). Perhaps the greater movement times necessitated by the reaching task used in the present study and the hand posturing task in the Harrington and Haaland (1992) study facilitated this awareness and improved pattern identification. It has been shown that responding in an SRT task results in sequence learning, while simply observing the sequence on screen does not (Howard, Mutter, & Howard, 1992; Kelly & Burton, 2001). Willingham (1999) showed that the sequence learning in Howard et al. (1992) was actually facilitated by explicit knowledge of the sequence. Once participants who had significant explicit knowledge were excluded from analysis, participants who merely observed the stimuli did not show implicit sequence knowledge. Interestingly, observation of a model performing the SRT task has been shown to result in sequence learning as much as physical practice (Heyes & Foster, 2002); the authors caution that observation may result in greater explicit learning. During their investigation of the response structure of an upper arm movement sequence, Park and Shea (2005) found that all participants demonstrated strong explicit knowledge of the repeated sequence.

Perhaps the reaching task's increased movement time facilitates an observational component that in turn may increase explicit awareness. It is also plausible that, unlike in Harrington and Haaland's (1992) experiment, implicit learning was maintained in the SRT reaching task because pattern learning focused on response location; whereas the hand posturing task required participants to learn different motor responses, which requires greater attention. The increased attentional demand of the hand-posturing task was put forth as a possible explanation for the poor sequence learning in their study (Harrington & Haaland, 1992).

Finally, similar to Meulemann et al. (1998), the results of the sequence recognition task in the present study indicated that participants were not able to differentiate between old and new sequences, despite the interview and PDP findings. When participants were asked to verbally demonstrate explicit learning of the pattern, they were unable to convey any consistent awareness of the pattern. Considering these findings, it may be that greater movement times increased awareness of the presence of a pattern, but not enough to identify it. It is plausible that the greater movement time compensates for the slower processing speed. Further research is necessary to determine if tasks with different movement times influence the gain in explicit knowledge. Perhaps tasks with greater movement times facilitate awareness. This may be an important aspect to consider in rehabilitation for teaching various motor abilities and daily tasks.

CONCLUSION

These study results show that older adults can learn a repeated pattern during a gross motor SRT task. Whether the learning during a gross motor SRT task in the older adults compares to learning in young adults and children, as it has been shown in simple tasks, remains to be seen. The participants in this study did not appear to be cognizant of the repeated pattern per se; however, they did demonstrate a greater awareness of the presence of a pattern than in previous studies using the more simple key press task. Whether movement time required for a task influences whether learning remains implicit or becomes explicit needs to be explored. This will have implications not only on the understanding of the learning of novel motor tasks in the elderly, but on what instructional methods best facilitate each type of learning.

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Presence: Head Mounted Display vs. Translucid Screen

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Abstract: *Among others, two displays are used when exposure to virtual worlds is required: Head Mounted Displays (HMD) and Translucid Screens (TS). The higher sense of immersion brought about by these two devices gives them an advantage over traditional media displays. In fact, both HMD and TS enable a superior sense of presence in virtual worlds. However, the difference in the degree of presence between them is not well documented. This article presents and discusses a study that measured presence using a HMD and a TS. Sixty-nine subjects were exposed to two different neutral virtual worlds (20 minutes each world), one using a HMD and other a TS. Presence was assessed through Slater-Usoh-Steed questionnaire (1994). Significant differences (α=.05) were found between HMD and TS. In fact, results from Paired Samples T-Test (t(68)=-5.49, p=.00) revealed that presence with the HMD (X=3.23; s=.61) was significant higher than the one with the TS (X=3.01; s=.51). Cybersickness was found on 21.7% of the HMD subjects and on 27.5% of the TS subjects. In both conditions, presence was significantly inferior on subjects with cybersickness.*

INTRODUCTION

According to Schuemie and Van der Mast (1999), during any virtual reality (VR) experience subjects often have the sense of being within the computer-generated environment. This sense of "being there" is defined as presence. Ditton (1997) refers to presence as the ability to interact with a VR environment as if he or she were in a real environment. Sheridan (1992) proposed three categories for presence: (a) quantity of sensorial information displayed to the subject; (b) subject control level over the VR environment; and (c) subject capacity to alter the environment. On the other hand, Heeter (1992) divides presence into three types: (a) *Personal Presence* – how the subject experiences herself or himself as part of the VR environment; (b) *Social Presence* – existence of other beings in the VR environment; and (c) *Environmental Presence* – the ability of the VR environment to recognize the subject.

The nature and origin of presence is still unclear. Although it can be characterized, from the neurophysiologic perspective, as a process resulting from a synchrony between cognitive and perceptive systems (Heeter, 2003), the multitude of associated processes reduces the chances of brain mapping presence. More likely, presence is a dynamic set of reactions that take place between several brain structures rather than a localized and individual process. Witmer and Singer (1998) stated that presence is all about attention processes, involvement and immersion being the two most important concepts. Involvement may be defined as the psychological state concerning attention towards a set of relevant stimuli, whereas, immersion refers to the psychological state characterized by the perception of being included in or interacting with the VR environment (i.e. an experience of entering a multi-sensory representation of three-dimensional space; Witmer & Singer, 1998).

Whatever it may be, presence is an important variable to take into account when studies with VR take place, as it measures the environment's ability to pull the subject into the VR world. Higher levels of presence may indicate that the subject recognizes the VR environment as a real world experience. This can be crucial when VR is the best solution for replacing reality. Such is the case for VR worlds that are developed to mimic war scenarios. Subjects with war PTSD (Posttraumatic Stress Disorder) are exposed to virtual war situations (Gamito et al., 2005; Rothbaum et al., 1999; 2001) as a psychotherapy strategy to help them overcome their anxiety disorder. VR as a substitution for real experiences is also applied to the treatment of several phobia and panic disorders (Rothbaun et al., 1999; Riva et al., 2001; Em-

melkamp, et al., 2002; Botella et al., 2000; Blanchard et al., 1998; Wiederhold et al., 2002). These studies showed that high levels of presence enabled the development of fear as a response to the displayed anxiogenic stimuli, which is the basis of psychotherapy procedures. In fact, in psychotherapy it is required that the subject is exposed to his or her fears until he or she can manage them.

Some studies reported cybersickness on several subjects that were exposed to VR environments (LaViola, 2000; Lo & So, 2001; Hale & Stanney, 2006). Stanney et al. (2002) characterized cybersickness as a discrepancy between visual, vestibular and proprioceptive information. By moving the head during a VR simulation with a HMD, the sensation of movement that is produced by the subject's inner ear is some milliseconds desynchronized with the movement generated by the computer graphic board. This means that when subjects 'see' movement on the screen, the information from it was already sent to the brain by the inner ear. The subsequent incongruence may produce nausea, headaches, spatial disorientation, and vomiting. According to LaViola (2000), the cause of this discrepancy resides in the precision of tracking devices (in the case of HMDs), and on the reduced frame rate of screens. Gender and age also matter. Women are more susceptible to cybersickness because their perception of screen flickering is stronger than men's. On the other hand, Arns and Cerney (2005) pointed out that younger subjects (less than 30 years old) reported less cybersickness.

Typically VR may be experienced using one of following types of settings: (a) desktop personal computer (PC); (b) workbench; (c) CAVE, (d) HMD, and (e) screens. The PC, workbench, and CAVE are usually neglected in psychology studies, the first because the level of immersion and presence are not consistent with the desired ones, the final two because of the financial resources required to set them up. Consequently, HMDs and screens are currently used. The HMD, when associated to a tracking system, allows a 360-degree field of view and 3D stereoscopy, which are the factors considered to be responsible for its effectiveness in immersion. On the other hand, most HMDs are heavy, expensive, and when used for a long time, may cause retinal strain. Screens allow for use by more than one subject at a time and are not as intrusive as HMDs. Nevertheless, because the field of view is limited to the projection area and they lack a tracking system, screens usually produce less immersion.

Despite a number of studies, it is not yet clear which device, the HMD or the screen, provides the best sense of "being there." This paper presents and discusses a comparative study that assesses differences in presence between HMD and screen exposure.

METHODOLOGY

This study took place at the Psychology Computing Laboratory at University Lusofona de Humanidades e Tecnologias, Lisbon, Portugal. It involved 69 subjects that were assigned to two VR worlds. This sample, drawn from a university population, consisted of 31 males and 38 females, with an average age of 23.71 (s=4.6) years old.

Virtual world A was a beach scenario (Figure 1a) and virtual world B was a city environment (Figure 1b). Both VR worlds A and B were modified from two of Valve's Half Life 2 maps. On each world, subjects were to perform a simple task of finding a bird. To accomplish this, VR worlds needed to be exhaustively explored for approximately 20 minutes. Two subjects examined the same world simultaneously.

Two P4 3.4 GHz with NVIDIA 6600 GT graphic boards were connected on a local area network. While one subject was playing with a Cybermind HiRES 800 Head Mounted Display (HMD) with an intertrack InertiaCube (Figure 2a), the other was experiencing the world watching a 295cm x 225cm Translucid Screen (TS; Figure 2b). Headphones were plugged into both personal computers. After 20 minutes, subjects switched worlds and exposure devices. Following each world experience, subjects were asked to fill in the SUS presence questionnaire (SUS, 1994). This scale measures one single dimension of physical presence in an environment through six items.

Data was processed using SPSS 14. Two variables were created: SUS_MEAN_HMD (Head

Figure 1a. Beach scenario

Figure 1b. City scenario

Figure 2a. HMD

Figure 2b. Translucid screen

Mounted Display) and SUS_MEAN_TS (Translucid Screen). In order to assess the normality of these two variables Kolmogorov_Smirnov (K-S) was performed. Related Sample T Test tested the existence of significance between variables.

RESULTS AND DISCUSSION

The distribution of both variables (SUS_MEAN_HMD and SUS_MEAN_TS) was normal. Kolmogorov_Smirnov (K-S) test did not find significant differences between test probability function and the probability function of each variable.

Related Sample T Test showed significant differences between SUS_MEAN_HMD and SUS_MEAN_TS (r = .000*), with SUS_MEAN_HMD (X = 3,2281; s = 0,61340) significantly higher than SUS_MEAN_TS (X = 3,0139; s = 0,51350), pointing towards a higher presence when using HMD than when using TS (Table 1). HMD 360º point of view is most likely responsible for this difference, since it enables higher interaction with the environment. Higher interaction is conducive to higher presence (Held & Durlach, 1992; Sheridan, 1992; Steuer, 1992).

Nevertheless, both variables showed low average values. In fact, SUS questionnaire responses were always less than 5, on a 1 to 7 Likert scale. This means that both devices did not bestow subjects with a sense of being in the VR environment. Several reasons may have contributed to this outcome. Despite the fact that hardware and software used in this study were state of the art, both VR worlds (beach and city environments) may not have captured subjects' full attention. Contrary to studies that assessed presence on phobic subjects (Krijn et

Table 1. Related Sample T Test for SUS_MEAN_TS and SUS_MEAN_HMD

		Mean	Std. Deviation	t
Pair	SUS_MEAN_TS	3,0139	,51350	-5,493*
	SUS_MEAN_HMD	3,2281	,61340	

(*$r < ,05$)

al., 2004; Hoffman et al., 2003) where phobic cues (spider, elevator, and heights, for example) are themselves partially responsible for the subject being drawn into the VR world, in this experience, besides the VR environment, task goal, and interaction with the other player were the only events that would catch subjects' attention.

On the other hand, the SUS questionnaire (1994) assesses presence through a comparison between the virtual and real world. Basically, through six questions, subjects are asked if their experience in VR worlds is similar to reality. This means that only subjects who established a parallelism between the specific VR perceived world and the real world may be able to positively answer the questionnaire. This probably indicates that for subjects that find no correspondence between the VR world and any real world that they know, presence would be reduced. Usoh et al. (2000) found a similar trend in a study that assessed presence through the SUS questionnaire (1994) on non-phobic subjects.

Cybersickness may have also contributed to these results. In fact, cybersickness was present in 21,7 % of the HMD condition and in 27.5 % of the TS condition. The incidence of cybersickness is in accordance with DiZio and Lackner (1997) and Wilson et al. (1995; 1997). These studies revealed that 5% to 30% of subjects experienced symptoms of cybersickness. Nevertheless, it was expected that cybersickness on the HMD condition would be higher than the TS condition, which did not occur. Probably, this comes from the fact that subjects in the TS condition did not move their head along with VR world movements, creating a sensory conflict. In the HMD condition, subjects had to move their heads as scenes were coming, reducing conflicts between vestibular and visual systems. On both HMD and TS conditions subjects with cybersickness reported significantly less presence (Table 2) than other subjects.

The sample was divided into two groups according to age P50 (P50 = 23). Significant differences (Table 3) were found between older and younger groups in relation to presence in the TS condition. The younger group manifested higher presence than the older subjects. No significant differences were found between genders.

FINAL CONSIDERATIONS

This paper presents and discusses a comparative study on presence. Sixty-nine subjects were immersed in two virtual reality environments using a HMD and a TS. One VR world was a beach scenario and the other a city set up. On both worlds subjects were to perform a simple task of finding a bird. The SUS questionnaire (1994) reported lower presence independently of the VR world or exposure device. However, significant differences were found between HMD condition and TS condition, the latter being inferior to the former. Cybersick-

Table 2. Independent Sample T Test for SUS_MEAN_TS and SUS_MEAN_HMD

	Cybersickness	Mean	Std. Deviation	t
SUS_MEAN_TS	YES	2,9642	,50352	-,28576*
	NO	3,2500	,51553	
SUS_MEAN_HMD	YES	3,1865	,60237	-,23892*
	NO	3,4254	,65370	

*$r < ,05$

Table 3. Related Sample T Test for SUS_MEAN_TS and SUS_MEAN_HMD

	Age	Mean	Std. Deviation	t
SUS_MEAN_TS	<23	3,0648	,51446	2,184*
	>23	2,6746	,37476	
SUS_MEAN_HMD	<23	3,2640	,64081	1,263
	>23	2,9883	,30889	

*$r < ,05$

ness was present in 21.7% of the HMD condition and in 27.5 % of the TS condition.

The questionnaire used to assess presence, cybersickness, and difficulty capturing subjects' attention were probably responsible for low values of presence. Nevertheless, the HMD condition revealed higher presence than the TS condition. In further research a more comprehensive and complete questionnaire of presence, like the ITC – SOPI (Lessiter et al., 2001), should be used.

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Evaluation of Group Performance in a Mediated Environment

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Abstract: *Wearable biosensors allow for the non-invasive collection of a range of biometric data. A better understanding of the physiologic corollaries of emotional and behavioral response patterns is promoting keen insight into the way the mind and body work in synchrony. Empirical research has already established significant findings related to psychophysiologic characteristics and individual performance. Similarly, groups may express unique biologic patterns or, a collective flow that is indicative of optimal group performance. Groups continuously modify based on the perpetual sharing and streaming of mutually relevant information. A group's idea formation, leadership, affect, cohesion, flow, motivation, efficacy and problem solving change in an ongoing system of reciprocity. This project establishes research into how group biometrics capture dynamic group processes, and identify psychophysiologic patterns associated with group performance. We hypothesize that there are patterns of group physiological change that can be detected through biometric data analysis; further, that these group rhythms reflect a dynamic interchange associated with group performance and group dynamics including cohesion, flow, and group efficacy. Using a nested mixed-model design, this study aims to evaluate group performance in a collaborative gaming environment within groups with variant performance levels. Thirty-three experienced computer game players were randomly assigned into 11 groups of three. Each team engaged in four one-hour sessions of collaborative, multi-player computer video game play (CounterStrike). Participants wore non-invasive sensors during game play, which allowed for the continuous collection of low-level physiological data. Follow-up questionnaires assessed individuals' perceptions of several characteristics associated with group dynamics. This article will provide descriptions of initial project outcomes and discuss implications of anticipated results related to leadership orientation, situational motivation, group efficacy, perceived cohesion, self-efficacy, and flow. Long-term plans include the application of findings to develop new strategies and intervention tools for better communications, dynamic interrelatedness, empathic performance, and transformative learning.*

INTRODUCTION

Group performance is an emerging area of interest for biosensor research (Pancerella et al., 2003). Sensors are an enabling technology that offer portability, innovation, and wireless connectivity, affording new potential for biometric data collection with groups. Improving team performance and group dynamics is especially important for those working in high consequence, stressful, and time critical situations (Doser et al., 2003). Personality variables, physiologic parameters, focus of attention, and interpersonal factors are key data elements that new technologies may help to elucidate, enhancing group performance. High stress or high consequence teams (e.g., disaster response teams; surgical teams; military special-op maneuvers) demand efficient and accurate performance. It has been suggested that systemic analysis of the physiological and psychological group parameters may provide significant insights into a group's effectiveness (Doser et al., 2003). The utilization of biometrics to define essential patterns of group interactivity may allow teams to develop specific behavioral and communication strategies that yield optimal group performance.

Effective group performance is the result of interdependent dynamics including cohesion, group size, potency (or efficacy), composition, leadership, motivation, and goal setting (Yancey, 1998). A variety of individual and task traits have been associated with optimal performance including efficacy, motivation, anxiety, confidence, leadership, risk-taking, determination, and task structure, involvement and importance. To date, only *individual* physical and personality traits have been ex-

plored as characteristics that enable more successful performance.

Groups are dynamic. Idea formation, leadership, affect, cohesion, flow, motivation, efficacy and problem solving continuously change in a mutually aggregate pattern (Grammer, Fink, & Renninger, 2002). Interactions modify based on continuous sharing and mutual streaming of relevant information. For example, the development of rapport has been attributed to the synchronization of body movements (Grammer, Kruck, & Magnusson, 1998). The importance of synchronization and vicariousness of emotion to interpersonal and group performance has been further noted in research on empathy (Preston & Wall, 2000); for example, Couvade's Syndrome (Klein, 1991), physiological synchronization in musical dialogue (Neugebauer & Aldridge, 1998), and dynamic interaction in learning between cognition, physical expression and environmental events (Winn, 2003). Aggregate movements have also been described as a critical element in theoretical descriptions of crowd behavior, mob dynamics, and dynamic changes related to group behavior (Badler, Allbeck, & Bindiganavale, 2001).

The dynamic nature of group performance suggests that teams may express unique patterns or a collective biologic rhythm (Harrison, 2004). Data collected with sensors can improve our understanding of emotion and behavioral response patterns (Badler et al., 2001; Doser et al., 2003; Picard, 2001). A number of studies have explored associations between specific physiologic parameters and individual performance. Research into optimal group performance has traditionally analyzed individual biometric data and then extrapolated this information to describe the implications for group performance. No research to date has explored the hypothesis that groups have a biologic rhythm that is reflected in patterns of physiological change and expressed collectively. Group performance is a complex interplay of individual, team and task characteristics, informed by the continuous exchange of new information (Becker, Predinger, Ishizuka & Wachsmuth, 2005). By probing the relationship between the physiological, emotional and behavioral aspects of group performance, this study seeks to establish evidence of a physiologic group expression; and, to obtain new insights into group performance.

Research has demonstrated strong physiologic connections between emotional expression and physiological arousal (i.e., skin conductance, temperature, respiration, blood flow) (Nasoz, Alvarez, Lisetti, & Finkelstein, 2003; Picard, 2001; Rani, Sarkar, Smith, & Adams, 2003). Biosensor research has traditionally analyzed *individual* biometric data and then extrapolated this information to describe the impact on group performance. For example, individual performance profiles and performance predictors have been described for athletic teams (Perkins & Pivarnik, 2003); workload monitoring and adaptive aiding for operator functioning (Perkins & Pivarnik, 2003; Wilson, Lambert, & Russell, 2000). Research suggests that team decision-making can improve when individual team member performance parameters are communicated as input for the decision-making process (Pancerella et al., 2003). There is no previous research that seeks to detect the psychophysiologic rhythm of groups and their dynamic processes. The current research aims to identify patterns of psychophysiologic responses associated with group performance and to detect physiological patterns that correlate directly with group cohesion, efficacy and flow.

This study is being conducted in two phases. During Phase 1 of the study, individual participants were randomly divided into 11 groups of three. All participants completed a battery of baseline questionnaires (described in detail in the Measures section). Data collected via wearable sensors and through self-report will be analyzed in Phase 2 to identify group physiologic patterns that correlate with performance and group dynamics.

METHOD

Participants

Human subjects approvals were obtained by the University of Hawai`i's Institutional Review Board and the U.S. Army and Materiel Command's HSSRB. Recruitment was conducted primarily at the university campus between October 2005 and February 2006 using flyers, handbills, public service announcements, e-mail and classroom presentations. A total of 38 veteran gamers were recruited for the study. Informed consent was acquired during initial participant sessions and a series of questionnaires were then administered.

Participants were also fitted for cardiopulmonary and armband sensors, and were trained to use each device. In addition, a packet of take-home materials was provided, containing a letter of introduction, a copy of the informed consent document, and a website resource with reference and contact information. Two individuals could not meet the scheduling requirements, and three were disqualified for poor attendance, leaving a total of 33 participants who completed all four study sessions. Participants were divided into 11 teams (three players each) based on their scheduled availability and were randomly assigned to one of three computer stations (A, B, or C). To ensure confidentiality, participants were assigned an identification number, and were addressed only by ID, computer station number, or player profile name.

Measures

Self-report questionnaires

Subjective data were gathered from the following self-report questionnaires. The Situational Motivation Scale and the Task-People Leadership scale were administered at baseline and again after the fourth session; all others were administered immediately following each of the four gaming sessions.

Situational Motivation Scale (SIMS): The SIMS (Guay, Vallerand, & Blanchard, 2000) is a 16-item self-report inventory, designed to measure intrinsic motivation (four items), identified regulation (four items), external regulation (four items), and amotivation (four items). SIMS does not measure the introjected and integrated facets of extrinsic motivation. Each item is rated on a 7-point Likert scale.

Task-People Leadership Questionnaire (TPLQ): The TPLQ (Pfeiffer & Jones, 1974) is a 35-item questionnaire designed to identify two dimensions of leadership: task orientation and people orientation. These are not opposite approaches, and individuals can rate high or low on either or both. Some leaders deal with people needs, leaving task details to subordinates. Other leaders focus on specific details with the expectation that subordinates will carry out orders. Depending on the situation, both approaches may be effective. The important issue is the ability to identify relevant dimensions of the situation and behave accordingly.

Group Efficacy: This four-item questionnaire was adapted from Hackman's (1987) Flight Crew Survey. The measure addresses dependent variables associated with the group members' collective estimate of the group's ability to perform a specific task. Responses were made on a 4-point Likert Scale. Individual responses to the items were aggregated so that "group" remains the unit of analysis for all dependent measures. This method has been validated.

Performance Self-Efficacy: This scale is an adaptation of the generalized self-efficacy scale developed by Schwarzer & Jerusalem (1995). The scale was created to assess a general sense of optimistic self-belief that one can perform a specific task or cope with adversity in various situations. The scale is designed for the general adult population and consists of 10 questions. Responses are made on a 4-point Likert scale and summed to yield a final composite score.

Perceived Cohesion Scale: Bollen & Hoyle (1990) created this 6-item measure to reflect two underlying dimensions of cohesion: 1) sense of belonging, and 2) feelings of morale. Responses are recorded on a 5-point Likert scale. The version used in this study represented Bollen & Hoyle's (1990) suggested changes for small-group use.

Flow State Scale (FSS): The 36-item FSS (Jackson & Marsh, 1996) is a Likert scale that represents the nine dimensions of flow described by Csikszentmihaly (1988): 1) challenge-skill balance; 2) action-awareness merging; 3) clear goals; 4) unambiguous feedback; 5) concentration on task at hand; 6) sense of control; 7) loss of self consciousness; 8) transformation of time; and 9) autoletic experience.

Biosensor and Computer Equipment*BodyMedia SenseWear® Pro$_2$ armband:* The following data channels were collected from the armband sensor: *heat flux*—the rate of heat exchanged between the wearer's arm and the outside environment; *skin temperature*—temperature of the skin under the armband; reflective of the body's core temperature, although it is several degrees cooler; *ambient temperature*—the air temperature immediately around the arm; *galvanic skin conductance*—the ability of the skin to conduct

electricity; *movement*—longitudinal and transverse accelerometers track forward and lateral movement. (The armband sensor is a wireless system avoiding the distractions and problems associated with tethered sensors.) , Galvanic skin conductance has been found to correlate positively with novel stimuli, intensity, and/or emotional content, and may also show increased levels during stress (Andreassi, 2000; Fichera & Andreassi, 1998), and electromyography (EMG), a measure of muscle activity, has been shown to correlate with negatively valenced emotions (Becker, Predinger, Ishizuka, & Wachsmuth, 2005). Moreover, there is strong evidence for the physiologic connections between emotional expression and physiological arousal (Nasoz, Alvarez, Lisetti, & Finkelstein, 2003; Picard, 2001).

VivoMetrics LifeShirt® ambulatory monitoring system: The LifeShirt system measures respiratory function using sensors integrated in the shirt and also heart rate and activity level with an ECG. The LifeShirt attaches to a PDA that records and stores participants' data on removable data cards.

3 x video game stations: Each participant was seated at his own gaming station, which included a 17-inch Samsung SyncMaster TFT-LCD computer monitor; a CounterStrike video game for Xbox; and an Xbox video game system with handheld controller.

Linksys 5-port hub was used for interconnectivity between the three systems, so that players could compete as a three-man unit against the computer.

PROCEDURE

All teams were scheduled for four one-hour game playing sessions of CounterStrike on the Xbox game console. Sessions 2, 3, and 4 were required to occur between 48 hours and two weeks from a previous game play session. During the first session, a 30-minute trial period was allowed so participants could familiarize themselves with the computer game and one another. Teams were given no specific guidance for play or interaction, except were asked to "do their best" as a team and told that the best performing team at the end of the study would receive a year's subscription to Xbox Live. There were two 30-minute periods of gameplay for each (1 hour) session. Standardized play specifications were set at the beginning of each 30-minute match (i.e., game length, skill level, number of terrorists, starting money, weapons buy time, etc.).

Each actual game was a maximum of 5 minutes long. All participants were given 1-minute warnings when their 30-minute period was coming to an end. There were no long games (these were 5 minute games – you either kill the terrorists/ save the hostages in that time period or the terrorists win). Game play grew increasingly difficult as the four sessions advanced. Participants were required to press an "event button" on the armband at the completion of each game, and inserted an "event" (using a stylus and the Vivo Metrics) on the LifeShirt data between the two matches. These annotations on the raw data were used to synchronize the flow of each game cycle among team members. In conjunction with the timestamps placed on the armband sensor data, these annotations allow us to recognize when game sessions started and ended. Team scores, as well as individual wins and deaths, were recorded at the end of each match. Participants were given a $20 gift certificate for their participation in the study.

Immediately following each game-play session, biometric raw data was downloaded from the data cards from all devices into software specific to the manufacturer (InnerView *v.*4.1.904 by BodyMedia; Vivologic *v.*2.9 by VivoMetrics). For purposes of data analysis, all data were made anonymous by removing any personal identifiers (e.g., name, address, phone number, etc.) from the self-report and biometric data.

Data Analysis Plan

Planned data analysis during Phase 2 will include the analysis of physiological (sensor) and self-report data collected from individuals (and aggregated data for each group) to detect correlations between group performance and variance in the physiological data. Associations between individual and group performance characteristics, physiological response patterns and psychological data have been conducted, and reported in the following section.

Table 1. Correlations between variables collected by SenseWear armband (*n*=11,346).

NEW	ST	MAD	GSR	EE
Heat flux	.36**	.34**	.09**	.17**
Skin temp. (ST)		.25**	.12**	-.06**
MAD			.00	.52**
GSR				.03**

Notes. Heat flux = heat flux average original rate. Skin temp. = skin temperature average original rate. MAD = longitudinal accelerometer (mean absolute difference). GSR = galvanic skin response. EE = energy expenditure per minute. ***p* <.01.

Table 2. Correlations between variables collected by VivoMetrics LifeShirt (*n*=215,087)*.

	ViVol	RR	Ti
Heart Rate	.129	-.439	.011
Inspiratory Tidal Volume (ViVol)		-.045	.206
Respiratory Rate (RR)			-.009

Note. Heart rate = beats per minute. ViVol = inspiratory volume; litres of air inhaled with each normal breath. RR = respiratory rate; number of breaths per minute. Ti = tidal volume; litres of air inhaled and exhaled with each normal breath.

RESULTS

Descriptives

Descriptive statistics were tabulated for the sample (*n*=33). Participants were male, mostly college educated (mean years of education=15.2, *SD*=2.5); never married (84.9%), in excellent or very good health (72.7%), and had a mean age of 25.9 (*SD*=7.1). Most participants identified their ethnicity as White (75.8%), Native Hawai`ian (12.1%), or Asian (6%), with 39.4% reporting two or more ethnicities, and 24.2% with Hispanic origin. One-way ANOVAs (for continuous variables) and crosstabs (for discrete variables) found no significant differences on any demographics variable (*p* >.05), indicating that team composition was relatively equal. Further, one-way ANOVAs indicated no significant mean differences at baseline between any of the teams on the self-report constructs (*p* >.05), nor were there significant differences between the 11 groups on performance scores for the initial warm-up session, suggesting that the skill level of each team was well balanced (*p* >.05).

Correlational Findings

Bivariate correlations were calculated for all subjective measures and physiologic data at each of the four one-hour sessions. Subjective measures included sumative scores for group efficacy, performance self-efficacy, flow, perceived cohesion, leadership, situational motivation, and the respective subscales of each construct. Significant correlations were found between performance self-efficacy and group efficacy (r =.43, p <.05), flow (r =.68, p <.01), and perceived cohesion (r =.66, p <.01). Perceived cohension was also signficantly correlated with flow (r =.59, p <.01). Physiologic data channels included skin temperature, energy expenditure, galvanic skin response, heat flux, longitundinal accelerometer (mean absolute difference), heart rate, tidal volume, respiratory rate, and inspiratory time. Partial physiologic correlations are provided in Tables 1 and 2.

Team Differences Across Time

Aggregate relationships among variables for the entire sample were analyzed to determine the overall association among variables for all participants across the four sessions. An examination of the resultant correlations can identify any

variables that are collinear, as well as those have good concurrent and discriminant validity. Further, specific mean differences between the three-member teams were tested to ensure that there were no significant differences among teams at baseline for any dependent variables. Finally, all dependent variables are being plotted by subject by team across time to identify any immediately observable patterns associated with each team's rank performance.

ANOVAs determined that group efficacy scores were significantly different between teams at sessions 3 and 4 ($F_{T3}(10,22)=2.55$, $p < .05$, $\eta^2=.54$; $F_{T4}(10,22)=2.87$, $p < .05$, $\eta^2=.57$); although paired comparisons indicated that no statistically significant differences were detectable. In addition, performance self-efficacy scores between teams were significantly different at sessions 2 and 4 ($F_{T2}(10,22)=3.75$, $p < .01$, $\eta^2=.63$; $F_{T4}(10,22)=3.26$, $p = .01$, $\eta^2=.59$). These constructs (i.e., group efficacy, performance self-efficacy) will be further examined using paired comparisons to determine which teams' mean scores were signficantly higher and if these differences are consistent with team performance.

Individual Team Trends Across Time

A repeated measures analysis of variance was used to examine indvidual team trends over the four time points. Each of the major constructs (but not their respective subscales) was examined for significant mean differences. A team *x* time interaction was found for performance self-efficacy ($F(1,10)=2.32$, $p < .05$, Wilk's $\lambda=.16$). No interactions were detected for any other repeated measures. While there may be clear associations of psychological variables among team members, detecting patterns of both psychological and physiologic data associated with team performance is challenging. The volume of data alone prevents observable patterns from being easily detected, and it is conceivable that there is more than one way to predict optimal performance. The data analyses that are currently underway include investigation into potential relationships between group performance and the variance in the physiological data. Analyses will also yield predictor variables to identify the most salient variables that contribute to optimal group performance. The group physiologic patterns that are identified will provide insights into the physiological, emotional and behavioral aspects of group performance. Our task is to identify a parsimonious set of predictors that can accurately predict team performance under a given set of circumstances.

DISCUSSION

Descriptive statistics provide confidence that the teams in the current research are homogeneous in terms of team composition and self-report constructs, and that teams are well balanced for skill level. Substantive data analyses for this project are not yet complete, but initial correlational data is promising. Analyses completed so far point to a steady deepening of group cohesiveness as the number of game play sessions increases. Cartwright (1968) stated that members of a highly cohesive group are strongly motivated to contribute to the group's welfare, to advance its objectives and to participate in its activities. Further, cohesiveness contributes to a group's efficacy. Cohesive groups with relatively high performance goals are more productive than non-cohesive groups (Zaccaro & Lowe, 1988). Research has established strong links between group efficacy and group performance (Pescosolido, 2001). Therefore, group cohesiveness and group performance may be important variables for understanding the way that a group biometric is expressed.

Further, as team members have more opportunities to play together, they report higher levels of group flow. In a flow state individuals occupy a mental zone where their attention is intently focused on an activity that is challenging yet enjoyable. Flow is reached as more skills are gained. The gamers know what needs to be done, and they experience a sense of serenity, neither anxious nor bored. Flow occurs when the demands of a task match, but do not surpass, the skill available to complete that task (Csikszentmihalyi, 1990; Gee, 2003). Research suggests there are physiologic corollaries to the flow experience. PET scans and other neurophsiological measures have demonstrated that heightened levels of the neuro-modulator dopamine are present during video game playing, extreme sports, and gambling. This increase in dopamine represents the distinguishing morphological change during such flow pro-

ducing behaviors (Marr, 2000). Therefore, group cohesiveness and group performance may be important variables for understanding the way that a group biometric is expressed.

This study's initial findings related to cohesion and flow will provide a strong base for further analyzing the team's physiologic data. The data will be analyzed to determine whether physiologic patterns can be identified that correlate to a group rhythm, group performance and/or other variables associated with the way the groups interact.

The long-range goal of the research, regardless of specific outcomes, is to develop an area of research regarding physiologic expression of interpersonal and group events. Planning is now underway (and will be modified according to the outcomes of this study) for a follow-up study that will explore the role of empathy in group performance, as identified through biometrics and self-report data. Better teamwork and greater job satisfaction have followed empathy training provided to adults (Herbek & Yammarino, 1990). The follow-up research will expand on the current project in three ways: Single- and mixed-gender teams; inclusion of attention control groups; and, randomized design.

The idea of synchronization and vicariousness of emotion has recently been discussed in empathy research (Preston & Wall, 2000). The notion that empathy between two people is related to a state of shared physiology suggests a parallelism between psychological and physiological domains (Levenson & Ruef, 1992). Studies that measure heart rate, EMG, brain activity, and development support the idea that understanding the emotion of others entails experiencing the emotion observed (Preston & Wall, 2002).

Group communication is dynamic interaction that involves engagement, reciprocal affective problem solving, affectively mediated creation of ideas and affectively mediated thinking – with all elements continuously changing with respect to one another by forming a mutual aggregate pattern. Synchronization of body movements is a fundamental part of this process (Grammer, Fink, & Renninger, 2002). Evidence suggests that physiological processes change related to the modality of the relationship and communication. One study found a pattern of coordinated heart rate sequences associated with musical styles (Neugebauer, & Aldridge, 1998). Other research notes that friend dyads in toddlers have greater concordance in baseline heart rate and cortisol measures (Preston & Wall, 2002). Finally, neuroscientific empathy experiments indicate that the same affective brain circuits are automatically activated when we feel pain and when we observe others who are feeling pain (Singer & Fehr, 2005).

Empathy is the ability to imagine oneself in another person's situation. Empathy can therefore be elicited by role playing or simulations. The "sweet spot" for games and simulations lies in their unique ability to afford learners an opportunity to authentically experience something that is impractical, impossible or dangerous. Simulations provide flexible environments that allow for infinite possibilities and points of view. They also allow learning by doing and discovery through failure. Thus, simulations have the capacity to facilitate transformative learning (Galarneau, 2005). Transformative learning involves reflectively transforming beliefs, attitudes, opinions, and emotional reactions that constitute one's meaning (Mezirow, 1991). In a virtual environment, the user learns by moving through a scene and sampling available viewpoints (Bolter & Grusin, 1999). What can emerge from learning in simulated environments is immersive engagement that allows learners to try on new identities and construct new perspectives and world views. The development of empathic intelligence can be transformative (Arnold, 2003). We will explore the impact of allowing a person to actually see things differently, in a simulated environment, on patterns in group synergy and team performance.

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Changes in P300 Amplitude in Smokers in Response to Cigarette-Craving Cues

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INTRODUCTION

Generally, craving refers to the urge to experience the effect of a previously experienced psychoactive substance (UNDCP/WHO, 1992), and it can be regarded as an important mediator of continued substance use and relapse after abstinence (Anton et al., 1996; Kosten, 1992). Many studies have investigated the effects of nicotine craving and activity and have reported that smoking cues, such as a person holding, lighting, or smoking cigarettes, produce smoking cue-reactivity (Rickard-Figueroa & Zeichner, 1985; Niaura et al., 1992). In a study of smokers' reactions to presentation of smoking cues, blood pressure increased significantly, and heart rate reactions, although not significant, paralleled blood pressure response. However, these autonomic responses are often discordant. Physiological responses were somewhat different for self-reported craving (Niaura et al., 1992), and urge ratings showed a different pattern of response in the cardiovascular response. Drobes and Tiffany (1997) reported that there was no relationship between verbal and physiological urge indices. Alternative measures have been sought. Warren and McDonough (1999) indicate that event-related potentials (ERPs) may be useful as a tool for assessing smoking cue-reactivity, because smoking-related stimuli elicit enhanced ERP responses in smokers, paralleling the reactivity previously demonstrated in autonomic responses. Begleiter et al. (1983) reported the P300 of stimulus categories to vary as a direct function of the incentive. Warren and McDonough (1999) suggested that P300 amplitude increase is caused by the incentive response to greater value stimuli, and Johnston and coworkers reported that emotionally positive and negative stimuli evoked greater P300 amplitudes than neutral stimuli (Johnston et al., 1986, 1987; Naumann et al., 1992). The aim of this experiment was to investigate the change of P300 amplitude in response to each stimulus type. Our hypotheses were that P300 amplitude to craving stimuli for smokers would be increased compared with the response shown by nonsmokers, and the amplitudes to craving and aversive stimuli would be enhanced compared with neutral stimuli in smokers.

METHOD

Twenty men (10 smokers & 10 nonsmokers) were recruited to participate in an ERP session of approximately five minutes' duration. Nonsmokers were those who reported never having smoked (*M*=27.3years, *SD*=4.5), and smokers were those who had smoked more than two cigarettes per day (*M*=13.7cigarettes/day, *SD*=5.1), (*M*=30.6years, *SD*=7.5). The groups were balanced for educational level. Participants were informed that the study involved an experiment on ERPs, and took part voluntarily. Our task stimuli consisted of 10 pictorial stimuli for craving, 10 neutral pictorial stimuli, and 10 aversive pictorial stimuli. The craving stimuli were photographs of a cigarette with a lighter, a burning cigarette, a person holding a cigarette, and people smoking cigarettes. The neutral stimuli were photographs of everyday life, such as a baby riding a rocking horse, children in a classroom, a church, a crowded subway, and an empty subway. The aversive stimuli were posters about antismoking activity, such as a pregnant woman or a skeleton smoking a cigarette. Every stimulus was presented in the center of a 17" color monitor. The symbol '+' was first displayed on the screen for 3 s. One of the 30 task stimuli (21 ´ 16 cm2) was then randomly selected and presented for 0.5 s, followed by a

blank screen for 1.5 s until the next task stimulus was presented. A total of 245 stimuli were presented, comprising five '+' stimuli, 120 task stimuli (40 each craving, neutral, and aversive) and 120 blank screens. The '+' stimulus was presented at intervals of 63 s. Participants were asked to provide their demographic data and answers to smoking-related question items prior to the testing session. A Laxtha EEG-monitoring device in the EEG recording room acquired EEG data. EEG recordings were made using silver–silver chloride cup electrodes, on F3 and F4 (frontal), and on C3 and C4 (central) scalp regions. The EEG-monitoring device settings were as follows: 256 Hz sampling rate, 16-bit resolution, 1 Hz high-pass filter, 70 Hz low-pass filter, and 60 Hz notch filter. A three-factor (two groups [smokers vs. nonsmokers] ´ three stimuli [craving vs. aversive vs. neutral] ´ four coronal electrodes [F3 vs. F4 vs. C3 vs. C4]) repeated measures ANOVA was applied to the P300 data.

RESULTS

No significant group effects were found in the demographic data. Figure 1 illustrates the grand average waveforms for smokers and nonsmokers. The P300 amplitude for smokers was slightly smaller than for nonsmokers, but the group effect was not significant ($F(1,18)=1.85$). No significant interactions between group and stimulus were observed. The P300 amplitude to neutral stimuli was larger than that to craving stimuli and aversive stimuli ($F(2,36)=3.75$, $p<0.05$), but stimulus did not interact with coronal electrode ($F(6,108)=1.40$). The P300 amplitude was significantly larger at C3 than at F3 and C4 ($F(3,54)=4.06$, $p<0.05$). No interactions involving electrode and group were observed ($F(3,54)=1.40$). Group and stimulus did not interact with electrode ($F(6,108)=1.15$). The effect of stimuli for smokers was not significant ($F(2,18)=1.58$), but the P300 amplitudes for nonsmokers to neutral and aversive stimuli were larger than those to craving stimuli ($F(2,18)=3.62$, $p<0.05$). A marginal group effect for aversive stimuli was found ($F(1,36)=3.81$). The P300 topographies for craving and aversive stimuli differed between smokers and nonsmokers, but those for the neutral stimuli did not. The P300 amplitude was significantly larger at C3 than at F3 and C4 ($F(3,54)=4.06$, $p<0.05$). No interactions between group and electrode channel were observed. The largest P300 electrode sites for smokers for craving and aversive stimuli were similar (F4), but the sites for nonsmokers were different (F3, F4).

DISCUSSION

The present study investigated changes in P300 amplitude in response to craving, aversive, and neutral stimuli in smokers and nonsmokers, but no group effects were found. The results may have been affected by smoking deprivation. P300 amplitude generally increases, and latency decreases, immediately after smoking (Houlihan et al., 1996; Knott et al., 1995), and the amount smoked, or the nicotine level, can affect P300 measures (Kodama et al., 1996; Lindgren et al., 1999). Haarer and Polich (2000) used a visual task to compare normal young adults who smoked daily with individuals who smoked infrequently, and found smaller P300 target amplitude for the regular, compared to occasional, smokers before and after tobacco smoking. In the present study, the P300 amplitude for smokers may have been affected by unconditioned deprivation time. However, the P300 amplitude for smokers was about 3 mV smaller than for nonsmokers, and this result is consistent with previous findings that current smokers produce P300 amplitude about 5 mV smaller than those who have never smoked (Anokhin et al, 2000). The main effect of stimulus was significant. The P300 amplitude in response to neutral stimuli was larger than that to craving stimuli and aversive stimuli, but no significant difference was observed between responses to craving and aversive stimuli. These results are important because many researchers have reported that P300 amplitude is affected by target stimulus categories (Begleiter et al., 1983; Hansenfratz et al., 1989; Johnston et al., 1987; Naumann et al., 1992; Warren & McDonough, 1999). The neutral stimuli produced significantly higher P300 amplitudes than the craving and aversive stimuli. When the participants were made aware of the rationale of the experiment, the same trend was observed (Carretie L, Iglesias J, Garcia M, Ballesteros, 1996; Carretie et al., 1997). The results did not support our hypothesis that the P300 amplitude in smokers for craving and aversive stimuli may be larger than for neutral stimuli, and there was

no statistical difference between responses to cigarette craving and aversive stimuli on P300 amplitude. In the topographies, the P300 enhancements in smokers in response to craving and aversive stimuli were in the right hemisphere, but in nonsmokers they were in the left hemisphere. Several researchers have defended the idea of hemispheric asymmetry during emotional expression. More research is required to demonstrate such functional differences between the hemispheres. The right hemisphere is thought to be linked to generation of the autonomic components of affective responses, whereas the left hemisphere is thought to play a more important role in functions of intentional control of the emotional expression (Gainotti et al., 1993). In addition, the right hemisphere is predominantly activated during negative emotional reactions and the left hemisphere during positive ones (Davidson, 1995). Smokers may automatically produce negative responses to cigarette craving and aversive stimuli in the right hemisphere. In conclusion, we found that P300 amplitude was affected by stimulus categories, and suggest that there are different hemisphere responses to craving and aversive stimuli for smokers and nonsmokers. An interesting idea for further study would be to investigate the effect of various smoking histories on P300 amplitude to craving and aversive stimuli.

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Smokers' attentional bias to smoking-related cues in eye movement

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INTRODUCTION

One of the most distinctive features in the field of addiction is craving. It mainly refers to the desire or urge to experience the effect of a previously experienced psychoactive substance (UNDCP/WHO, 1992). It also represents the central dilemma of a fixation on addiction. Drug craving both contributes to the maintenance of substance abuse, and precipitates relapse following drug abstinence (Tiffany, 1990). According to these characteristics of drug craving, regular drug use will be associated with attentional biases for drug-related cues (Di Chiara, 2000). An attentional bias refers to a tendency for some cues to be selectively attended to, at the expense of other stimuli. In particular, differences in subjective craving are associated with attentional biases for smoking-related cues among smokers. There is evidence that smokers, but not nonsmokers, show attentional bias for nicotine-related words on stroop and dot-probe tasks (Ehrman et al., 2002). Moreover, abstinence from smoking has been found to increase attentional bias on the stroop task in smokers (Gross, Jarvik, & Rosenblatt, 1993).

The measurement of eye movement is a sensitive method to identify attentional bias because eye movements are normally automatic, and are guided by changes in covert selective attention (Kowler, 1995). Although the controversy about exact measurement of attentional bias in eye movement remains, initial fixation and gaze duration can indicate attentional bias. There is evidence that, in comparison to nonsmokers, smokers initially fixate on smoking-related pictures more than on neutral pictures, and gaze at smoking-related pictures longer than neutral ones (Field, Mogg, & Bradley, 2004).

Another aim of the study was to investigate whether deprived smokers would have attentional bias to aversive cues, as compared to neutral cues. Signs and symptoms of nicotine withdrawal syndrome may include depressed mood, anger, and anxiety (APA, 1994). Once smokers feel anxious because of deprivation, they will show attentional bias to aversive cues. Anxiety in humans is characterized by specific biases that result in the preferential allocation of attention to stimuli that depict fear and threat (Eysenck, 1997). There is evidence that highly trait-anxious individuals show greater attentional bias for threat than for neutral faces (Mogg & Bradley, 1998).

In summary, smokers have increased craving and anxiety levels after nicotine deprivation, and in this state will show attentional bias towards specific cues. Therefore, we measured the direction of the initial fixation when smoking-related, aversive, and neutral cues were presented simultaneously on the computer screen. The percentage of numbers of initial fixation should reflect the initial focus of attention. We also investigated the overall amount of time that gaze was directed to the smoking-related, aversive, and control pictures over the course of picture presentation. This time measurement should indicate the maintenance of attention. Eye-movement monitoring enables us to measure the initial orienting and maintenance of attention, which is an advantage over other measures of attentional processing.

METHOD

Participants

We recruited participants (who were all students) from the C University located in Seoul, Korea. Initially, there were 34 participants. However, as two were unsuited to the calibration, and two did not meet the nonsmoker criteria, the total number of participants was 30. The

mean age was 21.7 years (*SD* = 2.2), and 17 participants were male. The group of 14 smokers consisted of ten males and four females, with a mean age of 22.5 years (*SD* = 1.7). On average, they smoked 10.1 cigarettes per day (*SD* = 6.5, range = 1–20) and had been smoking for 5.3 years (*SD* = 2.7, range = 1-8.5 years). The average time elapsed since smoking their last cigarette was 11.4 hours. The control group consisted of 16 nonsmokers (seven males and nine females), with a mean age of 20.9 years (*SD* = 2.4). Additional selection criterion for all participants was that they had eyesight within normal limits.

Instruments

The tasks were presented on a 1700 MHz PC (with 17" LCD-TFT monitor). Participants' EMs were recorded during the experiment with a computerized eye-tracking system (Model iView X Hi-Speed, Applied Science Laboratories, Senso Motoric Instruments GmbH, Teltow, Germany).

We used the Questionnaire on Smoking Urges (QSU, Tiffany & Drobes, 1991) to measure each individual's current urge to smoke and used the Spielberg Trait Anxiety Inventory (STAI, Spielberger, 1975) to measure the levels of state and trait anxiety. We also used the modified Fagerstrom Tolerance Questionnaire (mFTQ) to measure the degree of nicotine dependence. Participants completed a questionnaire about their personal details (age and sex), smoking habits, and smoking history.

Procedure

Two groups attended the laboratory. One group consisted of nonsmokers, and the other group consisted of smokers who were required to abstain from smoking for at least 4 hours before coming to the laboratory. Testing took place in a dimly lit, sound- proofed room.

At the start of the task, participants sat at a desk. We positioned the eye-tracking camera in front of the participant, below their left eye. The distance between the monitor and the eye tracker was 52 cm. The eye-tracking equipment was calibrated for each participant by presenting five small round dots on the screen (four at the each corner of the screen, and one in the center), and participants were required to look at each dot in turn, while their position of gaze was recorded.

In the eye movement task, each trial started with a central cross fixation shown for 1000 ms, which was replaced by the display of a pair of pictures, side by side, for 2000 ms. The intertrial interval was 1000 ms. There were five practice trials and 56 critical trials. The size of each picture was 135 mm high by 156 mm wide when displayed on the screen, and the distance between the inner edges of the pictures was 24 mm (visual angle of 2.6˚ between the fixation position and the inner edge of each picture).

After the computer task, participants completed QSU, STAI, mFTQ, and the questionnaire about smoking habits and history. After completion of the questionnaires, participants were thanked for their efforts and received a 10,000-won bill.

Data analysis

We analyzed the data using the BeGaze 1.0 Program (Senso Motoric Instruments). The direction of gaze, measured in degrees, was recorded 240 times per second. EM stability within 1˚ of the visual angle for 100 ms or more was classified as a fixation to that position, and the duration was recorded. Fixations were classified as being directed at the left or right pictures if they were more than 1˚ wide of the central position on the horizontal plane.

We used SPSS 11.5 for Windows for statistical analysis, and between subject t-test, one-sample t-test, and 2X3 repeated measures analysis of variance (ANOVA; between subject variables: smokers, nonsmokers; within subject variables: smoking-related, aversive, and neutral).

RESULTS

The mean age and levels of state and trait anxiety were not significantly different between the two groups.

Eye movement results

The percentages of initial fixation, and gaze duration are presented in Table 1.

Direction of initial fixation

We counted the number of initial fixations on each stimulus type and calculated them as a percentage. Scores greater than 50% reflect a bias in orienting towards smoking-related pic-

TABLE 1. EYE MOVEMENT DATA

	Smoker		Nonsmoker	
	Mean	(SD)	Mean	(SD)
Initial fixation (percent)				
Smoking-related	51.56	(5.16)	48.82	(4.96)
Aversive	57.44	(12.78)	56.51	(13.26)
Neutral	38.99	(11.85)	44.53	(12.97)
Duration (ms)				
Smoking-related	889.18	(135.69)	774.95	(129.01)
Aversive	933.83	(226.86)	858.14	(239.24)
Neutral	800.88	(185.66)	859.08	(139.78)

tures, relative to other pictures (50% indicates no bias). Smokers directed their gaze at smoking scenes on 51.5% of trials (*SD* = 5.2), and nonsmokers directed their gaze at smoking-related pictures in 48.8% of trials (*SD* = 5.0). These percentages of fixations indicate no bias compared to 50% ($t(13) = 1.13$, n.s.), ($t(15) = -0.95$, n.s.). Smokers directed their gaze toward aversive pictures on 57.4% of trials (*SD* = 12.8), and this percentage of fixations was significantly greater than 50% ($t(13) = 2.18$, $p < 0.05$).

A 2**X**3 repeated measures ANOVA (group and picture type) showed a significant main effect of picture type ($F(2,56) = 10.08$, $p < 0.01$). Greenhouse-Geisser corrections to the degrees of freedom were used to adjust for violations of the sphericity assumption for repeated measures factors; only the correct probabilities are reported. There were no significant main effects of group ($F(1,28) = 1.30$, n.s.) and interaction ($F(2,56) = 0.82$, n.s.). Post hoc analysis showed that both groups initially fixated on aversive rather than neutral stimuli (Smoker: $F(2,39) = 6.37$, $p < 0.01$; Nonsmoker: $F(2,45) = 7.85$, $p < 0.01$).

Time of gaze duration

The mean amount of time that smokers spent fixating on smoking-related pictures was 889.18 ms (*SD* = 135.69), while nonsmokers spent 774.95 ms (*SD* = 129.01).

A 2X3 ANOVA (group and picture type) showed no significant interaction or main effect of group and picture type (interaction: $F(2,56) = 1.81$, n.s.; group: $F(1,28) = 1.40$, n.s.; picture type: $F(2,56) = 1.25$, n.s.). Post hoc analysis showed that smokers gazed toward smoking-related pictures significantly longer than nonsmokers did ($F(1,28) = 5.58$, $p < 0.05$).

DISCUSSION

The results from eye movement monitoring data provide proof of biases in visual orientation to smoking-related and aversive cues in smokers. Smokers showed attentional bias on smoking-related and aversive cues. Their initial fixation to aversive cues was significantly higher than chance and they had significantly longer gaze duration toward smoking-related cues than nonsmokers did.

In the initial fixation data, a 2X3 ANOVA showed a significant main effect of picture type. In post hoc analysis, both groups initially fixated on the aversive stimuli more than the neutral stimuli. There was no significant interaction between groups and picture types. With regard to the direction of the initial EM, smokers were more likely than chance to look initially at aversive pictures. However, nonsmokers did not indicate a significant bias on this measure, and there was no significant difference between the two groups. These results offer some support for our hypothesis and the preceding study (Mogg et al., 2003). Although not significant, smokers tended to have more initial fixation on smoking-related pictures than nonsmokers did.

In the current study, smokers gazed at smoking-related pictures longer than nonsmokers did. Mogg et al.'s (2003) study analyzed the duration time of initial fixation but found no significant difference on smoking-related cues between smokers and nonsmokers. In another study, deprived smokers gazed at smoking-related pictures longer than when in their normal (nondeprived) state (Field, Mogg, & Bradley, 2003). There are no studies that have identified the different gaze duration between smokers and nonsmokers. In our study, we analyzed the overall gaze duration time and found that

smokers have a significant attentional bias toward smoking-related cues.

Another interesting finding is that both groups had the tendency to gaze longer at, and initially fixate on, aversive stimuli rather than other stimuli. Smokers and nonsmokers both indicated a significantly higher degree of initial fixation on aversive rather than neutral cues. There were no significant difference between groups on gaze duration, but both groups gazed at aversive stimuli longest. This does not support our hypothesis that only smokers would show attentional bias to aversive stimuli. We also hypothesized that different anxiety levels would lead to different attentional bias between groups. In the study of smoking deprivation, various withdrawal symptoms appear 6-12 hours after smoking cessation (Hughes, 1992). In the present study, the mean time of deprivation was 11.36 hours. According to Hughes, this deprivation time is sufficient for withdrawal symptoms to occur, but there was no significant difference in anxiety level between the two groups. In future studies, the anxiety level should be determined before the experiment. Attentional bias to aversive stimuli could be accounted for by the characteristic of emotional stimuli. Previous studies have found that younger adults detect threatening stimuli more quickly than other types of stimuli (Vuilleumier, 2002). Stimuli with emotional valence tend to attract attention more than neutral stimuli. It seems that the emotional valence of aversive stimuli is higher than craving. The results suggest it is necessary to control the emotional valence of stimuli.

In a previous study, researchers identified additional information (pupil dilation and the number of eye blinks) when paying attention (Anita, Chantal, & Sandra, 2005). When attending to specific stimuli, participants' pupils dilated and the number of eye blinks decreased. Measuring not only the initial fixation and gaze duration in eye movement, but also the pupil size and number of eye blinks could provide a useful indicator of attentional bias.

In conclusion, smokers gazed at smoking-related pictures longer than nonsmokers did, but there was no difference in initial fixation. Gaze duration could therefore be a sensitive measurement tool for identifying attentional bias.

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Low-Cost Telerehabilitation Using Force Feedback Joysticks

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Abstract: *Research Status: Pilot study. Background/Problem: Telerehabilitation and rehabilitation robotics are two new technologies being applied in the field of physical rehabilitation. In recent years, many researchers have investigated the use of these technologies to improve movement therapy for neurological conditions. However, most of these systems are expensive and not suitable for standard clinic or home use. We are developing a low cost robotic system - The Jerusalem Telerehabilitation System - using a commercially available force feedback joystick, an ordinary home PC, and a standard high-speed internet connection. Methods/Tools: Using the joystick, the patient performs exercises designed to aid in recovering motor function of the upper limb. Patients who are unable to grasp the joystick use a specially designed armrest that allows them to control the joystick with movements of the shoulder and elbow joints. The system monitors the status and progress of the patient, records the kinematic parameters of his movements, and summarizes the results. There are two modes of operation – the cooperative mode in which therapist and patient are online together and the therapist can guide the patient's movements, and the stand-alone mode in which the patient works by himself, not necessarily online. As a preliminary test of our system, we conducted a pilot usability trial of the stand-alone mode with two subjects who had suffered a stroke. Two physical therapists also tested the system. The goal was to see if the subjects and the physical therapists felt comfortable using the system. In addition, we have also carried out some preliminary tests of the cooperative mode of the system over the Internet. Results: After a short training session, the therapists were able to use the system independently. Also, patient subjects had no problem understanding how to do the exercises; they reported that they enjoyed using the system as an alternative to their regular exercises, and felt safe using it. Tests of the cooperative mode over the Internet demonstrated that the controlling joystick was able to steer the guided joystick with a delay of 30-150 msec. Novelty/Discussion: In our system, client programs and data on exercise sessions are stored locally on the client's computer and uploaded to a central server at a later date. A specially designed arm support allows even subjects with little or no control of wrist and fingers to control the joystick without the inconvenience of attaching a splint. The Internet cooperative mode is another novel aspect of our system. Conclusion: We have shown that this low-cost system works as designed and that there is potential for the use of this type of system. Both therapists and patients are able to use the system, and we are ready to begin a full-*scale trial.

INTRODUCTION

One of the new technologies emerging in the field of physical rehabilitation is telerehabilitation. Telerehabilitation has been defined as the delivery of medical rehabilitation services from a distance using electronic information and communication technologies (Rosen, 1999). Use of telerehabilitation tools helps minimize the barriers of distance, both of patients to rehabilitative services and of researchers to subject populations. In-home therapy has the potential to increase a disabled person's self-sufficiency as well as family support and involvement in therapy. A panel of experts convened by the NIH concluded that treatment in home settings is potentially an efficient and cost-effective way to improve the practical effectiveness of rehabilitation (Fuhrer & Keith, 1998). Normally, home exercises are not done in the presence of a therapist; therefore it is difficult, if not impossible, for a therapist to

monitor a patient's progress. When home exercise is not monitored by a therapist, the patient often feels less motivated to do the exercises. Thus, there is a need for a networked home system that will allow the therapist to monitor and record a patient's rehabilitation routines and remotely change exercises. Rather than acting as a poor substitute for traditional care, telerehabilitation will help extend care to patients in their own homes.

Studies have shown that 73%-87% of people with brain and spinal cord injuries use computers, and more than half use the Internet (Hauber et al., 2002; Ricker et al., 2002). People with brain injuries expressed strong interest in a variety of potential Internet-based health services (Ricker et al., 2002). Approximately 50% of adult stroke patients prefer getting treatment at home (Weiss et al., 2004). In a study of post-stroke hemiplegic subjects, it was found that these subjects were capable of using a computerized device designed to measure hand movements. This population was capable of understanding and following the necessary instructions. They were also able to perform the cognitive transformation needed to translate vertical movement of a bar on the computer screen to the horizontal movement of a handle on the table (Sugarman et al., 2002). Therefore, it is reasonable to assume that people with disabilities would be willing and able to use telerehabilitation devices.

A second new technology being applied to physical rehabilitation is rehabilitation robotics. Evidence to date suggests that for a therapeutic intervention to be effective, it needs to be exercise-based, be delivered at an appropriate intensity, and involve repetition. In addition, it has been found that repetitive movement is more effective for recovery when it is challenging and meaningful (Coote and Stokes, 2005). Improvement is due to plasticity of the brain: the "unmasking" of relatively inactive pathways and the taking over of functional representation by undamaged brain tissue (Bach & Rita, 1990). However, the amount of time patients spend in therapy is limited as compared with normal activity and therefore might not optimize the cortical reorganization necessary for recovery. Robotic technology is ideal for delivering this form of intervention and for increasing the amount of therapy given (Coote & Stokes, 2005). Robotic-based training is automated and precisely controlled. A robotic-based system may act as a surrogate therapist that could be programmed to provide patients with diverse sources of feedback (Liebermann et al., 2006), thus providing the potential for an increased number of hours of therapy. Movement dynamics, as well as kinematics, may be restored through robotics resistance training (Scheidt et al., 2000). This type of therapy could be adjusted to the specific needs of individual patients and could be made available at home (Liebermann et al., 2006), thus merging rehabilitation robotics with telerehabilitation. Many stroke patients reach a plateau in recovery. However, further recovery is possible by modifying aspects of the treatment regimen – new exercises, changing intensity, etc. (Page et al., 2004). Data have repeatedly shown that chronic (>1 year) stroke patients can exhibit substantial improvement after participation in novel rehabilitation protocols requiring task-specific, repeated motor practice (Page et al., 2004). The combination of telerehabilitation and rehabilitation robotics provides the potential for overcoming plateaus in recovery.

In recent years, many researchers have investigated the use of computerized mechanical devices to automate movement therapy for neurological conditions (Krebs et al., 2004; Fasoli et al., 2004; Reinkensmeyer et al., 2002; Coote and Stokes, 2005; Broeren et al., 2004; Burdea et al., 2000; Jadhav & Krovi, 2004). Robotic therapy has been found to significantly improve the movement ability of the affected upper limb in stroke patients (Fasoli et al., 2004, Coote & Stokes, 2005). Broeren et al. (2004) used a PHANToM haptic device as a training device for the affected arm of a stroke patient. This system was used in the laboratory, but could be adapted for telerehabilitation. They reported on one patient who trained with the device and found improvement in fine manual dexterity, grip force, and motor control of the arm. Most importantly, after the training, the patient was able to use the arm in daily activities that were previously impossible. Recently Olsson, Carignan, and Tang (2004) described the system they are developing, which uses force-feedback robots for remote assessment and therapy over the Internet. Using this technology, both patient and therapist can feel the arm movement that the other makes.

Many of the robot-mediated systems reported in the literature are complex. Therapists or patients will not accept systems that are difficult to use or that require prolonged training time. Lewis et al. (2006) have documented the difficulties encountered by therapists learning how to operate one system. In addition, most of these robotic systems are expensive. Availability of suitable equipment at home is essential for compliance with a home-based rehabilitation program (Taylor et al., 2004). However, the current cost of most robot-mediated equipment is high, and this limits its availability for home use. Furthermore, some proposed telerehabilitation systems require special ISDN phone lines for operation (Piron et al, 2004).

An alternative approach is to adapt low-cost, commercially available devices for rehabilitation purposes. “Java Therapy,” based at the University of California, Irvine, is the main example of this approach. The Java Therapy system consists of a Microsoft Sidewinder force-feedback joystick together with specially written software for therapy games, status tests, and progress reports (Reinkensmeyer et al., 2002). Users log on to the system using the Web and practice exercises such as moving a cursor into a fixed target. Reinkensmeyer et al. (2002) reported on one stroke patient who performed rehabilitation exercises with their system. This patient showed improved motor control in his affected arm and felt that the exercises improved his arm movement in daily life. Another example of the adaptation of a low cost commercially available device to rehabilitation is the virtual driving environment developed by Jadhav and Krovi (2004). This system is designed to be used at home to assist rehabilitation of the upper limbs in stroke and physical injury patients.

We have followed the lead of the inexpensive Java Therapy System (Reinkensmeyer et al., 2002), and are developing a low cost robotic system - The Jerusalem Telerehabilitation System (Sugarman et al., 2006). Our aim is to develop a low cost, easy to use robotic system for employment in the clinic and home. The system consists of a commercially available force feedback joystick, a specially designed armrest, an ordinary home PC, and a standard high-speed Internet connection. There are two modes of operation – the cooperative mode, in which therapist and patient are online together and the therapist can guide the patient's movements, and the stand-alone mode in which the patient works by himself, not necessarily online. The system differs from Reinkensmeyer's system in several ways: (1) programs are stored locally and not online; (2) there is a specially designed armrest; (3) the system provides detailed kinematic analysis, examining many different parameters of movement; (4) the system includes a cooperative mode in which therapist and patient are online at the same time and can work together.

Patients will train with the system in the clinic setting with both the stand-alone and the cooperative modes. For the cooperative mode in the clinic, therapist and patient systems will be connected using a cable. Family members and caretakers will be encouraged to take part in these sessions and to give feedback. When the therapist feels that the patient and his family are ready, the patient will take the system home.

As a preliminary test of our system, we conducted a pilot usability trial with two physical therapists and two post-stroke subjects. The goal was to test the "user friendliness" of the system for physical therapists and patients, and to examine the quality of the Internet connection during the cooperative mode.

METHODS

The Task

Moving a joystick, the patient performs exercises designed to aid in recovering motor function of the upper limb. The exercises are in the form of a game seen on a computer monitor. In the first exercise, eight targets are arranged in a circle around the perimeter of the computer screen. The subjects use the joystick to move the cursor to each of the 8 targets in turn, moving according to a cue between targets on opposite sides of the screen. Patients who are unable to grasp the joystick use a specially designed armrest that allows them to move the joystick by moving their elbow and shoulder joints. Instead of a commercially available armrest that attaches to a table (Reinkensmeyer et al., 2002), we have designed an armrest that attaches to the chair the patient is sitting on; this moves the axis of movement closer to the

body of the patient, making it easier for him or her to move. The armrest is attached to the joystick base with a long rod, doubling the workspace afforded by the joystick alone. If the subjects are unable to perform a movement, forces applied by the joystick bring them very close to the target, and they then complete the movement on their own. Subjects who are stronger use the program in its resistive mode – i.e. the joystick resists the movement of the joystick towards the target. The mode of forces applied (either assistive or resistive) as well as the degree of assistance or resistance (high, medium, or low) is determined by the physical therapist.

Software Design

The programming environments we use are Java and Visual C++. The software and software libraries are: 1) NetBeans 5.0 – Java programming environment; 2) Visual C++; 3) Apache Tomcat – WebServer and Java support; 4) MySql – an open source relational database management system that uses Structured Query Language (SQL); MySQL is noted mainly for its capacity to store a large number of observations (50M records), and the fact that it is free and provides speed, reliability, and flexibility; MySQL will be used for the database; 5) OpenGL (Open Graphics Library) – the computer industry's standard application program interface (API) for defining 2-D and 3-D graphic images; OpenGL is designed so that some functions can be performed on a graphics accelerator card, freeing the microprocessor for other work; 6) DirectInput - an interface for input from I/O devices; 7) DirectSound - an interface for integrating and coordinating sound with the images.

Client programs and data are stored locally

In our system, the software for the client side is downloaded from a central server and stored locally. After the initial installation, most of the updates will be downloaded and installed remotely using push technology when the patient logs on to the Internet. In the system described by Reinkensmeyer et al. (2002), there is a web site with Java applets that download onto the user's computer for local execution; the client receives a fresh copy of the applet each time he logs on. We didn't use this option for several reasons: 1) Applets work in a send box, a mechanism in the browser that limits their operation. 2) Applets are not well controlled in terms of real time performance; that is, since they piggyback on the browser, they utilize some of the operating system resources. Thus, the browser can add jitter to the performance of the applet, interfering with the responsiveness of the applet. 3) Applets take time to download and, if used, would need to download each time a therapeutic game is played. If the game were small this would not be a problem, but our games are large and contain graphics and music that would take several minutes to download. Therefore, in our system we decided to arrange for the game to be downloaded once, and then the client can use it at will without waiting. Records of exercise sessions are stored locally on the patient's computer and are uploaded automatically to the central server at a later time.

RESULTS AND DISCUSSION

Usability of the stand-alone mode

Usability of a new therapeutic system is an important issue because many therapists, not to mention patients, are technophobic. It is essential to conduct a usability study before proceeding with a therapeutic trial because if the system is not easily useable, it will not be used by patients or by therapists.

Two physical therapists were trained to use the system. Both initially expressed hesitation about using a computerized system. However, after a short (less than 1 hour) training session, both therapists were able to use the system independently. They had no problems remembering and using the various features of the program. They were eager to try it out on other patients.

Two post-stroke subjects and several normal subjects have tried out the system. One of the stroke subjects used the armrest. The patient subjects had no problem understanding how to do the exercises; they reported that they enjoyed using the system as an alternative to their regular exercises. Subjects who received feedback as to their time to complete the game enjoyed the competition aspect and tried to improve their speed; subjects who didn't receive this feedback found the game boring after a couple of tries.

B, a 64-year-old male who had suffered a left Cerebral Vascular Accident (CVA) 10 years

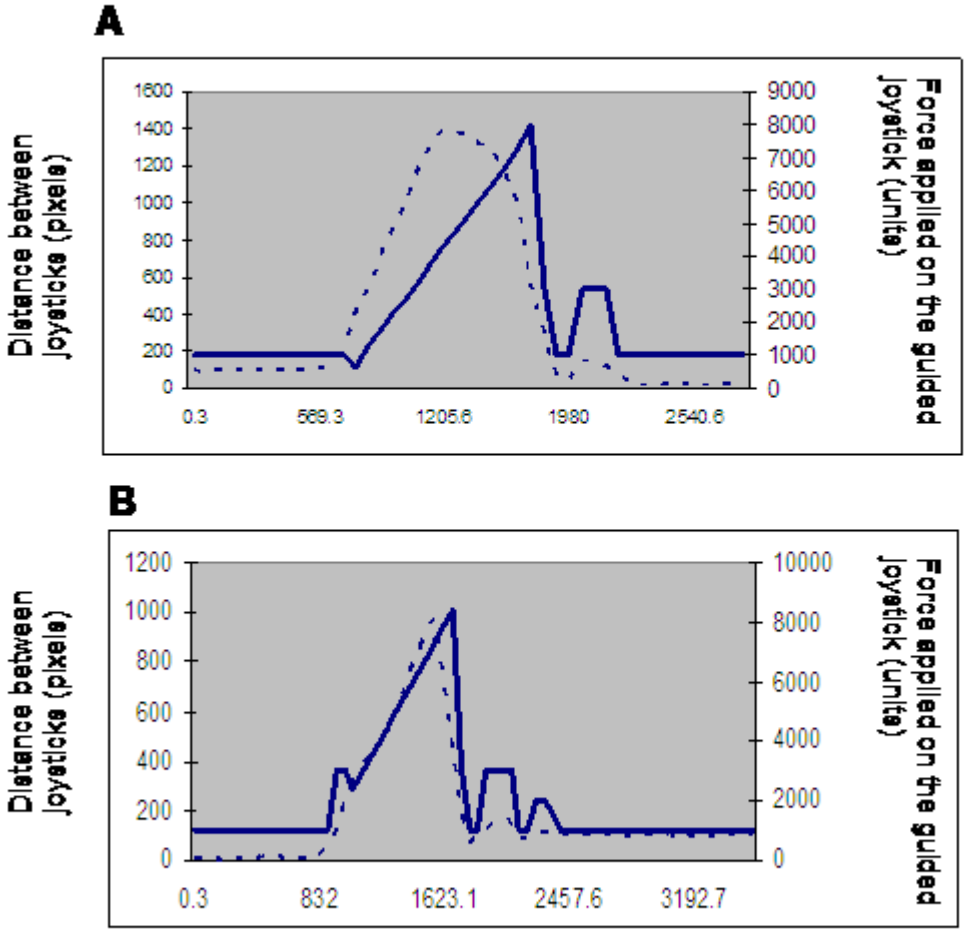

Figure 1. Force distance relationship between joysticks. The graph shows the force exerted on the guided joystick by the program for different distances between the controlling and guided joysticks for the oblique (A) and vertical (B) movement directions. Force is in Microsoft units.

earlier, used the armrest to move the joystick with his elbow and shoulder joints. He reported that he felt safe and secure using the system. He liked exercising with a game, and especially liked using the system in the resistive mode because he felt that it provided a challenge for exerting his muscles. He wanted to know when he could have a system to use in his home. A, a 65-year-old woman 2 months post-left CVA, had never used a computer before. When she was brought into the room in a wheelchair, she was apathetic and barely communicative. After being shown how to use the system by grasping and moving the joystick, she looked back and forth between the computer screen and her hand several times, in order to understand the relationship between movement of the joystick and movement of the cursor on the screen. She soon became very interested in the task and quickly learned how to use the joystick to move the cursor on the screen and play the game. These preliminary results indicate to us that the system has the potential to be well received by patients.

Tests of the Cooperative mode

The cooperative mode is an important innovation of our system. Only one other system (Olsson et al., 2004) has been described with a cooperative mode and that one used expensive robots. In the cooperative mode, the therapist and the patient are online at the same time and both the therapist and the patient grasp a joystick. The patient and the therapist each see, in real time, the position and movement of their own joystick *plus* the position and movement of the other party's joystick. The patient's and therapist's systems are totally synchronized – designed in such a way that the graphical representation of the joystick movements is displayed on the therapist's screen only *after* it has been displayed on the client's screen. This assures that patient and therapist are seeing the same thing at (almost) the same time. The only delay is that introduced by the Internet itself. We are continuing to develop this mode in order to minimize the effect of the delays on the visual display. Preliminary tests of the cooperative mode over the Internet, using a standard broadband connection, demonstrated that the controlling joystick was able to direct the guided joystick with a delay of 30-150 msec. This delay did not interfere with the task, which involved one joystick guiding another. Figure 1 shows how the force applied by the system to the guided joystick varies with the distance between the two joysticks – controlling and guided. As the distance between the two joysticks increases, the program applies force on the guided joystick in order to close the gap. As soon as the gap is closed, the amount of force applied is abruptly decreased. As can be seen in the figure, the coordination between the two joysticks is closer in vertical movements than in oblique ones.

CONCLUSION

We have shown that this low-cost system works as designed and that there is potential for this type of system. Both therapists and patients are able to use the system and we are ready to begin a full-scale trial.

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Reaching out to the youth suffering from idiopathic tinnitus via the Internet

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Abstract: *Idiopathic tinnitus is traditionally considered to be a hearing dysfunction typical of old age. Recent studies have shown a rapidly increasing number of individuals 30 years and younger suffering from idiopathic tinnitus. The goal of this study was to examine the nature of socially supportive communication that took place within an Internet-mediated support network for individuals affected by tinnitus. This support group list was created for individuals suffering from distressing tinnitus. Tinnitus involves the internal perception of noises and sounds that are not generated by the auditory sensory system. Preceding studies showed that out of 500 individuals affected by tinnitus, approximately 350 expressed significant distress and impact on daily activities and quality of life. Out of approximately 350 individuals expressing a need for support groups, 98 provided contact by email/ Internet, originating from six regional locations in Québec. All subjects were offered alternate support via the RQPA telephone help line, group meetings where participants are generally provided self-help advice from non-professional sources, and references to professionals. Using item analysis, 98 emails were examined with reference to three themes of questions for support: affective and informational/factual reports about daily aspects, networking for finding support, and professional/ paramedical help. Results suggest that the primary function of this Internet service was the communication of factual information, particularly with questions about symptom quality, intensity, duration, prognostic factors, and medical causative variables, including the second most frequently invoked theme related to the interpretation of evolution of symptoms. Another category of information related to requests for references to medical and para-medical practitioners. The last theme referred to issues of care, to ways of handling symptoms, and related impact on stress tolerance, depression, anxiety, and fear of aggravations. As expected, the main factor discriminating participants involved through the Internet from participants not available on the Internet was age, followed by education level. This initiative fostered new opportunities for individuals with tinnitus-related concerns to participate in supportive communication within a network of individuals dealing with similar issues. These results lead to the recommendation that regional contact agents attempt to provide Internet access to their support group members and to interested individuals without home access to email and Internet.*

INTRODUCTION

Tinnitus involves the internal perception of noises and sounds that are not stimulated externally to the auditory receptors, but rather are generated internally by dysfunctions of the auditory sensory system. In French, the term tinnitus is often translated with the term “acouphènes,” which is understood as a mild form of tinnitus, while tinnitus is considered a medical symptom in its own right. According to studies (Andersson, 1999), in the population over 40 years of age, 20% of normal individuals experience tinnitus for some period in their life. Ten to fifteen percent of them report the symptom as distressful to the point of adversely affecting daily functioning. Tinnitus is the tenth most common reported symptom among the elderly in primary care and is rapidly growing in affecting individuals younger than 40 (Andersson, 2002).

Idiopathic tinnitus was traditionally considered a hearing dysfunction typical of old age. Recent studies have shown a rapidly growing number of individuals 30 years and younger suffering from idiopathic tinnitus (Baribeau, 2004; Baribeau, Gordon, & Roy, 2005). Many adolescents and young adults expose themselves to loud music for cultural and sports activities. Younger individuals might not be aware that exposure to loud music could result in hearing loss and tinnitus. Preceding studies showed fewer responses to polls about tinnitus in the younger age group when using the usual newspapers and community group networks (Andersson, 1999; Baribeau et al., 2004).

The present study assessed the impact of an Internet and email-based method to exchange health information to and from this younger age group relative to the older age group. In young people, idiopathic tinnitus often goes unreported and is perceived as a non-medical condition, which most practitioners consider untreatable (RQPA, 2004). In Québec, idiopathic tinnitus is not presently medically treated with predictable results, despite the fact that on average, it lasts from several months to several years, with no scientifically demonstrable curative method. Preceding studies by Baribeau et al. (2004; 2005) showed that out of 500 individuals identified as having tinnitus, approximately 350 indicated experiencing significant tinnitus, and according to the method of questioning, 16% to 37% expressed significant distress with an impact on daily activities and quality of life. The highest incidence derived from a quantifiable and verifiable method in a semi-structured interview, which was verified with a standardized questionnaire (Baribeau et al., 2004; 2005). The lowest rate of 16% derived indirectly from the estimate based on the frequency of behaviors demonstrating seeking help. The high rate of 37% for distressing tinnitus is significantly higher than the 15% reported in older surveys (Andersson, 1999). This indicates that, with proper outreach, affected individuals might account for a larger percentage of distressing tinnitus in the general population of individuals with tinnitus.

According to Budd (1996), individuals with distressing tinnitus experience significant stress and major dwindling in their quality of life due to stress, the annoyance factor associated with tinnitus, and related symptoms such as hearing deficits and sensitivity to noise (hyperacusia). According Meric et al. (2000), rates of report of distress are higher when a more elaborate questionnaire is used. According to Baribeau et al. (2004; 2005), activities of daily living are affected in proportion to the distressing characteristics of the tinnitus, its qualitative aspects as much as its intensity.

Although tinnitus is often related to hearing loss, long-term noise exposure, and medications, many types of tinnitus demonstrate no known etiology. Often, the cumulative factors required for specifying an etiology are not consistently reported in medical files or clinical studies (Andersson & Lyttkens, 1999). However, careful analysis with comprehensive questionnaires demonstrates higher frequencies of etiological categories and distressing symptoms than the statistics derived from medical records (Baribeau, 2005). Subjective idiopathic tinnitus is more frequently correctly diagnosed in patients who care to make the extra requests for follow-up with one or another of the few available audiologists who specialize in tinnitus assessment. A minority will undergo the required longer diagnostic process, which involves the following: exhaustive anamnesis, repeated ORL examinations, and extensive audiometric testing. Because patients with cumulative and chronic distressing symptoms are often excluded from clinical statistics due to lack of treatment, and because the younger generation is less frequently amenable to exhaustive testing, the present study attempted to attract the younger age group through the Internet in order to more fully assess the phenomenology of such symptoms.

METHODS

According to the review of literature in Québec, no similar study was done on this topic in this part of Canada. Given the absence of Internet and non-Internet local support groups in many regions of the province of Quebec, and given the need for such support, this led to the creation of a web page and an email list.

Procedure

According to the RQPA publications (2004; 2005), a well-recognized obstacle deterring individuals from seeking help about distressing tinnitus is the non-recognition of idiopathic tinnitus as a true medical condition. For example, many associations publish leaflets using the French term “acouphènes” where "acouphènes" are considered benign by definition and are only secondarily mentioned as symptoms, and this only if a medical illness can be demonstrated. Since neurological research cannot explain the cause of idiopathic tinnitus in the large majority of cases, ORL practitioners often present “acouphènes” as non-medical conditions, as reported by the RQPA. In addition, according to the RQPA bulletins, the most frequent “treatment” given to tinnitus sufferers is

"clinical advice" to the effect that tinnitus is best handled by "getting accustomed to it."

On the other hand, the RQPA states that "acouphènes and tinnitus" are not recognized partly because the words and labels themselves are not familiar to the potential clientele, neither to the population at large nor to the paramedical practitioners. One of RQPA's major goals is to popularize the term "acouphène" and to provide basic definitions and advice as to how to get "accustomed" to them. In most cases, their main platform on their web page is fourfold: 1) to inform the population at large about the definition of tinnitus and "acouphènes," not to be confused with hallucinations or mental health problems; 2) to provide definitions; 3) to reassure tinnitus sufferers that tinnitus is generally benign; 4) to transmit general information to affected individuals about getting accustomed to "acouphènes."

However, many individuals with stressful tinnitus might not recognize themselves in this profile, especially younger people, since, by definition, "acouphène" is attributed mostly to the older age group, and because their own experience is often one of severe distress, which does not coincide with the advertised definition of benign "acouphènes."

In order to circumvent this communication issue, and in order to reach out to the younger population suffering from distressful tinnitus, potential subjects were signalled about these key words and terminology through the Internet, using advertisements for widely publicized public events related to music, such as concerts and music shows (Meetings of l'Association des musiciens de Montréal'05, Salon de la musique 2005, Music Fest Show'05, Place Bonaventure-Journées de la musique'05, etc.). The Internet address was thus distributed to hundreds of potential subjects via such media, along with a basic definition of key words such as "acouphène" and tinnitus. In itself, this resulted in hundreds of email responses and Internet access to the web page. When email addresses were missing, subjects were contacted by phone in order to obtain their email address. Internet follow-ups were conducted via email correspondence.

Participants

This support group list was created for individuals suffering from distressing tinnitus. In response to first contact, participants were offered support and answers to their questions while obtaining responses to items derived from a standardized preliminary series of 24 questions. Out of approximately 350 individuals expressing a need for support groups, 100 signed in, out of which 98 followed up with contacts by email/ Internet. Half of them could be identified as having heard of the group thanks to five public events organized by the RQPA (approximately half of them were older than age 30), and student and music groups or associations either at Université Laval or music events listed above, which involved major cultural musical events attracting musicians and music fans, the large majority of them below age 30. Thus, approximately 50% of the sample was 30 years of age and younger. The list of RQPA volunteers for the older age groups originated from regional locations: Québec, Montréal, Victoriaville, Bécancourt, Trois-Rivières, St-Eustache. In both age groups, about half were from a major city and half from regional and smaller town locations. Informed consent was obtained with the standard procedures. All were offered alternative support via regional support group meetings and peer counseling (non professional) via the RQPA telephone help line.

Statistical analyses

On structured questionnaire items, group differences were assessed with t-tests for ratio variables and Chi square tests for frequency counts. For content analysis of email text, frequency and category data were analyzed with non-parametric Chi square statistics. Other demographic data were analyzed with t-tests. All tests of significance were set at .05.

RESULTS

Out of 100 subjects with email addresses, the participants were 98 individuals with tinnitus with lasting more than six months. Since there were no major differences between urban and smaller regional town, the data from subjects of regions and cities were pooled.

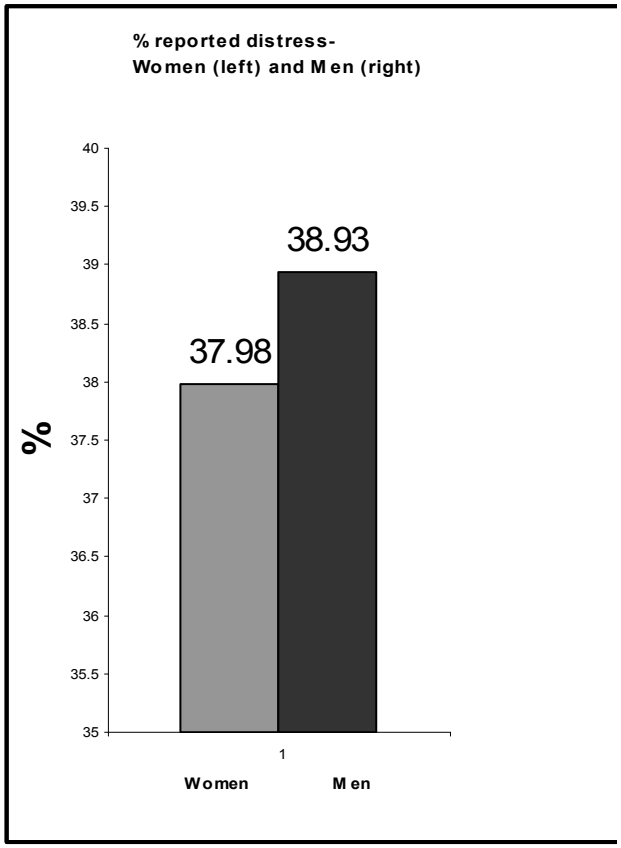

Figure 1

Using item analysis, 98 emails were examined in regards to three categories of questions, using methods similar to other comparable Internet studies (Coulson, 2005), such as affective, informational/factual, networking, and professional or paramedical help.

Participants reported tinnitus-related distress, depression, and daily annoyance in the percentages illustrated below. Immediately following the support-groups, about half of the participants showed appreciation of reassurance and satisfaction with the information obtained. The same ratio of appreciation was expressed in the Internet group.

Age and sex differences – There were no differences in number of males and females between age groups or regions. Figure 1 showed no significant difference in frequency between males and females, and no difference in reports or in number or nature of questions about distressing symptoms in relation to gender. All data about this factor was pooled for future analyses. In the following two figures, the reported values refer to frequency counts measured for each subject. Reference to distress was counted only once according to one or the other of the 24 items on the questionnaire, most items referring to how tinnitus affected daily domestic, familial, work, and social activities. The total count is reported here as an index of distress. There was no significant difference between men and women.

As per Figure 2, total counts of tinnitus related distress were similar in the younger and older groups. However, analysis of email contents showed some variation in terms of the factors of distress. Hearing loss was defined as a “severe and frequent problem” by 8% of respondents younger than 30 while it affected more than 50% of the older group. Most younger respondents had experienced tinnitus or hearing impairment attending concerts (61%) and clubs (43%). Only 14% of younger respondents had used earplugs. Approximately half of the younger respondents asked information about ear protection if they were aware of the potential for permanent hearing loss (60%) or were advised by a medical professional (50%). In summary, the analysis of young subjects’ responses suggested that approximately a third of these young adults have experienced tinnitus after exposure to loud music. Based on item analysis, this was the main difference with the older age group, while the total counts of distress reports were comparable between age groups.

Comparisons on demographic characteristics (age, education, sex, location) between the Internet sample of this study and the non-Internet sample in a preceding study (Baribeau, Gordon, & Roy, 2004) showed the following: As expected, the main factor discriminating participants involved through the Internet from participants not available on the Internet was age and location, followed by educational level. Age was confounded by the variable location since a large pool of younger subjects were recruited via the Internet addresses distributed at the music events, as opposed to the RQPA web sites. In the younger age group (less than 30 years of age), this email-based approach rapidly generated responses. It thus appears to be a feasible method to obtain tinnitus data from this younger age group. High dropout rates or delay in com-

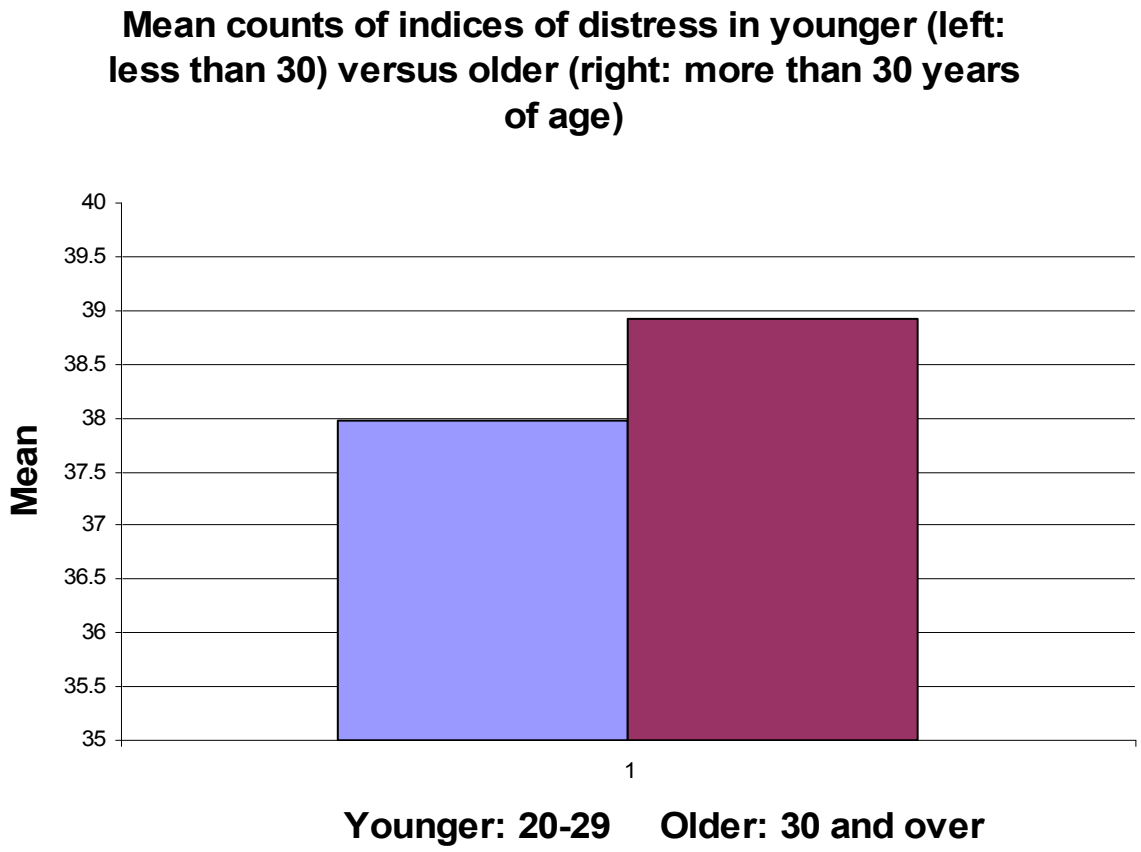

Figure 2

munication can be a characteristic of studies using the Internet with the older age group, but should be contrasted with the cost-effectiveness and accessibility of the Internet.

Based on the preceding study, 24 items of a 70-question survey (QDDT v.1) were used to serve as a reference point to categorize email exchanges. Responses and follow-up questions to emails were presented in a standard way using the formulations of the QDDT, and responses from participants were rated using the same procedure. The internal consistency of these questions was assessed with 79 subjects (with no missing values) in order to measure Cronbach alpha index of internal consistency. Similar methods to Zachariae et al. (2000) were used. This internal validity index calculated for the 24 items used in the Internet version of the present questionnaire (in French) is excellent, with a value of .92. It is significant and comparable to other questionnaires formatted in English (Meric et al., 2000), and Danish (Zachariae et al., 2000). The item validity index is reported in Table 1 on the following page, based on Cronbach alpha.

DISCUSSION

Content analyses

Analyses suggest that the primary function of this group was the communication of factual information, particularly with comments about how tinnitus affects daily activities and quality of life, and questions about tinnitus symptoms: quality, intensity, duration, prognosis, and medical or causal factors. These aspects correspond very closely with the first portion of the QDDT questionnaire and replicate similar findings.

The questions most often related to treatment generally referred to the following categories in

Table 1
Internal Consistency for all items: Cronbach alpha

Internal Consistency	Mean	Variance	Standard Deviation	N. variables
	8,75	39,44	6,28	24
	Mean	Variance	Correlation Item/total	Alpha index
Question 1	8,21	35,93	,54	,91
Question 2	7,91	37,52	,39	,92
Question 3	8,19	37,05	,35	,92
Question 4	8,51	36,88	,45	,91
Question 5	8,49	36,06	,60	,91
Question 6	8,43	35,87	,59	,91
Question 7	8,33	35,90	,55	,91
Question 8	8,68	38,17	,39	,92
Question 9	8,37	35,29	,68	,91
Question 10	8,21	34,90	,72	,91
Question 11	8,47	36,25	,55	,91
Question 12	8,67	38,04	,39	,92
Question 13	8,48	35,42	,72	,91
Question 14	8,28	36,04	,52	,91
Question 15	8,55	36,52	,57	,91
Question 16	8,51	36,09	,61	,91
Question 17	8,48	35,55	,69	,91
Question 18	8,52	36,23	,60	,91
Question 19	8,28	35,69	,58	,91
Question 20	8,67	38,47	,26	,92
Question 21	8,32	36,33	,48	,91
Question 22	8,13	36,04	,54	,91
Question 23	8,23	36,02	,52	,91
Question 24	8,27	36,14	,50	,91
N. of cases	75			
N. of items	24			
Cronbach Alpha	,92			

order of importance: 1) audiological management such as hearing aids for those with hearing loss; 2) psychotherapy, suggestion, and hypnotherapy; 3) informational counseling; 4) audiological techniques such as masking; and the least frequently mentioned 5) related specialized treatments such as tinnitus retraining therapy and cognitive-behavioral therapy provided by professionals. The latter category of treatment was generally lesser known by the individuals and by his or her referring clinician. If we pool together miscellaneous and heterogeneous references to other attempts to seek help, the largest category of treatment could be summed up in one category: alternative health methods and hygienic or domestic self-care, where individuals actively sought diverse types of volunteers, peers, and caregivers in order to handle the tinnitus effects on a long-term basis. This same large category included self-care activities and agents to improve both physical and mental-emotional health.

The second most frequently invoked theme related to the interpretation of evolution of symptoms. The third category related to requests for references to medical and para-medical practitioners in order to obtain advice for handling symptoms and related impact on stress tolerance, depression, anxiety, and fear of aggravation. Medication was often mentioned along with every other theme or category as an adjunct, and was mentioned as palliative care in order to reduce anxiety, stress, and insomnia.

In conclusion, analysis of emails demonstrated the nature of socially supportive communication that took place and illustrated the feasibility of an Internet-mediated support network for individuals affected by tinnitus. These results could provide the basis for offering an Internet-based continuous service as part of the health system. Future studies should compare responses on the QDDT and on the standard North-American form of the Tinnitus Reaction Questionnaire (Meric et al., 2000).

This initiative fostered new opportunities for individuals with tinnitus-related concerns to participate in supportive communication within a network of individuals dealing with similar issues. These results lead to the recommendation that regional contact agents attempt to provide Internet access to their support group members and to interested individuals without home access to email and Internet.

Before contact, few individuals were informed about possible treatments such as tinnitus retraining therapy or cognitive-behavioral psychotherapy. Preliminary reports from individuals who had attended support-group conferences and the interest expressed in these therapies indicate that more information on treatments should be transmitted via support groups and via the Internet. Such psychotherapies could complement other approaches, and can help individuals decrease annoyance, depression, and stress associated with tinnitus.

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Sexual Preference Classification from Gaze Behavior Data using a Multilayer Perceptron

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Abstract*: This study introduces a classification technique, the first objective of which is to distinguish sexual offenders from non-offenders. This technique relies solely on gaze behavior dynamics expressed in relation to synthetic characters presented in a virtual environment. Classification is done using a multilayer neural network. Results show that the network is able to perfectly learn the task. In addition, the network also shows good generalization performance with new participants.*

INTRODUCTION

Violent behaviors, like the ones resulting from sexual crimes, are major social and psychological distress factors. For this reason, it is important to thoroughly assess and diagnose these behaviors. However, there are important problems with the current diagnostic and measurement techniques of these violent behaviors.

PENILE PLETHYSMOGRAPHY (PPG)

Since its introduction by Freund (1963), the measurement of penile tumescence by means of a plethysmograph has been the target of much criticism on both ethical and methodological grounds (Kalmus & Beech, 2005; Laws, 2003; Laws & Gress, 2004; Laws & Marshall, 2003; Marshall & Fernandez, 2003). In particular, it has been attacked for demonstrating weak test-retest reliability and questionable discriminating validity with respect to distinguishing sexual deviants from non-deviants and in correctly differentiating the different categories of sexual deviants among themselves (Kalmus & Beech, 2005; Looman & Marshall, 2001; Marshall & Fernandez, 2000). However, a large part of the method's test-retest reliability and discriminating validity problems arise from PPG's proneness to strategies used by sex offenders to voluntarily control their penile response in order to fake their sexual arousal response and thus present a non-deviant preference profile (Quinsey and Chaplin, 1988; Seto and Barbaree, 1996). This is where the heaviest criticism has been leveled. Indeed, the use of mental distraction strategies is widespread. In this regard, it has been reported that up to 80% of subjects asked to voluntarily control their erectile response succeed in doing so (Farkas et al., 1979; Howes, 1998; Kalmus & Beech, 2005). They generally manage to lower their scores through the use of aversive or anxiogenic thoughts and images, that is, by diverting their attention from the sexual stimuli to which they are exposed. These distraction strategies are reputed to be difficult or impossible to detect. Attempts to control this factor have yielded mixed results (Proulx et al., 1993; Quinsey & Chaplin, 1988; Golde et al., 2000).

IMMERSIVE VIDEO-OCULOGRAPHY CONTROLLING FOR FAKING

The use of immersive video-oculography makes it possible to get around this problem (Duchowski et al., 2002; Renaud, 2004; Renaud et al., 2002a, 2003, 2005). This technique allows researchers to observe a crucial part of the subject's subjective experience; that is, his global visual perspective coupled with the exact position of his gaze such as it scans and dwells upon the various simulated objects in virtual reality and, particularly, the different corporal segments of a virtual sexual character. Moreover, with this technology, it is possible to record the immersion sessions from the sub-

ject's vantage point; researchers and clinicians can then replay the recording in order to validate a given segment of the assessment.

Aside from this qualitative validation of the subject's overt attention, a quantitative validation can also be conducted based on the analysis of dwelling time in strategic areas and the analysis of gaze behavior patterns relative to these areas. For example, if the analysis reveals that a subject does not spend enough time scrutinizing a given character's sexual features or that he demonstrates a tendency to turn his gaze away from these areas when he begins to be sexually aroused, it can establish that the subject avoids making visual contact with what could elicit a sexual arousal response in him. Preliminary results obtained in our lab tend toward such a conclusion (Renaud, 2004).

GAZE BEHAVIOR PATTERN AS DIAGNOTIC INDEX

The visual scanning of virtual stimuli produces a highly complex geometry of which we can analyze certain recurrences in order to discern patterns (Renaud, 2004; Renaud et al., 2002b, 2003, 2004). These recurrences include patterns of transition from one virtual area to another. For example, certain subjects have a tendency to begin their visual inspection with the avatar's feet, whereas others begin with the head or the genitalia. Moreover, certain subjects alternate their gaze between the face and the genitalia, whereas others punctuate their inspection with frequent visual samplings of the objects that surround the virtual character in the scene, which may act as sources of distraction (e.g., a flowerpot or window). These transition patterns constitute visual routines that are the dominant characteristic of the automatic cognitive processes implicated in the appraisal of the emotional and sexual signification of the stimuli (Janssen et al., 2000; Land & Hayoe, 2001; Renaud, 2004). They present the major advantage of not being as transparent to the subject as are measures of penile tumescence. The same is true for other factors, such as speed and acceleration of visual scanning, and other higher-level parameters. In fact, these measures and analyses of oculomotor patterns alone may possess sufficient discriminating diagnostic power to determine sexually deviant profiles without needing to resort to plethysmographic measures of sexual arousal.

AUTOMATIC PATTERN CLASSIFICATION

The first step in reaching these goals is to determine if an automatic classification system is able to discriminate sexual offenders from non-offenders using their oculomotor behaviors. Several classification algorithms exist; however, since the data are dynamic and nonlinear, not all of them are up to the task (Renaud et al., 2002b, 2003; Shellhamer, 1997). Multilayer neural networks present a good choice since it is a classic model that copes with problems that are not linearly separable (Haykin, 1999).

VIRTUAL CHARACTERS WITH SEXUAL FEATURES

The major asset of using synthetic characters (avatars) is that they guard against the victimization of the real models that are used with classic methods (Renaud et al. 2004). Avatars depicting naked characters of both genders and of clinically significant age phases are required to prompt sexual attraction and arousal. These avatars have been tested in order or make sure that they would minimally be perceived as representing the required sexual properties to assess sexual preference (Renaud et al. 2005). A neutral avatar was also developed for control purposes. Figure 1 illustrates the five characters used in this study, adult man and woman, young boy and girl, and the neutral character. Each character had two virtual measurement points (VMP) placed over their head and pubic areas for gaze behavior analysis.

Figure 1. Snapshot images of the avatars' prototypes: male and female adults, male and female children, and a sexually neutral avatar for control purposes.

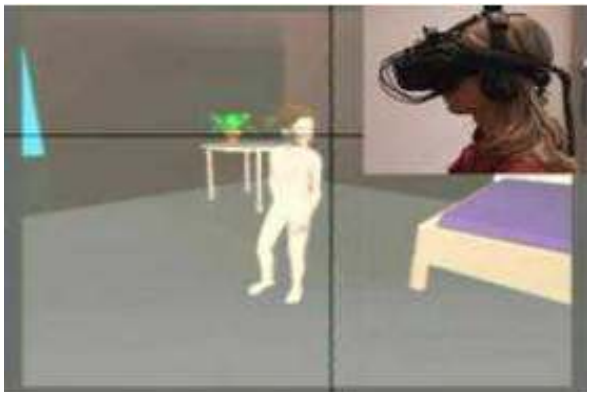

Figure 2. Inside the patient's point of view; the crosshair depicts the momentary point of regard of the immersed subject shown in the upper right corner photo.

GAZE BEHAVIOR MEASUREMENT IN VIRTUAL IMMERSION

Eye-tracking has been used in a wide variety of applications as a window to cognitive process (e.g. Albert, et al., 2005; Duchowski et al., 2002; Land & Lee, 1994; Satava, 1995; Suppes, 1990). The eye-tracker system relies on the corneal reflection of an infrared source that is measured relative to the pupil center location. These particular corneal reflections can be located with video-based eye-trackers collecting infrared reflections. From this information, a 2 degrees-of-freedom (DOF) computation of the point of regard (POR) can be performed (Figure 2). From that information, angular deviation between a given VMP and POR is computed (Renaud et al., 2002b, 2003).

From those data, it is possible to determine the number of eye fixations, saccades, average saccade speed, etc. However, data collected are usually not noise free. There is some noise due to eye blink and hardware failure in capturing corneal reflection. Figure 3 illustrates an example of 1 minute POR angular deviation data obtained from a human subject.

Noise degrades the signal and it is usually desirable to remove and replace it before any analysis can be performed. Thus, before any classification, the POR angular deviation was denoised using a filter based on a pulse couple neural network (Chartier & Renaud, 2006). From noise free data, a neural network was used to classify sexual offender from non-offender.

ARTIFICIAL NEURAL NETWORK

For the purpose of classification, a simple multilayer Perceptron was used. This network was chosen for its property of being a universal function approximator (Haykin, 1999). In principle, this network can approximate any function that exists. Like any other neural network, the multiplayer Perceptron is entirely defined by its architecture, output function and learning rule (Rumelhart and McClelland, 1986).

ARCHITECTURE

The network architecture is composed of several units that propagated the signal forward from the input layer to the output layer as seen in Figure 4.

OUTPUT FUNCTION

The output function of this network is a standard logistic function given by the following equation for the output layer

$$\mathbf{y} = f(\mathbf{a}) = \frac{1}{1+e^{-\mathbf{a}}}$$

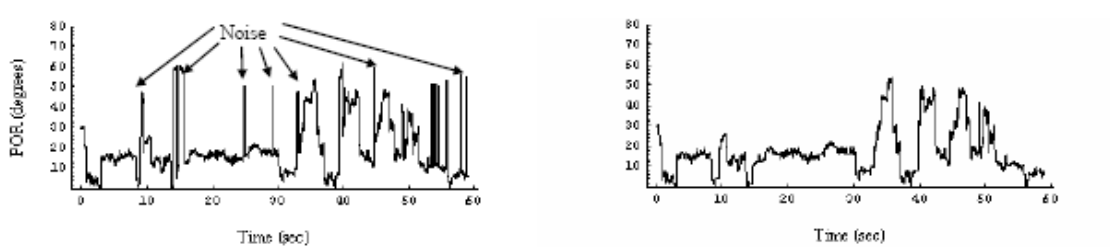

Figure 3. POR angle deviation before and after filtering

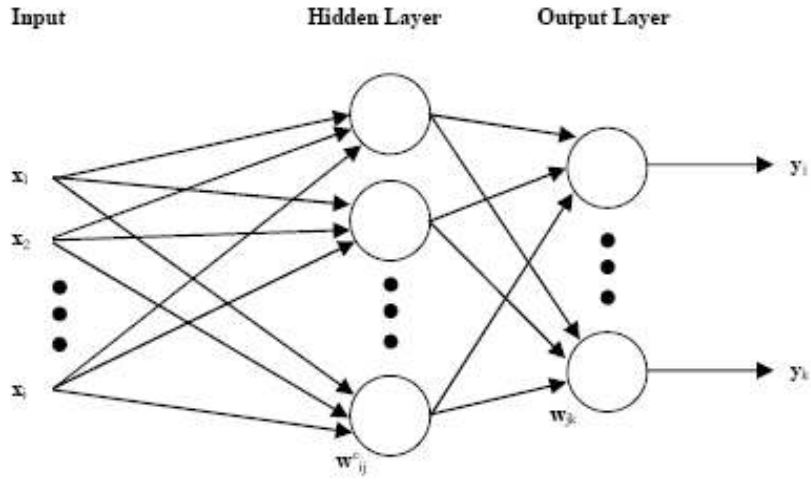

Figure 4. Architecture of the multilayer perceptron

Where **a** represents the activation (**a = Wy**^{c}), **W** the weights connection and **y**^{c} the output from the hidden layer. Similarly, the output of the hidden layer is given by

$$\mathbf{y}^c = f(\mathbf{a}^c) = \frac{1}{1+e^{-\mathbf{a}^c}}$$

Where **a**^{c} represents the activation (**a**^{c} = **W**^{c}**x**), **W** the weights connection and **x** the input. This general output function is illustrated in Figure 5.

LEARNING RULE

The learning rule used is the standard back-propagation algorithm. This learning consists of two passes through the different layer, a forward pass and a backward pass. In the forward pass, an input is introduced to the network and the corresponding output is computed following equations 1 and 2. From the difference between this actual output and the desired response (i.e. class membership) an error is computed. The greater the mismatch between the predicted membership classes (offender or non-offender), the greater the network parameter will be modified during the backward pass. In the backward pass, the error is thus fed back through the network and both the hidden and the output layer are modified to reduce this error. Formally, the learning in the network is accomplished, for the output layer, by the following equation

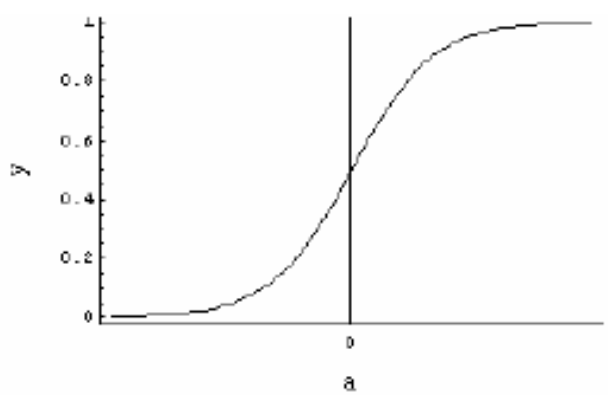

Figure 5. Output function

$$\mathbf{W}_{k+1} = \mathbf{W}_k + \eta \delta \mathbf{y}^{cT}$$

Where, η represent a general learning parameter (0< η <1), k the learning trial and δ is given $\delta = (\mathbf{t} - \mathbf{y}) \times \mathbf{y} \times (1 - \mathbf{y})$

For the hidden weights, the learning is accomplished using the following rule

$$\mathbf{W}^c{}_{k+1} = \mathbf{W}^c{}_k + \eta(\mathbf{y}^c \times (1 - \mathbf{y}^c) \times \mathbf{W}^T \delta)\mathbf{x}^T$$

Once the squared error is small enough (~ 0.01), the learning is stopped and the model is ready to be tested on its classification performance on both previously learned data and on new data.

METHODS

10 participants were recruited for the study. There were 6 child molesters attending the Sexual Behavior Clinic of the Royal Ottawa Hospital and 4 non-offenders. Each participant was tested with the 5 virtual characters presented above (neutral, woman, young girl, young boy and man). Each participant was immersed in the virtual environment for 1 minute per condition. Raw data were collected by an ASL 504 series eye-tracker combined with a V8 Virtual Research head mounted display. The single eye-tracker returns 2 DOF, i.e. variations in x and y plane, at 60 Hz with a margin of error ± 0.5 degrees. From the data file generated with ASL software, POR angular deviation was computed between the POR and a given target (WMP), which was the head or the pelvic area. Consequently, for each condition a vector composed of 3600 POR deviation angles elements was obtained. After data denoising, 4 variables were derived from the POR angular deviation. The first variable was the number of saccade, the second variable was the mean saccade duration, and the third variable was the amount of time the participant POR was within a virtual measurement zone (VMZ), i.e. 5 degrees around a VMP. Finally, the fourth variable was the mean POR dwelling time into a given VMZ. Thus for each participant, 40 data points were obtained (4 variables × 5 conditions × 2 VMZ), giving a total of 8 training patterns (4 offenders and 4 non-offenders).

To train the network, 4 sexual offenders and 4 non-offenders were selected. The remaining 2 sexual offenderd were used to test the network generalization capacity. The network was trained following equations 4 and 5. The number of hidden units was set to eight and the number of output units to one. The learning parameter was set to 0.05 and the number of learning trials to 10 000. Since the transmission function is asymptotic, we used a value of 0.999 to indicate that a given input belongs to the sexual offender and a value of 0.001 to the non-offender. For classification purposes, an

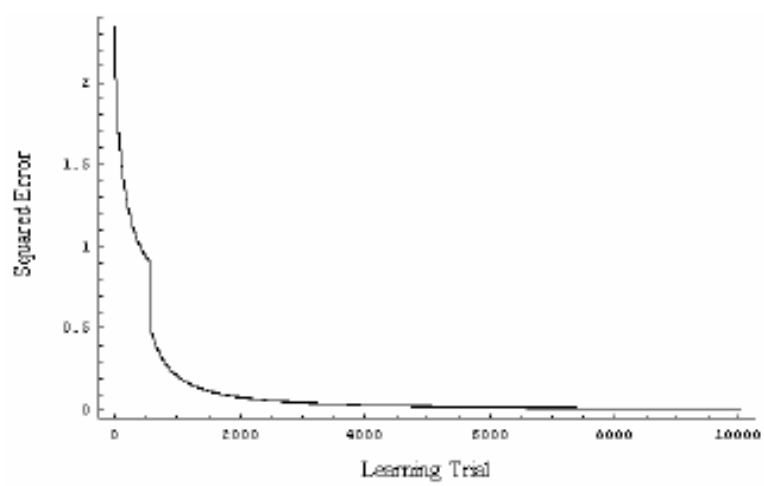

Figure 6. Network squared error in function of learning time.

Table 1. Network classification results

	Input measurement	Observed Output	Desired Output
Trained patterns	Non offender 1	0.0731	0.001
	Non offender 2	0.0438	0.001
	Non offender 3	0.0407	0.001
	Non offender 4	0.0438	0.001
	Offender 1	0.9530	0.999
	Offender 2	0.9705	0.999
	Offender 3	0.9875	0.999
	Offender 4	0.9705	0.999
Generalization patterns	Offender test 1	0.9699	0.999
	Offender test 2	0.9640	0.999

output value greater than 0.5 was classified as belonging to the sexual offender class, others to the non-offender class.

RESULTS

Figure 6 shows the squared error in function of the learning trial. After 10 000 learning trials the squared error was at a low value of 0.0128. Thus, indicating that the network had found a solution to the classification of offender from non-offender.

Table 1 reports the network output compared to the desired output. It can be seen that the network closely matched the desired classification. There is no case where the network could not assign a participant trained pattern to its corresponding class. Generalization capacity of the network was tested with two new sexual offender patterns (offender test 1 and 2). In each case, those generalization patterns were correctly assigned to the offender class. Thus even though the network had never before been fed with the given inputs, it nevertheless was able to accomplish the classification task.

CONCLUSION

It has been shown that oculomotor measurements could be used for automatic classification, distinguishing sexual offenders from non-offenders via an artificial neural network. The network classification is simply based on gaze pattern inputs coming from oculomotor dynamics recorded relative to virtual objects. Once trained, the network is able to generalize its classification function to new participants. This offline classification reveals a perfect performance even with few data.

For this classification task, the model used standard measures. Other more synthetic indices like gaze fractal patterns could be even more powerful variables (Renaud et al., 2002b, 2003, 2005). Before using this classification system for diagnostic purposes, several aspects must be further investigated. First, the network must be trained with more participants to give it a better variety of oculomotor patterns. Given the small sample of data in this study, results are preliminary at this point. In addition, other models, like the ANFIS model (Jang, 1993), must be studied to pinpoint which condition, time or measure, is the most explicit about the classification if underlying processes. Finally, the model should be modified to be used for real time classification. This online implementation would allow feedback in helping to better understand deviant behavior. In this way, this new tool would not only help in diagnostics and risk assessment, but it could also be an active ingredient in behavior modification therapy.

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Application of Virtual Reality-Cue Exposure Therapy for Reducing Alcohol Craving

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Abstract: *During abstinence from alcohol, craving is elicited by the cues and contexts previously associated with alcohol, which contribute to relapse. To prevent the craving and relapse experienced by alcoholics, cue-exposure therapy (CET) has been used to extinguish the association between alcohol and alcohol-related cues and contexts. This study applied CET, using a virtual reality (VR) system, to eight members of an Alcoholics Anonymous group, in eight sessions. Cues and contexts most likely to elicit an urge to drink were selected through a preliminary survey in order to compose VR-CET scenarios: a glass, bottle, food, and a bar were judged to be the most tempting for people in alcohol dependence and abstinence. Using these cues and contexts, a Japanese-style pub and a western bar were created. Each session was administered for 30 minutes by a psychiatrist and included an introduction, immersion, VR navigation, interviews about feelings, and self-report questionnaires about cravings. The eight sessions consisted of initial and closing sessions, and person-, object-, and situation-focused sessions. As a result, a reduction in cue-elicited craving after VR-CET was reported. A mean score of 15.75 (SD = 10.91) on the Alcohol Urge Questionnaire in the first session decreased to 11.57 (SD = 6.88) in the final session. This study suggests that using virtual reality can enhance the efficacy of CET so as to promote craving for alcohol and then to desensitize conditioned reactivity to alcohol.*

INTRODUCTION

Craving is considered the reason why many drug users and alcoholics fail to exercise restraint even after treatment. One of the explanations about craving is based on Pavlovian conditioning: some contexts or objects (e.g., bottles, glasses, and bars) are repeatedly paired with addictive substances (unconditioned stimuli: US) so that the contexts or objects which become conditioned stimuli (CS) that can elicit the addict's urge (conditioned response: CR) to use, just as an unconditioned response (UR) to addictive substances occurs. After this conditioning, the addict feels the craving when confronted with the CS. Thus, the cue that evokes cravings is regarded as an activator of addictive behaviors.

Other researchers have offered a different explanation of the cue's effects: Tiffany suggested (1990) hat, rather than eliciting cravings, drug-related cues provoke automatic behaviors, such as drug use, that have been formed through repeated administration. For example, if a person has been accustomed to dropping by a grocery store, buying alcohol, and then drinking every day, the person would buy alcohol and drink automatically after seeing a favorite brand of alcohol in a shop, even during abstinence. In any event, a cue may contribute to relapse; thus, many researchers and practitioners have tried cue-exposure therapy (CET) to reduce the urge to use a drug and the rate of relapse. CET is used to extinguish the associated responses (CR) through repeated exposure to the cues related to addictive substances, but without the US.

CET has been applied in the treatment of a variety of substance addictions, including smoking (Corty & McFall, 1984; Niaura et al., 1999), drinking (Rohsenow et al., 2001; Sitharthan et al., 1997) and drug using (Dawe et al., 1993; Franken et al., 1999). However, the effect of CET has not been consistent. Tiffany and Conklin (2002) supposed that some CET studies failed to prevent relapse because the treatments were done with just one cue, so that the extinction of a CR to one cue could not be generalized to the others. That is, the fact that drug administration is paired with many kinds of objects and contexts should have been considered. In addition, extinction in one context (e.g., hospital) does not have an effect in another

context (e.g., a site usually used for drug-taking). This explanation is based on the "renewal effect" from classical conditioning research (2002). Thus, it would be more helpful if the treatment setting were similar to the original conditioned context and had as many related cues as possible.

In terms of the various associations of drug use, previous trials have limitations: most research has been done in a treatment setting, such as a hospital or laboratory, with one or two stimuli. In contrast, VR technology and 3D animation techniques can provide a diverse range of situations and stimuli, and a feeling of being in a bar rather than in a hospital. This would evoke the craving more effectively than traditionally used methods, such as still photos, and allow the generalization of treatment effects into real life situations. In a previous study (Lee et al., 2004), abstinent smokers in VR-CET composed of various smoking-related cues reported presence (i.e., the sense of being there), and showed a reduced urge to smoke after VR-CET.

Thus, in this study, we investigated whether CET using VR was an effective method of reducing alcohol craving in alcoholics. Before applying this method for alcoholic outpatients, a precise and detailed survey was required to explore which cues were most likely to induce craving and which locations were most likely to elicit an urge to drink. A VR-scenario was then constructed. This survey is elucidated below with the VR-CET study.

MATERIALS AND METHODS

Preliminary survey and *composition of cues and scenarios:*

To investigate the cues and contexts most likely to elicit cravings, we asked open-ended questions of three groups: alcohol dependence inpatients (Ward group), abstinent people in an Alcoholics Anonymous group (AA group), and light drinkers (normal group).

The Ward group was recruited from the department of psychiatry at S Hospital in Seoul and consisted of 49 patients diagnosed with alcohol dependence according to DSM-IV criteria. The AA group consisted of 35 people (from S Hospital, and from R Hospital in Seoul). Sixty-three light drinkers were selected using the criteria that, at most, they consumed nine standard glasses of alcohol in a week. The Ward group's mean age was 42.98 years (SD = 87.03), the AA group's was 42.34 years (SD = 7.52), and the normal group's was 39.10 years (SD = 10.58). There was no significant difference in age between groups.

Participants in each group were asked: 1) which places elicited a craving to drink (list all that apply), 2) which objects elicited a craving to drink (list all that apply) and 3) which place or object was most likely to induce cravings.

The results showed that bars and one's own home were perceived to be the most likely places to elicit cravings in the Ward group. Bars and amusement quarters were thought to be the most likely places to elicit cravings in the AA group. Food and bottles were chosen to be the most likely objects to elicit cravings in both the Ward and AA groups. Furthermore, the Ward and AA group participants answered that places evoked more cravings than objects (Ward = 79.17%; AA = 93.10%; Normal = 95.16%); However, more Ward group participants regarded objects as being highly evocative of craving than the other groups. Based on these results, VR-CET scenarios were constructed for two places: a Japanese-style pub, and a western bar. Both places had people drinking, side dishes, glasses, some bottles of the participants' favorite alcohol, alcohol advertisement posters, and the types of noises that emanate from real bars.

Participants

Ten participants from an Alcoholics Anonymous group were recruited for the study and wrote their own fully informed consent statements; however, two participants later dropped out. Thus, eight participants underwent eight sessions of VR-CET for 4 weeks (2 sessions a week). The mean age of the participants was 50.5 years (SD = 14), and all had been hospitalized more than once for alcohol treatment. Their average period of abstinence was 58.75 months (SD = 98.07), and they used to drink, on average, 28 standard glasses (316.8 ml of pure ethanol) of Soju daily. Soju is an inexpensive, moderate-proof (21%) liquor that is very popular in Korea.

Measurement and VR instruments

Three scales were used for measuring the level of alcohol craving: the Penn Alcohol Craving Scale (PACS: Flannery et al., 1999), the Alcohol Urge Questionnaire (AUQ: Bohn et al., 1995), and the Obsessive Compulsive Drinking Scale (OCDS: Anton et al., 1995). The PACS is a five-item scale that focuses on the urge that the participant felt to drink during the previous week, using a 7-point scale. The AUQ consists of eight items about dependence on, and preoccupation with, alcohol, and also uses a 7-point scale. The OCDS consists of 14 items that quantify thoughts about alcohol and drinking behavior, and uses a 5-point scale.

The hardware consisted of a Pentium IV PC, Open GL Accelerator VGA card, a beam projector with a 2.4m × 1.8m screen, and surround speakers.

At the beginning of the VR-scenarios, the entrances to two bars in the middle of a hallway were shown. If a user entered a bar, a bartender and a few people drinking at tables were there. Some people drank alone, and others drank with buddies. On the tables, there were some alcohol bottles, such as beer, Soju, and whiskey with side dishes, and typical bar noise was ongoing. A poster advertising alcohol was on the wall.

TABLE 1. CONTENTS OF THE CET PROGRAM SESSIONS

session	*Theme*	*CET program content*
1	Initial navigation	The participant was free to navigate during the initial session. 1. Have you navigated VR sufficiently? 2. Tell us about what you felt and thought after the VR. 3. How do you feel and think about the objects and situations in the VR?
2	Person-elicited craving	Interview with the participant about the person that elicits craving 1. How do you feel seeing a man drink alcohol alone in the virtual bar? 2. How do you feel seeing a woman drink alcohol alone in the virtual bar? 3. How do you feel seeing people who drink together?
3	Object-elicited craving	Interview with the participant about the object that elicits craving 1. What bottle makes you want to drink? 2. What side dish makes you want to drink? 3. What advertisement poster makes you want to drink?
4	Situation-elicited craving	Interview with the participant about the situation that elicits craving 1. How strongly do you want to drink when you see someone drink in the western bar? 2. How strongly do you want to drink when you see someone drink in the Japanese bar? 3. If you run out of alcohol, do you want more? How would you drink more?
5	Person-elicited craving	Repeat the questions of 2nd session
6	Object-elicited craving	Repeat the questions of 3rd session
7	Situation-elicited craving	Repeat the questions of 4th session
8	Final navigation	The participant was free to navigate during the final session. 1. How do you feel and think now after you've navigated the VR for several sessions? (Compare with the 1st session) 2. How do you feel and think now about the objects and situations that you saw in the VR, and what do they make you feel like doing? 3. If the VR experience happened to you in real life, what would you do?

Procedure

The VR-CET was run with all the participants as a group session at R hospital. Before the first VR-CET session, participants were asked for their demographic data, medical history, and a survey of their drinking behavior (e.g., frequency of being fuddled and experience of injury due to alcohol), and asked to report their desire for alcohol on the three scales. After each session, participants again completed the AUQ scale, and at the end of the final session, all three scales were completed again.

Each of the eight sessions took 30 minutes, and each session was divided into three parts: an introduction and immersion part for 5 minutes, a VR navigation (a psychiatrist showed the participants VR scenes as if they had walked into the bars) and interview (about their feelings and thoughts) part for 20 minutes, and a self-report questionnaire part for 5 minutes. In Session 1, the whole VR environment was shown. In Sessions 2, 3, and 4, each cue-exposure focused on a different craving type; Session 2 focused on person-elicited craving, Session 3 focused on object-elicited craving, and Session 4 focused on situation-elicited craving. These three session types were repeated for Sessions 5, 6, and 7. Finally, Session 8 focused on the prevention of relapse. A detailed description of the contents of each session is shown in Table 1.

RESULTS

Findings from the preliminary survey showed that in all groups, people craved alcohol when faced with a bar and food, and that Ward and AA groups participants felt the urge to drink more at an amusement quarter, at home, and in front of their favorite alcohol bottle, compared with normal group. In the main experiment, repeated-measures Analysis of Variance (ANOVA) indicated that the mean scores of the responses to the three questionnaires did not change significantly from pretreatment to posttreatment (Table 2).

The mean score on the AUQ decreased between the first and final sessions (Figure 3), although ANOVA revealed that the reduction was not statistically significant.

Participants responded to interview about their feelings and thoughts, depending on the focus of the sessions (Table 3). In person-focused sessions, they reported, for example, “Seeing a woman drink alone, I wanted to join her and drink together”. In object-focused sessions, they reported, for example, “Soju bottle makes me crave more for drinking than a beer bottle”. In situation-focused sessions, they reported, for example, “The Japanese bar makes me crave more for drinking than the western bar because of familiarity”. They also made general comments about the series of sessions, for example, “Audio stimuli made me feel more realistic than visual stimuli” and “The more I was exposed to stimuli, the less tension was produced.” Given the variation in responses, the failure to find a significant change despite a decrease in self-reported craving is understandable.

DISCUSSION

This study surveyed the situations and objects that elicited craving in normal, inpatient, and abstinent people in order to create VR-CET scenarios, and investigated the effectiveness of VR-CET in reducing craving for alcohol in order to prevent relapse. Although mean scores of craving on the three questionnaires were not significantly reduced after 8 sessions, the participants’ urge to drink, as assessed by AUQ, had decreased gradually after each session. Admittedly, the effect of participant demand characteristics on the experiment should be considered.

As shown in Table 3, various environmental cues in VR-CET were effective in eliciting cravings, at least in early sessions. This effect of environmental cues is consistent with that of

TABLE 2. THE MEAN SCORES OF THREE QUESTIONNAIRES

Questionnaires	Pretreatment	Posttreatment	*F*
PACS	7.50 ± 2.62	11.50 ± 5.76	1.436
OCDS	23.25 ± 7.44	24.29 ± 8.38	0.286
AUQ	9.44 ± 2.23	11.50 ± 5.76	2.222

TABLE 3. SUBJECTIVE RESPONSE TO CET

Session	Interview responses to CET sessions
Person-focused sessions	*-Seeing a woman drink alone, I wanted to join her and drink together.* *-If I drank with a woman, I would drink much more.* *-I have never thought about drinking with a woman.* *-I have never drunk with a woman so that I really want to drink with a woman.*
Object-focused sessions	*- Soju* bottle makes me crave more for drinking than a beer bottle.* *-Only a bottle catches my eye in the screen.* *-I salivate as soon as I see a Soju bottle.* *-Western alcohol bottle was not attractive or realistic.*
Situation-focused sessions	*-The Japanese bar makes me crave more for drinking than the western bar because of familiarity.* *-I was evoked even at the hallway, and I wanted to enter other bars.* *-Because of repetition, I want to drink a little bit.* *-The fact that alcoholics are mostly fond of drinking alone was overlooked.*
General comments	*-Audio stimuli made me feel more realistic than visual stimuli.* *-It's not realistic.* *-The scene, drinking alone, is more attractive.* *-The more I was exposed to the stimuli, the less tension was produced.* *-The possibility of keeping abstinence would be increased.* *-I became curious.*

previous VR-CET study (Lee et al., 2004) about smoking cessation. However, eight sessions may be too few to desensitize the susceptibility to alcohol-related cues, to extinguish previously associated behavior, and to learn new associations (i.e., that alcohol-related cues no longer bring pleasure). Furthermore, because most people drink in a number of different places, two scenarios may be insufficient to cover all participants' familiar places that evoke conditioned responses. Thus, it would be better to increase the number of sessions until the extinguished responses do not re-emerge, and to show more scenarios in order to avoid the "renewal effect" mentioned above.

The clinical histories of the eight participants varied in severity. The duration of abstinence of four participants was at most 3 months; however, two participants had remained abstinent for at least 13 years. The latter consistently reported that they had no urge to drink. Thus, given the small number of participants, it is possible that the latter had a large influence on the overall insignificant changes of craving. Moreover, a bar scene might not elicit some participants to crave because they reported that the scene of drinking alone in their home would be more attractive. Similarly, in the preliminary survey, the Ward group reported that one's own house strongly elicited craving. Hence, in the next study, these alcoholics' atypical preferences should be considered. VR-CET would be more effective if adapted to each individual's history and favorite stimuli. Even though the dynamic interaction in the group setting is effective to promote participants' reaction to treatment, in order to practice individual-focused treatment, an individual treatment setting would be more convenient.

Alcohol and drug cravings include physiological arousal so self-reports of craving are usually inconsistent and not good predictors of relapse (Tiffany & Conklin, 2000). Thus, to assess one's craving and the effectiveness of CET more precisely, psychophysiological assessment is needed (Franken, 2003). Future studies will clarify the effectiveness of VR-CET for alcoholics by using psychophysiological measures such as fMRI, EEG, and an eye-tracker.

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Clinical Observations

Evaluating the Interaction of Blind Learners with Audio-Based Virtual Environments

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Abstract: *Diverse interactive virtual environments have been designed by using only visual interfaces, reducing the likelihood that users with visual disabilities can benefit from them. This study aims to create efficient ways for integrating these tools into the visually impaired community in order to improve their education and integration into society. We have created and applied a new tool to observe and record blind user interactions with an audio-based virtual environment. Thus we can observe and study how well blind users comprehend and understand virtual environments and extrapolate implications for later adaptation and orientation in real environments. The study highlights the advantages of an embedded computer system that processes information about the user interaction. The results demonstrate that blind users do not represent the whole virtual environment. There are some variables and conditions that set up different degrees of complexity in navigating through the environment. We have also determined that the representation capacity of a virtual environment is related to the user's audio memory.*

INTRODUCTION

The objective of this study is to help to solve two current problems in the study of the interaction of blind learners with audio-based virtual environments. The first problem is the need to get richer information from user interaction with the software. Current related projects include usability tests and cognitive tasks in conjunction with some anecdotal records of user interaction with the virtual environment (Sánchez, 2000, 2003; Sánchez & Flores, 2004; Sánchez & Aguayo, 2005; Sánchez & Sáenz, 2005). In the particular case of interaction with audio-based virtual environments, due to the number of users and facilitators involved in a test session, it is impossible to record all events. For this reason it has been necessary to include a computer system that helps detect usability problems and measures the cognitive impact of these virtual environments.

The second issue is uncertainty about whether any virtual environment, regardless of complexity and interaction time, can be represented by visually impaired users independently of its complexity and interaction time. Diverse research works (Baldis, 2001; Cooper and Taylor, 1998; Kurniawan et al., 2004; Lahav & Mioduser, 2000; Loomis et al., 2002; Mereu & Kazman, 1996; Sánchez, 2000; Westin, 2004) have demonstrated that by using auditory signals, it is possible to create virtual environments that can be mentally represented by visually impaired users. In order to explore this second problem we have designed *AudioGram:* a software program capable of processing information generated by user interaction with virtual environments. After an internal process of data acquisition, the software allows researchers to recreate interactions with computer simulations. It also allows the creation of graphs with relevant data, visualization of the information from different points of view, observation of a particular interaction session in detail, and the processing of information from a group of interaction sessions in order to analyze problems and the achievement of goals over a long period.

AudioDoomII, the new version of the software AudioDoom (Sánchez & Lumbreras, 1999), developed in 1997, was used during this study for modeling AudioGram. This new version includes new features: a) Automatic saving of log files with information about the whole interaction behavior of a user during a gaming session; and b) Loading new maps of labyrinths from external files, allowing the freedom to study different maps depending on the needs of the study.

By using these tools, we have studied and observed with higher precision the capacity for mental representation of different virtual structures. In doing this we aim to define the minimum, medium, and maximum degree of complexity of a virtual environment for use by the visually impaired. The goal is to create work plans for an environment that allows blind people to improve their audio perception capacity (audio memory, fidelity, and audio discrimination) and to comprehend geometrical problems such as shorter distance and symmetry.

AUDIOGRAM

AudioGram is a tool capable of taking blind users' log files from a particular game and displaying them on the screen for information analysis. A timeline is shown on the screen with different events that represent user actions in the game. In AudioDoom2 these events are, for example, opening doors, shootings, bullets recharging, monster elimination, walking, etc. It is also possible to move through the timeline in both directions in order to observe a sequence of actions in more detail. This option has two other associated elements: a text description of actions as they occur in the game, and a small map that shows the exact location of the player on the map at a certain time (see Figure 1).

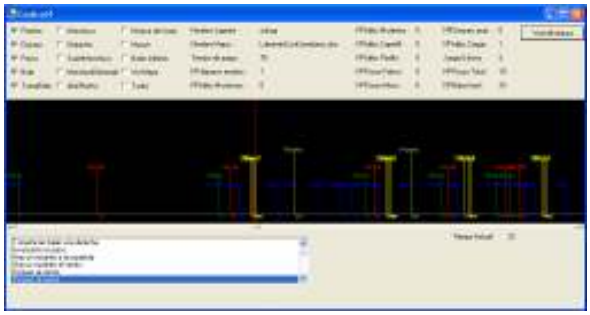

Figure 1. *AudioGram, game analysis.*

AudioGram also offers the possibility of observing some long-term variables such as playing time, the amount of actions performed, errors, collisions, and the like. The software graphs these data with the purpose of displaying the player's behavior variations. On the horizontal axis of the graph a number representing each session is displayed, offering the option of selecting any session to show a detailed analysis in a new window (see Figure 2).

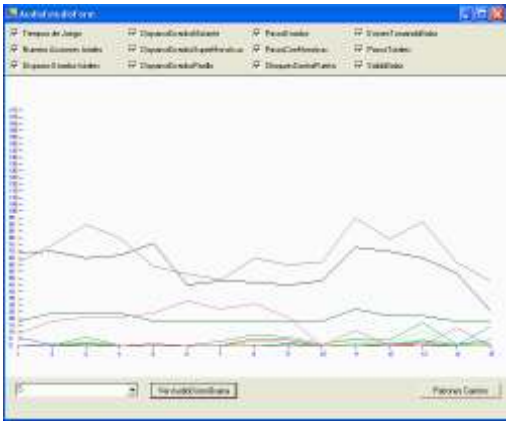

Figure 2. *AudioGram, analysis of multiple players.*

METHODOLOGY

This study was implemented in two stages. The first stage consisted of using AudioGram to discover and define blind user limitations when navigating through different virtual structures of AudioDoomII. Using these results, during the second stage a working plan was defined for a set of cases.

During the first stage of this study we selected a sample of 10 blind users ages 20 to 31 from the "Escuela de Ciegos Santa Lucia." In each session an average of 4 subjects participated in different experiments. Each experiment consisted of an interaction exercise with the virtual environment. The interaction was repeated until the user felt capable of representing the navigated environment on a drawing assisted by a special education facilitator. Then researchers processed the log information with AudioGram to be able to visualize user behavior during the session and compare it with his or her representation on paper.

The second stage consisted of studying a work plan for users to play AudioDoomII progressively and with increasing complexity. The user is able to pass from one stage to another by transferring a mental representation to a physical medium. In this stage, 5 users ages 10 to 16 from the "Escuela de Ciegos Santa Lucia" participated. At the beginning, a short-term audio memory test was taken (AMI). The idea was to focus on audio memory as the key variable for virtual environment comprehension, thus determining whether or not continuous interaction with AudioDoomII improves the user's audio memory capacity.

AudioGram functionality was tested with AudioDoomII in a previous stage. Children interacted with the virtual environment in the school once a week for 4 weeks. At the end of the sessions, AudioGram's log files were processed.

RESULTS

During the previous stage, some usability problems of AudioDoomII where detected. It was observed for example that the use of unlimited bullets affected the user comprehension of the events involved in the software. Some audio feedback problems where also detected. We also observed that users did not travel through the entire labyrinth embedded in AudioDoomII (see Figure 3).

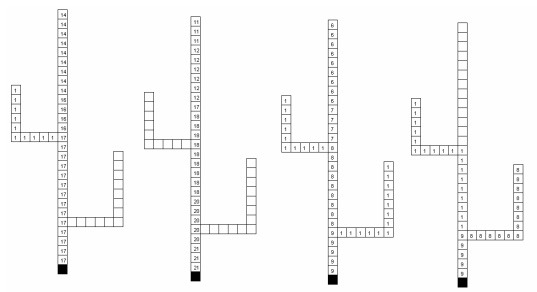

Figure 3. Travel patterns obtained by AudioGram. Numbers in cells represent the number of times the user passed through them. Cells without numbers where not crossed by users. Numbers at the first cell shows the number of times the user played.

First stage

Experiment 1

This experiment was designed to establish whether or not blind users are capable of representing any type of virtual environment. With this purpose in mind, a map with four different routes (including a zigzag route) was designed. These routes were longer than those used in earlier studies (Sánchez & Lumbreras, 1999). Figure 4 displays the original map (left side) together with displacement frequencies (AudioGram). The black square shows the initial point. Users were requested to follow all routes up to the final point identifying the shortest route. At the right side of each figure a described representation of each subject case is shown. The gray route was the shorter route perceived by users. Representations without a gray route are from users who did not identify a shortest route. It is important to observe Case 3. This user had the highest representation performance, but made errors when perceiving the shortest route. By using the information processed by AudioGram, we verified that regardless of using less time to travel through the shortest route, he had an incorrect perception of the route.

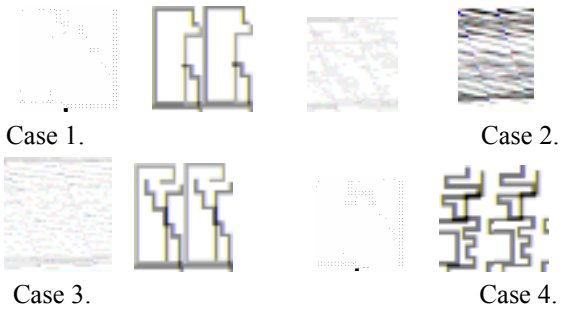

Figure 4. *Representation of routes followed by users.*

With the help of AudioGram we can observe the user's real routes through the environment. This allows us to know what the user can represent, avoiding errors when evaluating the user's performance.

As a result of this experiment we understand that users memorized the number of turns and sequences, but that they did not represent the routes followed with high fidelity. We also comprehended that a map with more than one route implies extra complexity. A zigzag route was almost never represented regardless its symmetry.

Experiment 2

In light of the results of the first experiment, we decided to generate a new experiment with only one route in order to study the zigzag route. Figure 5 shows the representations described by the subjects along with the actual route followed.

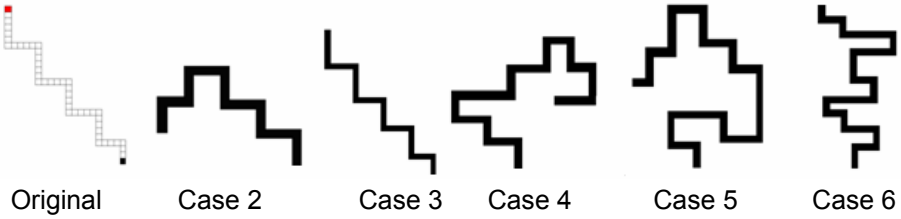

Figure 5. Representation of the zigzag route traveled by users.

We can observe that the user who obtained the highest representation in the first experiment also obtained the best representation in this experiment by achieving the comprehension of symmetry. The other cases did not comprehend the map symmetry, illustrating that a zigzag environment is complex to represent, despite the symmetry and the repetitive form of the displacements.

Experiment 3

The purpose of this experiment was to analyze user performance on a map that included 15 non-symmetrical direction changes. As this is a high complexity map, we hypothesized that users would hardly be able to represent it. Figure 6 displays the representations made by the subject cases.

Surprisingly the results obtained were not expected. Two out of five cases accomplished the representation of the map in a range of 75%. It is observed that they are the same cases that obtained the highest representations in earlier experiments.

Experiment 4

The purpose of this experiment was to determine if users who participated in previous experiments were capable of mentally modeling a labyrinth with a proof design (original Audio-Doom labyrinth). The idea was to study whether or not the problems observed in previous experiments referred only to the number of direction changes made in the maps. We also studied labyrinth modeling fidelity according to the number of steps followed. Figure 7 displays the

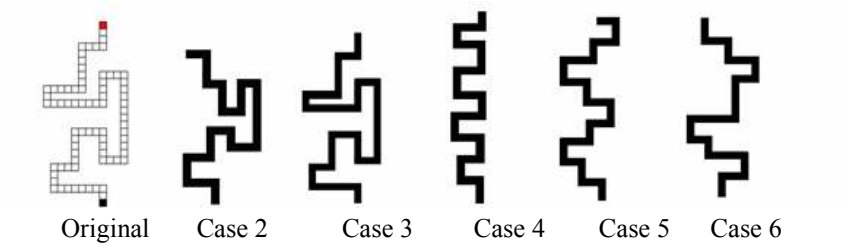

Figure 6. Representation of a non-symmetrical navigation.

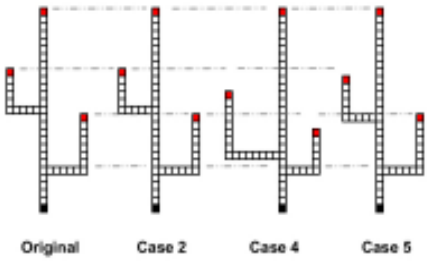

Figure 7. Representations by fidelity level based on navigation.

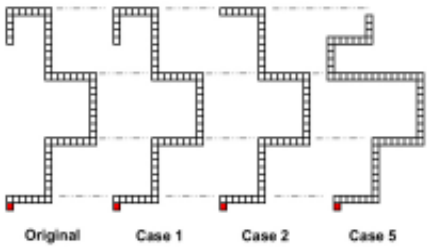

Figure 8. Representations obtained after interacting with a complex environment.

described representations of subject cases. Each cell describes a step in concordance with the real map.

From these results we can deduce that a labyrinth with two turns per route is very easy for blind users to represent; thus fidelity is tied to the number of times a specific route was traveled. As was observed during data analysis through AudioGram, when a user travels a route more than four times, their representations are very similar to reality.

Experiment 5

Using previous results, we inferred that navigational complexity in virtual environments is produced by the number of direction changes a labyrinth offers. This experiment tries to find the maximum number of turns a user can retain for a given period of interaction of interaction with the virtual environment (15 minutes). A single route with 8 direction changes was used. Figure 8 displays the described representations for each case compared to the original map.

These results show us that all users could represent the route correctly except two subject cases. Users 2 and 5 became disoriented after the seventh direction change. Through these experiments we observed that the number of turns or direction changes creates complexity in a virtual environment, and that, on average, more than 6 turns cause most users to become disoriented. This makes us think that the representation capacity of this type of virtual environment is directly related to the capacity of the user audio memory. The strategy used by all users to represent a map was to memorize the sequence of turns and estimate the number of steps between them.

Stage 2

By considering all the experiments designed in the first stage, we developed a leveled work plan to study the relation between the user's audio memory and their capacity to represent virtual environments. Once users took the audio memory test (AMI), they interacted with the software by following the level order shown in Figure 9, increasing a level once they could make a paper representation of the previous one.

Table 1 displays a comparison between the results of the AMI test and the ones obtained from the experiments made in Stage 1. The achieved level is the highest users could represent correctly. Correlation coefficients between the results of the test (and its sections) and the user performance are also included.

As we can see in Table 1, there is a correlation between the test section on numerical memory and the performance of subject cases in the representation of navigated vir-

Figure 9. Levels by increasing the number of turns.

Table 1. Memory test scores and results of achieved levels.

	Logic Memory	Numerical Memory	Associative Memory	Audio Memory	Level Achieved in Gaming
Case 1	8/46	12/15	25/42	49/118	1
Case 2	2/46	0/15	0/42	2/118	0
Case 3	12/46	12/15	35/42	71/118	2
Case 4	12/46	13/15	15/42	53/118	3
Case 5	7/46	10/15	38/42	65/118	4
Correlation Coefficient	0.533	0.763	0.671	0.755	

tual environments, which leads to a correlation with audio memory.

DISCUSSION

This study verifies that not all audio-based virtual environments are capable of representation by blind users. We also observe the advantages of having a computer tool that processes user interaction with the virtual environment. This allows for a deeper observation and analysis of different experiments with audio-based virtual environments. This tool was also useful for the detection of some functionality failures and usability issues that were not detected by classical evaluation methods.

We identified the strategies employed by blind users to represent a virtual environment. The main aspect of this strategy consisted of memorizing the sequence of direction changes and comparing relative distances between landmarks or reference points. It is interesting to reveal that the strategy used for navigating in a virtual environment is very similar to the strategy used by blind users in their travels in real life. This offers us the possibility of improving this ability by training blind users with this type of software, providing a powerful tool for their integration into real life.

We also observed that there is a direct relation between audio memory and route representation. The higher audio memory capacity a user has, the better their capacity for representing a virtual environment. This challenges us to study the possibility of improving the user's audio memory by using these virtual environments more thoroughly.

Another future task is to study and measure other skills related to the capacity of representing virtual environments by clearing up which skills are really involved in cognitive representation of navigated spaces and routes.

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Generic virtual reality treatment applied to space-related phobias

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Abstract: *Several studies have demonstrated the efficacy of virtual reality (VR) for treating phobias, justifying its use as an alternative to exposure therapy. However, we argue that VR goes beyond in vivo therapy in that it challenges multisensory integration, thereby providing a radically new form of treatment. We recruited 10 patients with space-related phobias to follow a new form of VR therapy. In all cases, samples were homogeneous, presenting one specific phobia. We hypothesized that non-specific VR treatment would be effective, regardless of the phenomenological specificity of the phobia. We propose the use of global desensitization, by means of VR exposure, for agoraphobic, acrophobic and claustrophobic patients. Three types of virtual environments (VEs) were presented to the patients:*

- *VE devoid of frightening features, to allow the patient to get used to the set up.*
- *VE containing anxiety-generating features. The chosen VE did not include the situation feared by the patient, but could potentially generate anxiety as it dealt with space (VE non-representative of the main phobia).*
- *VR representing the main specific phobia (phobia-specific VE). This type of exposure was designed to address the threat-related beliefs and behavior.*

Post-treatment evaluations (clinical global improvement, phobia severity, quality of life, handicap, behavioral avoidance, and fear questionnaires) showed an improvement in overall functioning for all measures.

INTRODUCTION

Patients with anxiety disorders show several cognitive and behavioral symptoms. Some types of phobias (acrophobia, claustrophobia and agoraphobia) share a common property: strong sensitivity to space. Patients with anxiety may present with other disorders, especially those related to a vulnerability to sensory conflicts. Several VR-based studies have shown that anxious patients may find multisensory integration difficult (Viaud-Delmon et al., 2000; 2002). We took into account the sensitivity to space and problems with sensory conflicts, and developed a VR protocol addressing both of these issues, as well as the main phobia.

In addition to exposing and desensitizing the patient to anxiety-generating situations, as shown by previous studies (Emmelkamp et al., 2001; Krijn et al., 2004; Botella et al., 1998; Moore et al., 2002), VR challenges multisensory integration (Viaud-Delmon et al., in press). Patients have to cope with different sensory information (visual, auditory, vestibular, proprioceptive) and with the sensory conflict inherent to VR technology (due to the delay in feedback between action and its consequences in VR).

We hypothesized that patients with agoraphobia, claustrophobia and acrophobia would have similar cognitive distortions in the representation of space. Indeed, such patients might find it difficult to construct a coherent representation of spatial dimensions. Patients may experience discomfort (cybersickness) and anxiety in various situations representing different types of space: large or small spaces, open or closed spaces, heights, etc. We therefore used the same therapeutic program for patients with these three space-related phobias.

MATERIALS AND METHODS

Design

All the subjects included in the study underwent one evaluation session and nine sessions of exposure to different virtual environments (VE). Sessions were separated by at least one week. Before and after each session, patients had to complete questionnaires assessing parameters relating to immersion.

Procedure
The first session was devoted to evaluation of the patient and an explanation of the procedure to be followed. Virtual exposure began from the second session. Each session began with fifteen minutes of relaxation, which was then followed by immersion in a VE.

For exposure to the VE, patients were equipped with a head-mounted display coupled with an electromagnetic sensor system. They were immersed in the VE, in which they could move forward by pressing a mouse button. The patients could change direction in the VE by turning around their own vertical axis.

The first set of three sessions was designed to habituate patients to the sensory conflicts inherent to the technique (conflict due to the delay in feedback between action and its consequences in the VE). These conflicts generate cybersickness: symptoms and sensations associated with autonomic arousal (nausea, sweating, heart pounding, etc), vestibular symptoms (dizziness, fainting, etc.), and respiratory symptoms (feeling short of breath, etc). The symptoms of the type generated in response to VR resemble the symptoms of panic experienced by patients confronted with the situation they fear. Such symptoms may arise during therapy, particularly in anxiety-generating environments. These initiation sessions enable the patients to learn to control bodily sensations.

In the next stage of therapy (3 sessions), patients were immersed in a VE containing features that generate anxiety in various space phobias. The chosen environments did not represent the precise situation feared by the patient, but could potentially generate anxiety as they dealt with space. The aim was to treat anxious reactions in situations other than those dreaded.

The final stage (3 sessions) corresponded to more classic progressive exposure to the feared situation. Patients were immersed in a VE representing the main phobia. The main aim was to address threat-related beliefs and behavior. During this stage, the therapist helped the patient to learn adapted cognition and behavior to reduce anxiety in the feared situations. Patients received training in the use of anxiety management strategies (reducing physical symptoms through relaxation, verbalizing their fear, trying to think more objectively). The anxiety of the patients was monitored through both observation and communication. During immersion, after five and fifteen minutes of navigation through the VE, they were asked to rate their level of anxiety on a ten-point scale (Subjective Units of Discomfort Scale, SUDS).

The virtual environments used in this study represented open and closed spaces and heights. Patients had to navigate and locate various landmarks. Involvement in a task increases the patient's capacity to cope with exposure, even in the presence of high levels of anxiety.

Participants
Subjects were recruited from the Psychiatry Department of Pitié-Salpêtrière Hospital in Paris.

Inclusion criteria
A licensed clinical psychologist diagnosed subjects using the Mini-International Neuropsychiatric Interview (MINI; Sheehan et al., 1998), which generates DSM-IV (1994) diagnoses. Only patients aged 18 to 65 years satisfying the DSM-IV criteria for panic disorder with agoraphobia, agoraphobia without history of panic disorder, or specific phobias related to space (acrophobia and claustrophobia) were included.

Patients participated in the protocol on a voluntary basis, and in accordance with ethical guidelines, gave informed consent for participation. The study was approved by the ethics committee of the Pitié-Salpêtrière Hospital, Paris.

Exclusion criteria
The following exclusion criteria were used:

- Principal diagnosis other than the types of anxiety disorder listed above
- Psychotic disorders
- Neurological or mental organic disorder
- Substance abuse or dependence
- Currently receiving another psychotherapeutic intervention
- Subjects on medication meeting the selection criteria were included only if they agreed not to change their medication and not to increase its dose during the study.

Table 1: Characteristics of participant

Case	Sex	Age	Phobia (type)	Anxiety (STAI-Y-B)	Depression (BDI)
Patient 1	F	26	Claustrophobia	27	2
Patient 2	F	50	Acrophobia	46	6
Patient 3	F	57	Acrophobia	33	4
Patient 4	F	57	Acrophobia	51	7
Patient 5	M	37	Claustrophobia	61	29
Patient 6	M	65	Acrophobia	54	10
Patient 7	F	57	Agoraphobia	48	6
Patient 8	F	43	Claustrophobia	47	6

Sample

Ten patients met the selection criteria: two later withdrew (one moved away, the other withdrew for personal reasons) and eight patients completed the study. The patients' characteristics are described in Table 1.

Anxiety was measured with the Anxiety Trait Scale (Spielberger et al., 1983)
Depression was measured with the Beck Depression Inventory (Beck & Beamesderfer, 1974)

Measures

Pre-treatment measures

Diagnoses were established with a structured interview (MINI). The level of depression was measured with the Beck Depression Inventory (Beck & Beamesderfer, 1974), and that of anxiety with the Trait Anxiety Inventory (Spielberger et al., 1983).

Pre- and post-treatment measures

Other parameters were evaluated twice, to determine the effects of treatment. These measures included determinations of Clinical Global Impression scale score (Guy, 1976), phobia severity (Cottraux, 1993), handicap and incapacity (Sheehan, 1983), quality of life (Marks, 1993), and behavioral avoidance (Marks, 1985).

During treatment

Anxiety state (STAI-state) was measured before each session, upon arrival at the laboratory and then again after completion of the session. A 22-item cybersickness scale was used after the session to assess the level of discomfort during exposure to VR. This scale consisted of a list of symptoms and sensations associated with autonomic arousal (nausea, sweating, heart pounding), vestibular symptoms (dizziness, fainting), and respiratory symptoms (feeling short of breath). Patients were asked to rate each symptom on a scale of 0 to 4 (absent, weak, moderate, strong).

The presence questionnaire (Schubert et al., 2001) was completed at the end of each exposure session, to assess the level of immersion. Anxiety levels were assessed at the beginning and end of exposure, using the Subjective Units of Distress Scale (SUDS), which give a score of zero to ten. We also evaluated the cognition and emotions of patients during exposure.

Apparatus

We used a V8 head-mounted display (Virtual Research Systems, Santa Clara, CA). The LCD displays had a monocular field of view of 48° by 36°, with an array of 640Ï480 (true VGA) color triads (pixels) refreshed at a rate of 60 frames per second. The orientation of the subject's

Table 2: Self-reported scales, before and after treatment

Patients (n=10)	**CGI** (0-7)		**Phobia severity** (0-8)		**Quality of life** (0-40)		**Handicap** (0-30)		**Fear Question-naire** (0-120)		**Behavioral avoidance** (0-4) Symptoms when faced with the feared situa-tion (0-32)			
	pre	*post*	*pre*	*post*	*pre*	*post*	*pre*	*post*	*pre*	*post*	*pre*	*post*	*pre*	*post*
Patient1	6	2	6	4	9	3	11	6	15	3	2	0	31	20
Patient2	5	1	8	4	9	8	9	8	25	20	3	0	31	14
Patient3	5	2	8	2	6	3	6	1	11	5	2	0	31	15
Patient4	6	1	8	4	22	9	20	12	34	12	2	0	32	18
Patient5	7	2	8	5	25	15	17	15	34	14	2	2	32	20
Patient6	7	2	8	5	26	9	16	9	33	16	2	1	32	18
Patient7	6	2	8	2	24	8	15	4	36	13	1	0	30	19
Patient8	4	2	6	3	9	3	8	4	23	12	1	1	26	15

head was determined with an electromagnetic sensor system (Nest of Bird, Ascension) with an update rate of 120 Hz.

RESULTS

As predicted, anxiety reactions were observed even when patients were immersed in environments that did not represent the targeted situation described by the patient (second step of the therapy). SUDS scores were also high in environments dealing with another type of space phobia. For example, patients with agoraphobia experienced anxiety reactions when immersed in a VE dealing with acrophobia. Our results for the more classic exposure to the targeted situation confirmed the efficacy of VR therapy for reducing anxiety.

All scores were lower after exposure to VR (Table 2). The scores for phobia severity and avoidance behavior decreased considerably, providing evidence of a therapeutic effect. In three cases, the patient continued to display avoidance behavior, but nonetheless felt less anxious in the feared situation. The general treatment proposed in this study was therefore beneficial to the patients.

All patients declared that they were able to carry out at least one activity that was impossible before therapy. For example, one patient with claustrophobia took his wife to the movies. At the end of therapy, one patient with acrophobia went on vacation in the mountains. In addition, patients manifested numerous symptoms of cybersickness during initial exposure, which decreased during treatment, suggesting improvements in the integration of multisensory information delivered by VR.

DISCUSSION

The results concern various subclinical symptoms. Although the situations feared by the patients were very different, all patients found it difficult to cope with different representations of space. This general treatment for space-related anxiety was effective. Participants in this study with various space-related phobias declared themselves more able to face the specific situation in real life. All stages in this therapy had therapeutic effects. The first step in therapy, designed to habituate the patient to VR, made it possible to correct erroneous beliefs and the misinterpretation of bodily sensations (experienced as cybersickness generated by the VR set-up), without visualization of the feared situation. The use of nonspecific environments (step 2) made it possible to treat anxious manifestations independently of the main phobia. This type of exposure was crucial for treating the fear reaction and avoidance in general.

Patients were desensitized not only with the avoided situation, but also with other types of situations dealing with space. At the end of the therapy, patients displayed greater self-confidence when exposed to the feared situation. The initial results obtained in this study show improvements in overall state, and particularly in the quality of life of patients with space-related anxiety. Further controlled studies are required to demonstrate the common dimensions of phobias and the generic effects of VR therapy applied to phobias.

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Virtual Therapy in Patients with Depression. Preliminary Observation

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INTRODUCTION

Depression disorder with anxiety is considered an important public health problem. The efficacy of cognitive-behavioral therapy (CBT) for depression has been widely demonstrated. Depression is a serious disorder that needs a careful diagnosis. Also the duration of the illness is important, as all people tend to experience bouts of depressed mood that disappear in a few days. Severe depression can last for weeks, months or years. Many therapists tend to combine the cognitive and behavioral techniques into one single package for the patient, customizing it to the needs of the individual. Studies have shown that these strategies can be very effective with a large number of depressed patients.[1,2]

Anxiety disorders are classified according to whether the anxiety is persistent (general anxiety) or episodic, with the episodic conditions classified according to whether the episodes are regularly triggered by the same cue (phobia) or not (panic disorder). The more severe form of panic disorder features agoraphobia - the fear of open spaces, fear of being outside of the house alone or fear of being in crowds. [2,3]

The use of VR as a therapeutic tool, in the psychological field, has made a big impact in the last five years. The desire to improve people's quality of life has meant, at the same time, an evolution regarding the instruments used compared to the traditional tools in psychology. But Virtual Therapy (VT) has several advantages compared with conventional techniques. [4,5]

VR is having a great acceptance by clinical community given the enormous potential that offers.

The inclusion of the virtual environment does not alter anything of what Korchin considers essential for psychotherapy, that is, the belief in the possibility of change, the faith in the therapist as an expert, the positive expectations towards therapy and the motivation to change, the therapist's qualities as a person who inspires reliance and safety, communicates respect and desire for helping, who is able, in short, to get the patient's complete cooperation. [6,7]

The therapist can make the patient to understand that the virtual scenario allows him/her to know the situation that he/she has always considered threatening and with absolute security of being protected since nothing he/she fears can occur. The virtual scenario is, actually, a "safe base" that therapy offers to the patient and from which he/she can freely explore, experience, feel, live, revive feelings and/or thoughts being these either current or past. Finally, another important advantage of VR is that allows the person to go beyond reality. [8,9,10]

Measures: In this open study we compared two types of treatment – virtual reality therapy and cognitive-behavioral therapy – for patients showing a major depression and anxiety. Two groups of patients are formed and compared: a "VT" group and a "CBT" group. For collecting the data concerning this issue we used these scales: HAMD, STAI, CGI, Q-LES-Q. The data were processed using the SPSS statistics software, 11.0 version.

Equipment: The devices used are a PC. The features required are: Pentium IV or equivalent, 256 MB of RAM, CD-ROM drive, a monitor capable of displaying 1024 by 768 in 16 bit color, a Direct3D or OpenGL compatible 3D Graphic Accelerator Card with 32 MB of RAM, a Pointing Device (Mouse, etc.), and a Sound Card. The software required is Microsoft Windows XP, 2000, Microsoft Internet Explorer 5.0 or

higher, and Microsoft DirectX 9.0 or higher for DirectX compatible 3D Graphic Accelerator Cards. As for the visual devices we use a V6 (*Virtual Research*) HMD (Head Mounted Display) as the patient visual device, and a 17" Monitor as the therapist visual device. The Navigation & Interaction Devices are a mouse (2 Buttons) as the patient navigation & interaction device, and a Keyboard as the therapist interaction device. The Audio Devices are Headphones as the patient audio device, and Headphones as the therapist audio devices.

We use the computer program that was created by our engineer collaborator. The patients need to choose what they want to see. This includes many small programs, multiple imagines for different theme, and the patients select few small programs and in finally he created an inedited therapeutic plan in VT.

Objective: These were aimed at highlighting: 1. Decreased severity of the depression; 2. Interference of depression with academic performance and social life; 3. Identification of a possible VR efficacy.

Participants: The survey included 20 patients with depression and anxiety, ages between 25 to 50, all received antidepressive medication. Two groups of patients are formed and compared: a "VT" group and a "CBT" group. For all 20 patients the duration and severity of the depression were estimated by the HAMD's scale, anxiety estimated by the STAI's scale, CGI-S's scale and Q-LES-Q to assess the degree of enjoyment and satisfaction experienced by subjects in various areas of daily functioning.

The allocation of patients to one of these two groups was done according to some constraints (more specifically the ability to use computers and virtual reality software) while ensuring of the homogeneity of the two groups in terms of significant criteria: sex and age of the patient, duration and severity of the depression.

The themes for VT were chosen according to the objectives of the study and were based on the previous research concerning patient' interests and needs at this severity depression and anxiety.

METHODS

The instruments used to establish the diagnosis are the following:

Screening Interview: This instrument, developed by our group, screens information about demographic variables, reasons for seeking treatment, duration of the disorder, perceived severity, past treatments, alcohol and substance intake, and presence of physical illness. The instrument also screens the occurrence of possible anxiety disorders.

Consent Form: Patients will read and sign an informed consent form about the study before starting the assessment phase.

Medication control: During the study, the patient cannot increase the medication dosage. However the patient can start taping medication when he/she feels better with the guide of a psychiatrist. This is an index of improvement that should be recorded using this instrument. The therapist has a record of the type and dosage of medication throughout all the process.

Diagnostic Interview: It is a semi-structured interview that assesses the DSM-IV anxiety disorders and mood disorders and screens for other major disorders. We will use the sections for depression and anxiety.

Hamilton Rating Scale for Depression: This is one of the most widely used inventories for evaluating the presence of depressive symptoms. It is a 21-item self-report questionnaire.

State-Trait Anxiety Inventory: The Anxiety Trait is defined as a relatively stable anxiety apprehension by which participants differ in their tendency to perceive situations as threatening and to increase, consequently, their state of anxiety. The State Anxiety reflects a "transitory emotional state or condition of the human organism that is characterized by subjective, consciously perceived feelings of tension and apprehension, and heightened autonomic nervous system activity." State anxiety may fluctuate over time and can vary in intensity. The scale has 20 items, half of them formulated in a positive way and the other half in a negative way. Scores on the STAI have a direct interpretation: high scores

on their respective scales mean more trait or state anxiety and low scores mean less.

Clinical Global Impression (CGI-S): The therapist answers the question: *Considering your clinical experience, how do you evaluate the global severity of this patient?*, and evaluates from a clinical point of view the global impression about the patient's severity in a 1-6 subjective scale.

Q-LES-Q (Quality of Life Enjoyment and Satisfaction Questionnaire): To assess the degree of enjoyment and satisfaction experienced by subjects in various areas of daily functioning. It is aself-administered questionnaire may aid in monitoring quality of life outcomes of mood disorder patients.

The treatment program for Cognitive behavioral therapy include several components: a) Educational; b) Slow breathing training; c) Cognitive Therapy; d) Exposure; e) Relapse prevention. The treatment program includes nine sessions.

Our VR program is called Depression- Anxiety. It has seven Virtual Environments: "the room", "the subway", "the sea", "the mountains", "the shopping mall", "the family", "the colleagues".

RESULTS

Results show that the virtual therapy group will improve at least as much as the cognitive and behavioral therapy group, and the results for virtual therapy group show up quickly, after 2 months of treatment.

Virtual reality offers the therapist and patient total control over their environment and the ability to proceed at an individualized pace. It is important to remind patients that VR allows them to "feel and experience" what happens when coping with a anxiety situation, but in a completely safe context. Patients should be introduced to the system at the first session with a brief explanation of what they are going to do and what they will encounter. It is very important to help patients get inside the situation. Therapists must be careful to contextualize the environments, adapting them to aspects of daily living with short introductory stories.

The results show that if we compared media of two groups we see that media of depression before and after CBT decreased more like for media of VT. But, the differential is small. We need emphasize that results of VT are received much early, in 2 month.

Regarding the measures related to the level of depression, our data so far showed that VR exposure and in vivo exposure achieved a similar efficacy and both were

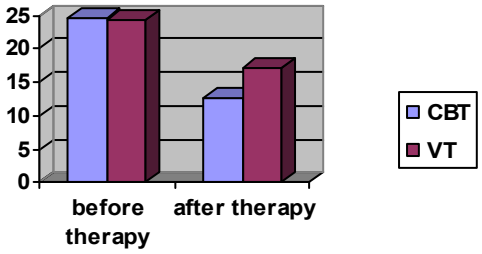
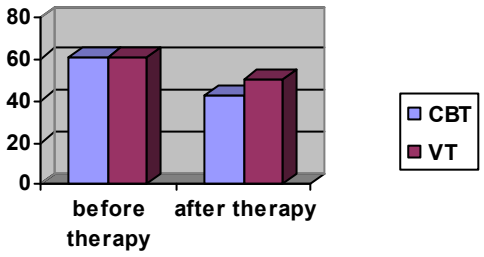


Table 1: Depression Level: before and after therapy (CBT or VT)

	Group	Moment of Assessment	N	Media	P
Depression Level	CBT	Initially	10	24,63	0,001
		Finally	10	12,66	
	VT	Initially	10	24,40	0,001
		Finally	10	17,10	

Table 2: State Anxiety Level: before and after therapy (CBT or VT)

	Group	Moment of Assessment	N	Media	P
State Anxiety Level	CBT	Initially	10	50,46	0,001
		Finally	10	32,40	
	VT	Initially	10	50,26	0,001
		Finally	10	39,90	



significantly more efficacious than the waiting list group in measures directly related to depression and anxiety and impairment.

As for the measures related to effectiveness axis, both treatment conditions seemed equally effective regarding the expectations and satisfaction related to the exposure component, the improvement rated by both the clinician and the patient, and the clinical status evaluated by the clinician.

CONCLUSION

Results show that the virtual therapy group will improve at least as much as the cognitive and behavioral therapy group, and the results for virtual therapy group show up quickly, after 2 months of treatment. Benefits in VT: more realistic assessment, reduced therapy cost, increased safety, improve quality of life.

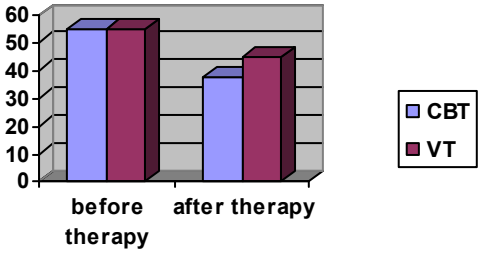


Table 3: Trait Anxiety Level : before and after therapy (CBT or VT)

	Group	Moment of Assessment	N	Media	P
Trait Anxiety Level	CBT	Initially	10	54,96	0,001
		Finally	10	37,60	
	VT	Initially	10	54,50	0,001
		Finally	10	44,46	

The study was conducted in the Virtual Therapy Unit of the Socola University Hospital, Iasi, Romania. This unit it is the first Centre of Virtual Therapy in Romania.

Virtual Therapy (VT) has several advantages compared with conventional techniques. One of the essential components to treat these disorders is exposure. In VT the therapist can control the feared situations at will and with a high degree of safety for the patient, as it is easier to grade the feared situations. Another advantage is that VT is more confidential because treatment takes place in the therapist's office. It is also less time consuming as it takes place in the therapist's office.

We think that VT exposure can be a useful intermediate step for those patients who refuse in vivo exposure because the idea of facing the real anxiety situations is too aversive for them. VT was specifically indicated to allow patients in recovering their planning, executing and controlling skills by implementing sequences of actions and complex behavioural patterns that are requested in everyday life. Also, several story developments can be made available, each of them containing situations designed with different persuasive messages, depending on the user's responses and stage within the treatment, along several sessions.

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The Effects of Virtual Reality on Presence and Dissociative Experience

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Dissociative experiences, in particular derealization and depersonalization in particular, are characterized by a sense of unreality and detachment. The concept of detachment has a conceptual overlap with the idea of presence (i.e. the feeling of "being there"). The current study investigates the effects of immersion in a virtual reality environment on the sense of presence, and symptoms of derealization in objective reality using a non-clinical sample of ten participants. To measure presence both inside and outside of the virtual reality environment an adapted version of the iGroup Presence Questionnaire was used. To establish the extent of dissociative experience, the state version of the Cambridge Depersonalisation Questionnaire was administered to the participants. After completion of the initial baseline measures, participants were instructed to explore a virtual reality environment for twenty minutes. The experimental manipulation was followed by a second measurement of sense of presence and symptoms of dissociation (in normal reality). Results are discussed in terms of possible common underlying imaginative processes related to presence (or the absence of presence) in virtual reality environments and feelings of unreality and detachment in objective reality.

Biofeedback and Virtual Reality for Fear of Flying

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Current literature reviews reveal that virtual reality (VR) treatments are effective in reducing anxiety related to fear of flying (FOF). Furthermore, close examination of these studies suggests that biofeedback techniques based on respiratory sinus arrhythmia (RSA) may bolster the VR protocol, and thus, are worthy of investigation. RSA is frequently employed as a breathing technique designed to generate feelings of relaxation, by psychologists, who seek to help patients reduce sympathetic arousal. Biofeedback equipment is used to measure heart rate, EKG, respiration rate, diaphragmatic (belly) breathing and thoracic (chest) breathing. By engaging in slow (approximately six breathes per minute) diaphragmatic breathing and making sure to keep chest breathing to a minimum, patients gradually enter a state of RSA. This is clearly revealed on the computer monitor when inhalation is paired with an increase in heart-rate and exhalation is paired with a decrease. A "scalloping" effect emerges as both waves move together. The greater the disparity between maximum inhalation heart-rate and exhalation heart-rate drop, the larger the RSA, and thus, the more relaxed the patient appears to become. It appears that deep states of RSA are accompanied by feelings of deep relaxation, which can later be paired to phobic situations, in virtual reality, that typically generate anxiety. The present study will examine an experimental biofeedback (RSA) treatment protocol using VR for fear of flying phobia in comparison to the existing state of the art VR treatment therapy protocol of exposure therapy and extinction (no biofeedback). Treatment will be delivered over an eight-week period at Behavioral Associates (BA), in NY, investigating 40 patients seeking treatment for fear of flying. Participants will be randomly assigned to one of two treatment groups after they sign informed consent. Both groups will meet with their therapist for 45-minutes once a week for eight consecutive weeks. Furthermore, both groups will be requested to do at home exercises for 15 minutes daily and will receive Virtual Reality treatment as the method of exposure. One group will receive a treatment protocol of VR only. The experimental group will receive a combination of RSA biofeedback and VR exposure. Assessment will include a set of self-report measures at baseline and at the end of treatment, assessing

personality, (MMPI2), anxiety symptoms, sleep patterns, medication and treatment history In addition, physiological responses of heart rate, respiratory rate and galvanic skin resistance will be recorded while being exposed to the feared stimulus via VR. It is expected that both treatment groups will exhibit clinically significant reductions in anxiety, but a greater reduction of anxiety is expected in the experimental group. Thus we expect to see an interaction by treatment group. Outcome will be based on both subjective self-reports of anxiety and objective physiological responses (from biofeedback instruments).

Virtual Reality as a Research Tool in Neuropsychology: Depth Estimations in the Peripersonal Space

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Neuropsychology discovered the advantages of virtual reality. High realism, interactivity and control provide a wide spectrum of experimental possibilities. However there is a fundamental problem scientist have to deal with when using VR applications: depth perception. A large variability between subjects was observed regarding their ability to perceive distances in VR. Results on distance estimation are especially inaccurate, when objects are far away. In an experimental series different estimation tasks were compared to examine where participants perceive a virtual object in peripersonal space. This is the 3D space in which prehension movements take place and it is controlled by the dorsal cerebral cortex. In three experiments participants had to estimate distances in a simple virtual environment (blue space with a red target sphere) projected on a rear projection screen. In the two experiments verbal estimations were given, in the third experiment participants had to either point to the location where they perceived the target or had to fulfil a matching task with a real ball. The distance of the virtual sphere from the observer in Experiment 1 and 2 was 40 cm and 45 cm in Experiment 3. In Experiment 1 and 2 mean estimation values are 39.2 cm and 38.8 cm for the 40 cm sphere with no significant differences between estimated and true values. In Experiment 3 participants underestimated the distance of 45 cm in the matching task and overestimated it in the pointing task. So, the output transformation has an influence on the accuracy of depth estimation in VR. When discrepancies are compared between the verbal, pointing and matching task, MANOVA results reveal significant differences. Significant pair wise comparisons identify the matching task as the worst condition with an average discrepancy in percent of -29.6%. Accurate depth perception of peripersonal and extrapersonal distances in virtual space is essential for (neuro-) psychological research using VR. Targets have to be perceived where they are projected to avoid confounding effects. The purpose of this work was the identification of the influence of different output transformations. The verbal and the pointing task show that participants are able to perceive peripersonal distances in virtual environments correctly. There are no differences between estimating verbally or using ones own hand to describe a distance. From a neurological point of view this is important because especially in the peripersonal space depth perception plays a fundamental role for action control. When VR is used as a research tool, it is essential that depth perception is not limited, only then generalizability can be ensured. On the basis of the results, it is not expected that confounding effects occur when virtual objects are presented in the peripersonal space. But problems occur when real object (e.g. the hand) can be seen in the virtual scene or, as we know from previous studies, when distances beyond the peripersonal space are displayed. Hence, we recommend to use neuropsychological paradigms in peripersonal space without any real objects, which can cause depth confusion, to avoid confounding effects due to an unsatisfying depth perception.

Simulation-Based Training of Communication and Emotional Competence for the Improvement of Physician-Patient Relationship

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Recent research has determined that the training of health-care professionals in communication and emotional skills management is related to patients' satisfaction and compliance towards medical treatments. Moreover, a good communicative and emotional competence enhances the physician's sensitivity to the psychosocial aspects conveyed by patients and it may also help physician to cope with his/her own emotions, then reducing the burn-out effect. The learning of these capabilities is rooted in the real experience, since they require a number of cues that are managed *hic et nunc* in the flow of the communicative exchange. Therefore communication competence has been traditionally considered as a typical face-to-face/classroom learning topic. However, recent work on computer-based interactive simulations and autonomous agents is offering new opportunities for the training of communication and emotional competence in different professional contexts, as the medical one. In this way, the physician-patient interaction can be developed and enhanced in a realistic, but non-threatening situation. Practitioners in the medical field can train their communicative style in critical settings through different interactive scenarios that lead user's identification and experience in a safe context. The present work, as part of the EU-funded "MYSELF-project-*Multimodal e*-learning System based on *Simulations*, Role-Playing, Automatic Coaching and Voice Recognition interaction for Affective Profiling" (www.myself-proj.it), aims at investigating the potential benefits of computer-based interactive simulations for enhancing communication and emotional competence training in physician-patient relationship. In particular, this work is focused on the development of 3D interactive simulations and targeted multimedia exercises to improve specific communicative and emotional skills, such as empathy, emotional coping, non verbal communication management, reassurance, focusing on patient's needs, personal commitment. Within the e-learning simulations, the trainee interacts with virtual patients (modelled and animated with Poser 5) facing a number of problematic situations; he/she plays the role of the physician and is asked to actively manage the interaction with the patient. The system is endowed with speech-recognition capabilities, so that conversational interaction in the simulation is mainly voice-based. Throughout the learning path, a 3D animated virtual tutor that provides consistent feedback and monitoring assists the trainee. The research is currently in progress: the simulations and related exercises will undergo a validation study starting from the month of June. Developing training simulations requires a process of translation of real interactive situations into virtual environments and animated characters, and poses a number of challenges concerning how to elicit trainees' sense of presence in the simulation and how to ensure an effective transfer of learning into real professional context. This work represents an effort to face such challenges by focusing on key features for maximizing the simulation experiences: first of all, the development of an adequate model of the complex real-world social dynamics with which the user interacts; second, characters' design and animation with focus on believability and multimodality. The limitations and potential of such approach will be discussed into depth from theoretical and technological perspectives.

A VR Application for Dealing Difficulties with Hardship and Enhancing Resilience: A Treatment for Adjustment Disorders

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An Adjustment Disorder (AD) is a debilitating reaction to a stressful event or situation. It differs from Post-Traumatic Stress Disorder

(PTSD), which usually occurs in reaction to a life-threatening event and can be longer lasting. ADs disorders are very common and can affect anyone, regardless of gender, age, or lifestyle. The stressful event can be anything: it might be just one isolated incident (e.g. car accident), or a string of problems that wears the person down. (e.g., illness, divorce). An AD occurs when a person can't cope with a stressful event and develops emotional or behavioral symptoms. People with AD may have a wide variety of symptoms, depending on the particular subtype of AD and personality and psychological variables. AD has failed to interest researches (Stein & Wilkinson, 1998). However, this lack of interest contrast with the high prevalence of this disorder (5-20% of individuals in out-patient treatment, according to DSM-IV, APA19094) . and especially with the vast concurrent interest in related topics such as PTSD and life-events research into the precipitation of a range of mental disorders (Casey, Dowrick & Wilkinson, 2001). In previous studies, we have developed a Virtual Relaity (VR) application in order to treat PTSD, named "EMMA's world" (Botella et al. 2005). In that RV application the therapist and the patient could represent the experience suffered by the patient according to the specific therapeutic needs. In the present study**,** the potential for using new technologies (VR) with the aim of treating AD is examined. An adaptation of "EMMA's word" has been developed. The goal of this VR application is also to work with emotions related to the participants' psychological problem. The specific emotions depend on the specific ways in which the problem is symbolized in each of the scenarios. The VR application is designed to help the person experience the emotions and experiences which he/she is going through, to touch them and feel them; in short, to accept them and to live with them from another perspective. The therapy target is not only to help patients to cope with the stressful situation but also to train them in resilience skills. So, as Positive Psychology proposes, the target is more than an end to suffering, but also to help individual leading meaningful and fulfilling lives (Seligman. & Csikszentmihalyi, 2000). In this work we present the VR application, the clinical treatment protocol for AD, and the initial data about its efficacy in a controlled study.

The Use of Virtual Reality in Cognitive Neuropsychology: A Meta-Analysis

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Virtual reality is defined as a way for an individual to navigate and interact both in real time and in real life with objects and with different environments all of which in 3D that has been simulated by a computer. In the last couple of years, a number of studies in psychology, primarily for the treatment of specific phobias, were done by means of virtual reality. Furthermore, researchers in the field of neuropsychology have mostly been interested in the attentional, executive and mnesic dimensions of cognitive functioning. This type of research is in emergence and the virtual environments used in the evaluation and treatment are far too few and their evaluation is ongoing. The principal objective of this study is to present the main results that were obtained from a meta-analysis on the use of virtual reality from the viewpoint of cognitive evaluation and intervention. In order to carry out this study a systematic review of literature of cognitive evaluation and intervention in neuropsychology was done using the following computerized search engines: MEDLINE, CYNAHL, COCHRANE LIBRARY, PSYCINFO, INGENTA, ERIC. 184 studies were compiled. After reading all of the summaries, 62 articles were retained and special consideration was given to studies that presented results derived from an experimentation done with a correlationnal or quasi-experimental estimate. Case studies were also used in this meta-analysis. Finally, the findings will help answer the following questions: were the cognitive treatments offered by using virtual reality efficacious? Is there a difference if the treatment is done in immersion or not? Which experimental schemas are most wildly used in research? What are the indicators of effectiveness of the treatment?

Empirical Bases for an Internet Mediated Support Group for Individuals Living with Tinnitus in Québec

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The goal of this study was to examine the nature of socially supportive communication that took place within an internet-mediated support network for individuals affected by tinnitus.. This support group list was created for individuals suffering from distressing tinnitus. Tinnitus involves the internal perception of noises and sounds that are not generated by the auditory sensory system. Preceding studies showed that out of 500 individuals affected by tinnitus, approximately 350 expressed significant distress and impact on daily activities and quality of life. Tinnitus is not presently medically treated with predictable results and, in average, lasts from several months to several years, with no scientifically demonstrable curative method. Methodology and procedures: No similar study was done on this topic in the review of literature in the province of Québec, Canada. The absence of non-internet local support groups in many regions of the province of Quebec, and the research surveying the need for such support (Baribeau et al, 2005) led to the creation of an email list where participants were offered support and answers to their questions. Out of approximately 350 individuals expressing a need for support groups, 98 provided contact by email/ internet. The list of volunteers for such a group was made from contacts at conferences on tinnitus at regional locations: Québec, Montréal, Victoriaville, Bécancourt, Trois-Rivières, Informed consent was obtained with the standard procedures. Using item analysis, 100 emails were examined with reference to four themes of questions, using similar method to other similar groups on the internet (Coulson, N.S., Cyberpsychology & Behavior), 2005, Vol. 8, No. 6: 580-584) for support: such as affective, informational and factual, networking, and professional and paramedical help). Results: The analysis suggests that the primary function of this group was the communication of factual information, particularly with questions about symptoms quality, intensity, duration, prognostic factors, and medical causative variables. The second most frequently invoked theme related to the interpretation of evolution of symptoms. The 3rd category related to requests for references to medical and para-medical practitioners; The 4rth theme referred to issue of care, to ways of handling symptoms and related impact on stress tolerance, depression, anxiety, fear of aggravations. These results will provide the basis for the offering of a internet-based continuous service as part of the RQPA- Quebec grouping of resources for individuals suffering from tinnitus. As expected, the main factor discriminating participants involved by internet and participants not available on the internet was age, followed by education level. Conclusion: This initiative fostered new opportunities for individuals with tinnitus-related concerns to participate in supportive communication within a network of individuals dealing with similar issues. These results lead to the recommendation that regional contact agents attempt to provide internet access to their support group members and to interested individuals without home access to email and internet. Thanks to RQPA-Québec.

Flexible Virtual Reality Cue-Exposure Platform for Drug Abuse Studies

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Background/Problem: Drug abusers suffer an abysmal record of relapse after treatment, and new treatment strategies are clearly necessary. Craving to use is strongly correlated with relapse. In combination with cognitive behavioral techniques, cue exposure has been used to treat many forms of drug abuse through graded exposure and desensitization to relevant stimuli that trigger cravings. We have developed software featuring a user interface that allows flexibility for researchers and clinicians in configuring graded, cue-exposure sessions with abusers of cigarettes, alcohol and/or crack cocaine. Method/ Tools: Several environments have been created using the Source game development engine from Valve, the makers of Half-Life2. These consist of a crack house, an apartment, a bar/restaurant and an outdoor, urban street-scene that interconnects the interior environments. Models and characters were created in 3D Studio Max, and the characters animated using the Gypsy Gyro 18 motion

capture system and two Cybergloves. All of the characters and many of the models are available for placement in the virtual world through a drag-and-drop interface that allows the experimenter to configure the software before a therapy session with a variety of models, characters and interactions appropriate for the individual client and their therapeutic stage. For example, initial treatment sessions for crack cocaine might have only an empty crack house, but in later sessions the crack house might contain many models of drug paraphernalia and characters smoking or dealing crack. These configurations can be saved for later editing and use with other clients. Presently, the environments and characters can be configured for any one of three drugs of abuse, so that the apartment can be populated with appropriate paraphernalia and interactive characters for cigarette, alcohol or cocaine studies. Results: Open trials are now in progress. Preliminary results indicate that the virtual environments are effective at provoking graded cravings across a broad range of desired craving levels. The user interface is sufficiently flexible that the experimenter is capable of manipulating craving levels (on a scale of 0-10) from lowest to highest urges in a single therapeutic session. Conclusion: A flexible VR platform has been created that can be used in studies of treatment effectiveness for multiple drugs of abuse. Ongoing open trials indicate the effectiveness of the software in provoking a wide range of cravings tailored by the experimenter to the ongoing state of the client within and between individual treatment sessions. Novelty/ Discussion: Previous studies have shown the utility of using VR for drug abuse, cue-exposure studies, especially for cigarette smoking (Bordnick et al., 2004; Baumann & Sayette, in press). The basic technique has been modified and extended to create a software platform with broad flexibility and utility for the treatment of multiple drugs of abuse - presently cigarettes, alcohol, and crack cocaine; and the underlying drag-and-drop architecture, featuring a library of selectable, graded, stimulus cues, can readily be extended to other drugs of abuse as well.

Virtual Reality for Teaching Street Crossing Skills to Children with Autism

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Many children with autism are not independent in their instrumental activities of daily living (IADL) including the skills needed for street crossing. This is a particularly crucial skill because it involves exposure to potentially dangerous situations, and it is an important step in the development of independence. Moreover, the difficulties that characterize people with autism cause them to be at a higher risk for getting hurt in pedestrian accidents. Most of the existing programs designed to teach these skills are presented within a classroom setting and have not been demonstrated to be effective. In contrast, virtual environments facilitate learning in a safe environment, provide opportunities for repeated learning trials, and enable a gradual increase in the complexity of tasks until they approach the conditions of real life situations. The purpose of the current study was to describe the use of a desktop virtual street crossing environment by children with autism, to examine whether they are capable of learning the skills needed to safely cross a street via this VR system, and to determine whether any skills learned via VR are transferred to a real life situation. A desktop VR street crossing environment was adapted for use by children and adolescents with autism. Twelve children took part in the study. The experimental group included six children who were diagnosed as having autism/Pervasive Developmental Disorder and who went to a school for children with autism. Three of the children (two boys and one girl) were in Grade 2 and three children (all boys) were in Grade 8. The control group included six typically developed children who were matched for grade and sex with the experimental group. The research tools included the Childhood Autism Rating Scale to determine the severity of autism. The children's performance while street crossing within the virtual environment was scored within the program. A pedestrian safety checklist, based on observation of taped video clips, was used to assess the children's functioning while they walked within a protected real sidewalk and street crossing environment before and after

the VR intervention. The results demonstrated that children with autism were capable of understanding the virtual environment and of learning to use it. A significant difference between the performance of the experimental and control groups within the virtual environment was obtained on the maximum level completed during the first meeting. The experimental group showed substantial improvement in their ability to safely cross the virtual street from the beginning to the end of the intervention. Finally, half of the experimental subjects improved in their pedestrian behavior within the protected real street setting when tested at the completion of the VR intervention. These findings demonstrated that this virtual street crossing environment was eminently suitable in both its cognitive and motor demands for the target population, children and adolescents with autism. The results of this study emphasize that VR may be used as a tool for teaching skills that are needed for street crossing because of their likelihood to be transferred to real life situations.

The Technology Acceptance Model: A Potentially Useful Tool to Understand Why Therapists Intend to Use or Not Virtual Reality

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The Technology Acceptance Model (TAM) developed by Davis (Davis, 1989, 1993 ; Davis & Venkatesh, 1996) has been extensively validated to explain the factors involved in people's intention to use computers or softwares at the office or at home. The TAM can reliably predict the usage intentions and the actual usage of information technology. This model is based on four factors: external factors, perceived usefulness, perceived ease of use and attitude toward using the specific technology under study. Venkatesh (2000) has added four personal factors to the TAM: computer self-efficacy, perceptions of external control, computer anxiety and computer playfulness. As confirmed with structural equation modeling, all these factors impact directly the perceived ease of use dimension and on the behavioural intention to use the technology. No studies have yet been conducted on factors related to the use of virtual realty by mental health practitioners. The aim of this poster it to share with people attending to the CyberTherapy conference information about the TAM and discuss how if may apply to virtual reality. It will also describe a research project that we will launch at the Conference. Based on the TAM model and questionnaires used by Davis and Venkatesh, we developed 32 items to measure the factors potentially involved in therapists' intention to use virtual reality to treat mental disorders. As this study is still in its infancy, attendees at the CyberTherapy Conference will be welcome to participate in the study.

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A Flexible Virtual Environment: The Treatment of Storm Phobia

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Most of the virtual environments currently available in the field of psychological treatments are designed and developed to solve a specific problem, being this acrophobia, flying phobia, claustrophobia or panic disorder. Our research group has tried to develop versatile

virtual reality (VR) systems that could be useful in different fields, that is, an adaptive display. In a previous study we developed a VR application called "EMMA's world" for the treatment of PTSD (Botella, García-Palacios, Baños, Guillén, Quero, Lasso de la Vega & Osma, 2005) and pathological grief (Botella, Baños, García-Palacios, Quero, Guerreo, Liaño & Perpiñá, 2005). The aim of the present work is to show the utility of that environment for the treatment of a storm phobia. The patient is a 70 year-old woman. The problem caused her a severe interference and distressing when there were storms. At those moments, unless the patient could "protect herself" completely at home (getting into a wardrobe and wearing headphones to isolate herself from the exterior world), severe panic attacks were produced. The phobia started in her childhood, getting more severe as time went by. The patient contacted the group through information published in a local newspaper about our works. The treatment was applied in two phases: a) *In vivo* exposure, which consisted of exploding globes following a hierarchy from small to bigger size; b) Exposure to virtual environments simulating storms, rain, thunders and lightning. The intervention was composed by these two phases because the patient was not able to confront a storm, even being a virtual storm. The reason why a first exposure hierarchy of exploding globes was introduced was that the patient also feared unexpected and strong noises. Results indicated that the first treatment phase was useful so the patient could go forward to the next phase of what she called "terrible", that is, a virtual storm. However, *in vivo* exposure to the noises produced by the globes did not solve the problem at all. When the patient started to confront a virtual storm, she showed an intense anxiety and distress. Later, the anxiety was notably reduced and the positive results were generalized to real life. The patient was able to travel (something that she never did since she feared that a storm could happen and she could not protect herself) and go out of home even with bad weather. Besides, these results were maintained at one-month and one-year follow-ups. In summary, the utility of our VR adaptive display as a therapeutic tool in a case of an elderly patient (who still considers new technologies very useful) is proven.

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VR Exposure in the Treatment of Panic Disorder and Agoraphobia: A One-Year Follow-Up

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Research status: Controlled Clinical trial. One-year follow-up data available. Background: Panic disorder, with or without agoraphobia (PDA), is one of the most prevalent mental disorders in the general population. PDA could affect patients' quality of life severely (Schmidt & Telch, 1997). The efficacy of Cognitive-Behavioral Treatment programs (CBT) for the treatment of PDA has been widely demonstrated (i.e., Barlow, 2002; Barlow, Raffa & Cohen, 2002; Gould, Otto & Pollack, 1995) However, despite these promising findings, there are still limitations on the availability of these treatments or the non-acceptance rates and difficulties in the application of some therapeutic strategies in these programs like exposure. It is important to explore new ways of delivering CBT programs in order to reach a higher number of patients. The main aim of this study is to offer data about the effectiveness of Virtual Reality Exposure (VRE) in the treatment of panic disorder and agoraphobia (PDA). Method: The study is a clinical trial with a between-subject design. Participants were randomly assigned to three experimental conditions (VRE group, IVE group, and waiting-list group (WL) and repeated measures (pre-treatment, post-treatment and one-year follow-up). The treatment programs lasted nine weekly sessions. Thirty-six patients meeting DSM-IV criteria for PDA (APA, 2000) partici-

pated in this study. Results and conclusion: Our results support the efficacy of VR exposure in the treatment of PDA. The improvement achieved using virtual exposure was superior to a waiting list condition and similar to that achieved using in vivo exposure. The therapeutic outcomes were maintained at one-year follow-up. Novelty: This is the first study showing long-term efficacy of VR exposure in the treatment of PDA.

Perceived Realism has a Significant Impact on the Feeling of Presence

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Studying the impact of realism on the feeling of presence and anxiety is becoming a popular research topic. In general, studies are suggesting that a minimal level of pictorial realism is necessary to induce the feeling of presence. Less realism may be required to induce anxiety. However, every study is focusing on objective properties of the virtual experience, such as pictorial quality, texture and shading, or adding sensory information (i.e., smell, touch). The aim this study is to experimentally manipulate perceived realism to assess its impact on the feeling of presence. The sample consists of 31 adults suffering from the specific phobia of mice randomly assigned to either an experimental or a control condition. First, all participants are immersed in a neutral / irrelevant virtual environments (virtual streets, no mouse) and rate their level of presence. Second, participants are subjected to the experimental manipulation. Participants in the experimental condition are falsely lead to believe that they will be immersed live in real time a “real” room with a “real” mouse in a cage. To create this illusion, participants first discuss in videoconference with a research assistant who is standing beside a cage containing a live mouse located in a room two floors below. The videoconference system is linked with abundant electronic cables and blinking switches to four computers. After the videoconference discussion, two cables are installed to link the four computers to the VR computer and electronic switches are turned on. Participants are then told that VR will immerse them in real time in the room they saw moments ago. In the control condition, participants watch a pre-recorded video of a discussion in videoconference with a research assistant (same duration and visual content as in the experimental condition). The videoconference system is not linked to the VR computer and control participants are told they will be immersed in a replica of the room they saw a moment ago. All participants are actually immersed in the exact same virtual environment. An I-Visor head-mounted display, an Intertrax2 motion tracker from Intersense, a Pentium IV PC and a wireless mouse are used for the VR immersions. A manipulation check confirmed that 82% of the participants in the experimental condition believed in the experimental manipulation. The mouse was rated as realistic by 81% of the participants in the experimental condition and by 77% of those in the control condition (Chi-square = .11, ns). The immersion in VR was rated as realistic by 94% of the participants in the experimental condition and by 88% of those in the control condition (Chi-square = .3, ns). A 2 times by 2 conditions repeated measure ANOVA revealed that leading people to believe they are seeing a real mouse in the virtual environment increases the feeling of presence compared to an immersion where participants are told the mouse is not real [$F(1,29) = 4.73$, $p < .05$]. Results are discussed in the light of the potential ingredients required to suspend disbelief and foster the feeling of presence.

Immersive Virtual Reality beyond Self Help

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With Immersive Virtual Reality **(**IVR) we can work out human development. This medium makes possi-ble the representation of complexity. It makes someone prone to be sure of his/her own decisions. Negative developments in our present moment in the information society like high unemployment, high health costs, high criminality, etc. are obsta-

cles for societal and individual progress. These obsta-cles are not the result of the material innovations of our developed societies, but of our own interpersonal abilities and attitudes (immaterial innovations) which lag behind their own greater possibilities. Technological development and the quality of interpersonal relations should be brought together on the same level. An impor-tant indicator of the positive condition of people, and therefore of society, is always their psychosocial well-being. Psychosocial and inter-personal skills are now central to our current social, economic and political moment in the information society; well-being and health will be the most important factors in the future. Our concern is the pro-duction of virtual worlds in which the possibilities of IVR offer the "user" a world of experiences and adventures, in which he/she can learn, work and relax as complementation to the real world. The goal of our work is to develop a comprehensive individual care space for each person. Our pro-ject W.O.M.B. is an example of such an application. W.O.M.B. works like a body-brain-sup-porter: a new IVR project as a learning system helps to create the health con-sciousness and well-being of a person in the sense of a saluto-genesis-ori-ented training system. W.O.M.B. is a new way to interact, in which the "user's" breath and movement cre-ate the size, space and shape of his/her immersive world. An emotional environment like the IVR can release deep reactions and strongly affects consciousness. Obtaining emotional support is very critical for the personal development. We realized, that many of our students feel isolated and alone with a lot of requirements and tasks to fulfil, which are coming permanently from outside. We report these experiences because they have given us a much better understanding of the phe-nomenon of the emotional effects of IVR worlds and have led us closer to a re-orientation of working with this IVR environment. Working with IVR is like a coaching that helps a person develops good internal management skills. It has helped the students to set concrete goals and to develop the specific skills needed to meet them. We have seen IVR as a very powerful environment for people, who tend to struggle with issues of management and self management, goal setting, behavior in a group and making something very concrete without any lost or risk. By working in some specific IVR worlds we saw how helpful it is to feel certain control over the issues, control over the own feelings, control of changes over the own belief system and behavior. People come to the point that they are able to change a lot of things which are holding them back in life. Our purpose is to use IVR as an instrument for salutogenesis.

Ankle Muscle Activation of Children with Cerebral Palsy Exercising in Virtual (VR) Versus Physical Environments

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Objectives: To compare the use of a VR game environment with the use of conventional exercises to elicit specific selective movement of ankle dorsiflexion in children with cerebral palsy. To determine whether: 1) exercising in a VR environment would result in greater fun and interest than a conventional exercise program, 2) the active ankle dorsiflexion movements would be similar between approaches and 3) the ankle muscle activity would be similar between approaches. Participants: Ten children with CP (8 spastic hemiplegia, 2 spastic diplegia) and ten children without CP. The children were between the ages of 7 and 17 years old. The GMFCS levels were 4 at level 1 and 6 at level 2. Methods: Sessions (90-minutes) consisted of two conventional (A) ankle dorsiflexion exercises and two VR (B) exercises. An ABBA design was used with order counterbalanced between children. Children with CP used the affected ankle. Children without CP used their preferred ankle. Exercises included ankle dorsiflexion in chair sitting and ankle dorsiflexion in long-legged sitting. The VR system included 2 different scored game scenarios using flat screen display, camera and computer. Measurement: Visual analogue "interest" and "fun" scales were completed after each exercise series by child and parent. An electrogoniometer measured starting position, time to complete each repetition, hold time and number of repetitions for each exercise. Surface electrodes recorded bilateral gastrocnemius and tibialis anterior muscle activity during the exercises. Results:

Participants with and without CP reported higher "fun" and "interest" using VR versus conventional exercises. Both groups also showed greater range of active ankle dorsiflexion, longer hold times and less repetitions in the VR environment. Greater levels of co-contraction were recorded in ipsilateral gastrocnemius and contralateral tibialis anterior during the VR exercises. Conclusion: VR environments may provide means of promoting participation and adherence to exercise through variety and enjoyment of programs used. Our data suggest improved quality of movement of ankle dorsiflexion which may be due to the goal-oriented nature of VR games. Further longitudinal research is being planned. Acknowledgements: The Ninja Flip and Coconut Shooter applications were provided by Vivid Group (www.irexonline.com). Funded in part by the Ministry of Economic Trade and Development.

Manipulating Stuttering During Virtual Job Interviews

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Background/Problem/Research Question: Stuttering is a "disturbance in the normal fluency and time patterning of speech," in which "the extent of the disturbance varies…and often is more severe when there is special pressure to communicate (e.g., *interviewing for a job)"* [DSM-IV, 1994; p. 63, italics added]. Situations that can exacerbate stuttering include speaking: to persons in authority, under time pressure, on the telephone, and in situations that require a specific answers. Treatment can assist stutterers to speak more fluently and to manage their stuttering. Generalization of treatment effects is essential and often challenging. Challenges include *difficulty creating realistic situations*, *loss of therapeutic control over the situation*, and *loss of confidentiality in real life exercises.* Virtual Reality (VR) technology has potential to alleviate many of these challenges. In this study we developed a virtual job interview (VRJI) environment, and tested its effects on speech patterns of persons who stutter. We predicted that *challenging* virtual job interviews would elicit more stuttering than *supportive* VR interviews would. Method/Tools: Twenty stuttering adults whose stuttering severity was calculated using the *Stuttering Severity Instrument-3* (SSI-3) participated. The VRJI contained a challenging interview, with the "company CEO" and who exhibited: interruptions, increased speaking rate, loss of eye contact, and increased time pressure. The supportive interview was with a "Human Resources" worker who exhibited facilitative behaviors (e.g., a slightly slowed speaking rate, eye contact, not interrupting). The content of the interview questions was the same, though the delivery varied. Each subject participated in one supportive and one challenging interview. The order of the interviews and the gender of the interviewers were counter balanced. VR equipment included a Dell PC, with an nVidia Fx5200 graphics card, a VFX-3D head-mounted display and tracker. Results: One-tailed Student's t-tests confirmed our prediction that more stuttering occurred during the challenging interview condition ($t = 2.14$, $p = .02$). We interviewed participants prior to VR as part of the SSI-3. The percentage of stuttered syllables (%SS) in both VR conditions were positively correlated with the %SS in the SSI-3 interview (for challenging: $r = .49$, $p. = .05$; for supportive: $r = .652$, $p = .006$), suggesting that the frequency of stuttering behaves in similar ways during VR and "real" interactions. Subjective comments from participants suggested that participants found the VRJI realistic, and that it induced feelings similar to those that they experience in "real world" speaking activities (e.g., "It simulated me when I'm bad. All the physical responses and reactions, eyes and mouth and tension, it was all there"). Novelty/ Discussion: This is the first study to evaluate the use of VR technology with persons who stutter. Our findings are consistent with literature linking perceived stress to increases in stuttering, and suggest that VR environments can elicit stuttering in similar ways to real-world environments. VR may be a useful tool in the treatment of stuttering, and has promise as an efficient method for measuring treatment progress and generalization of treatment effects.

Selective Sensory Strategies in the Regulation of Upright Balance in Older Adults Can be Entrained Through Exposure to Sensory Conflicts

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BACKGROUND: Conflicting visual and somatosensory stimuli can modulate automatic postural responses in both healthy young and old adults. However, balance regulation may be more affected in older adults who rely heavily on vision. Postural imbalance may be caused not only by primary age-related sensory-motor declines but also by the inability to resolve sensory conflicts and to select pertinent sensory information. AIMS: The present study aimed to determine the effects of aging and repeated exposures on the capability of the center nervous system (CNS) to select pertinent sensory information and resolve sensory conflicts created by virtual reality. METHODS: Healthy older adults (65-75 yrs) were tested for standing balance while immersed in a virtual environment (VE) for 1 hour during which a total of 72 visual and/or surface ramp perturbations of 8° (36°/s) was randomly presented. Visual perturbations were induced by sudden movements of a VE viewed through a helmet-mounted display, and combined with or without surface perturbations presented in a direction (pitch/roll/yaw) that was either identical or opposite to the visual perturbation. Functional balance and mobility in terms of gait velocity, ability to maintain tandem stance, timed sit-to-stand and postural responses to surface perturbations without sensory conflicts were assessed before and after VE exposures. The EMG responses of eight bilateral postural muscles, body kinematics and ground reaction forces were captured. EMG onset latencies and integrals as well as center of pressure (CoP) and centre of mass (CoM) were calculated and compared. RESULTS: When the VEs were manipulated to be discordant with the surface perturbations thus creating sensory conflicts, older adults had significantly increased EMG activation and longer latencies as compared to conditions where the perturbations were concordant and no sensory conflicts were present. Ankle and hip muscles onset latencies were prolonged by 40-60 ms in conditions of sensory conflicts. CoP and CoM excursions were sensitive to the presence of sensory conflicts. A general training effect associated with less number of steps and improved ability to maintain balance was observed in older adults as they were exposed to increasing number of perturbations with sensory conflicts. The last 10 out of 72 perturbations had significantly reduced CoP and CoM excursions and shorter ankle muscle onset latencies, as compared to the first 10 perturbations. Subjects scored higher on the ability to maintain tandem stance after repeated exposures to sensory conflicts. CONCLUSIONS: Aging affects the interaction of the somatosensory and visual systems on the ability of the CNS to resolve sensory conflicts and to maintain upright stance equilibrium. Even with a one-hour immersion in virtual environment and exposure to sensory conflicts, it is possible for the CNS to recalibrate and adapt to the changes and improve balance capability in older adults. A training program of longer durations is needed to confirm sustainable long-term effects. Preventive and rehabilitation programs targeting postural control in older adults should take into account the possible impairment of sensory organization or sensorimotor integration and include VE training under conditions of sensory conflicts.

Autonomous Eye Pattern Classification in a Virtual Environment Applied to Sexual Offenders

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Problem: Violent behaviors like the ones resulting from sexual offenders are social and psychological distress factors. These behaviors harm in an important way the population health. There are different problems associated to the diagnostic and the measurement

of threat level from violent individuals. More precisely, for the sexual deviant, phallometric measure is often used to determine their sexual preferences. From those results, it is possible to predict the risk of second offence or treatment efficiency. However, research has shown that it is possible to control sexual responses in presence of a visual or auditory sexual scene (Quinsey and Chaplin, 1988). Therefore, internal validity of phallometric measurement is reduced. A new promising tool for the study of perceptual and motor processing is the utilization of virtual environment combined with video-oculography (Renaud et al., 2003). Then, from the oculomotor pattern recording it could be possible to determine if sexual offenders fake responses by, for example, looking away or to the periphery of the visual content to reduce their penile responses. Method: Analysis of eye movement dynamics informs on the attention processing in regard to various stimuli. Since the vast quantity of simultaneous data generated and their nonlinear dynamic nature, eye patterns must be classified using non standard methods like artificial neural networks. Those models have been widely used in the context of temporal series and they can be easily implemented online (Wörgötter & Porr, 2004). Thus, from the standard measures obtained with video-oculography (e.g. eye saccade, fixation) and non standard measures (e.g. power spectrum, dimension correlation) a neural network has been trained following a supervised algorithm to classify sexual deviant from non deviant. Results: Results show that the network is able to find a function that allows the classification of sexual offenders from non offenders. Moreover, the network is able to generalize its learning to new participant and classify it accordingly. Conclusion: From the results, it is concluded that eye pattern dynamics gives enough information for a neural network classification to distinguish sexual deviant from non deviant. Novelty: By better knowing what the dynamic of oculomotor pattern is, it is then possible to improve the internal validity of current diagnostic tools as well as to develop new ones based on oculomotor responses as such. This study is thus a first step in the development of a new tool for risk assessment of second offence as well as therapy efficacy among sex offenders.

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Emotions May Not Have to Match with the Content Afforded by the Virtual Environment to Induce Presence

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In previous studies, Bouchard and colleagues have shown that inducing anxiety increases the feeling of presence when phobics are immersed in virtual environments that are frightening to them. This finding might be explained by a simple increase in arousal induced by the experimental setting. On the other hand, feeling anxious in a situation that is expected to induce anxiety might suggest to phobics that they are really «there» in the situation. The aim of this study was to assess if emotions that are congruent or incongruent with what is expected from the virtual environment have an impact on presence. It was hypothesized that experimentally inducing a positive emotion in a virtual environment that is expected to induce a positive emotion be would induce more presence than when experimentally inducing a negative emotion. The sample consisted of 28 adults who had never experienced virtual reality before and who would like to visit Egypt. Following random assignment and a baseline immersion in a controlled virtual environment, two experimental moods are induced (positive or negative) and crossed over two experimental immersions in virtual reality. The detailed procedures are as fol-

low: (a) completing pre-experiment questionnaires; (b) being immersed in a control virtual environment for five minutes; (c) completing cybersickness and presence measures; (d) being subjected to a first Velten mood-induction task (induction of either a positive or a negative mood state); (e) rating their mood; (f) being immersed for seven minutes in a virtual reality tour of the mythical temple of the Egyptian god Horus; (g) rating their feeling of presence after 3.5 minutes of immersion in the Temple of Horus; (h) after the first experimental immersion, rating their mood, feeling of presence and cybersickness; (i) completing a distraction task for five minutes; (j) being subjected to a second Velten mood-induction task; (k) completing a second experimental immersion in the virtual environment; (l) rating their feeling of presence after 3.5 minutes of immersion; and (m) post-immersion, completing mood, presence and cybersickness questionnaires. Analyses on the manipulation checks confirmed the statistically significant impact of the mood-induction task ($p < .001$). However, the repeated measures ANOVAs did not reveal any significant impact of mood on presence. Further replications are warranted, but three post-hoc hypotheses have to be ruled-out before reaching a definite conclusion on the match between participants' mood and what is afforded by the virtual environment. The impact of mood on presence might be related to the intensity of the mood, and thus a stronger manipulation may be needed. Second, it is possible that the virtual environment was not positive enough *a priori* to create a strong match with the positive mood and a strong mismatch with the negative mood. Third, it is also possible that the results found in previous studies apply only to people suffering from anxiety disorders.

Virtual Therapy in Patients with Depression: Preliminary Observation

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Depression disorder with anxiety is considered an important public health problem. The efficacy of cognitive-behavioral therapy (CBT) for depression has been widely demonstrated. Virtual Therapy (VT) has several advantages compared with conventional techniques. One of the essential components to treat these disorders is exposure. In VT the therapist can control the feared situations at will and with a high degree of safety for the patient, as it is easier to grade the feared situations. Another advantage is that VT is more confidential because treatment takes place in the therapist's office. It is also less time consuming as it takes place in the therapist's office. We think that VT exposure can be a useful intermediate step for those patients who refuse in vivo exposure because the idea of facing the real anxiety situations is too aversive for them. VT was specifically indicated to allow patients in recovering their planning, executing and controlling skills by implementing sequences of actions and complex behavioural patterns that are requested in everyday life. Method: In this open study we compared two types of treatment – virtual reality therapy and cognitive-behavioral therapy – for patients showing a major depression and anxiety. Two groups of patients are formed and compared: a "VT" group and a "CBT" group. The survey included 20 patients of ages 25 to 50, all received antidepressive medication. The allocation of patients to one of these two groups was done according to some constraints (more specifically the ability to use computers and virtual reality software) while ensuring of the homogeneity of the two groups in terms of significant criteria (sex and age of the patient, duration and severity of the depression estimated by the HAMD's scale, anxiety estimated by the STAI's scale, CGI-S's scale and Q-LES-Q to assess the degree of enjoyment and satisfaction experienced by subjects in various areas of daily functioning). Results show that the virtual therapy group will improve at least as much as the cognitive and behavioral therapy group, and the results for virtual therapy group show up quickly, after 2 months of treatment. Benefits in VT: more realistic assessment, reduced therapy cost, increased safety, improve quality of life. The study was conducted in the Virtual Therapy Unit of the Socola University Hospital, Iasi, Romania. This unit it is the first Centre of Virtual Therapy in Romania.

A Model for Developing and Evaluating Video Games or Other Technology-Based Solutions to Improve the Health and Quality of Life of Young People with Cancer or Other Chronic Illnesses

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Background/Problem: A review of available research suggested that harnessing the power of video game technology to fully engage young people with cancer about their disease held promise. HopeLab consulted oncologists, epidemiologists, cell biologists, behavioral psychologists and video game producers, as well as young people with cancer themselves, to identify critical issues in using video game technology to impact health-related outcomes. We then set about developing a high quality video game and applied rigorous scientific methods to evaluate whether it would have measurable effect in kids with cancer. Method/Tools, Results : HopeLab adopted an iterative game development process to incorporate the input of young people with cancer and our scientific objectives into game design. We consulted oncologists, nurses, cell biologists and behavioral psychologists throughout the game development process to ensure that the medical terminology in the game was accurate, and that the goals of each mission represented medically valid problems. We consulted young people with cancer throughout the process to ensure that the game would meaningfully reflect their perspectives. We utilized patient interviews and questionnaires (on-line & in-person) and provider feedback on missions and cinematics, and also obtained gamer and patient feedback on game play and controls. Patients consistently emphasized that the game should be realistic *and* fun. The result was *Re-Mission*, a 20 level, 3rd person shooter video game in which players pilot a nanobot, Roxxi, through the body of fictional cancer patients to destroy cancer cells, defend against bacterial infections and grapple with often life-threatening side effects. We then conducted a 34-site, randomized controlled trial to test the effect of *Re-Mission* on adherence, cancer-related knowledge, and quality of life measures among young people with cancer. Conclusion : Study findings demonstrate a theoretically-based, data-driven intervention designed with direct patient involvement and delivered in an appealing interactive videogame context can produce significant improvements in a variety of health-related outcomes for young people with cancer. Novelty/Discussion : Much has been made of the potential of "serious games" to effect change in a broad array of health issues. By incorporating scientific principles and the direct input of young people living with cancer into the design of a video game, and by applying a rigorous research protocol (comparable to clinical trial methodology used in testing drugs) to assess how and to what degree the game has an impact on the young people who received it, HopeLab has (1) validated the feasibility of taking a patient-centered, evidence-based approach to product development and evaluation; (2) shown that video games can successfully be designed to be fun and to improve the health and quality of life of young people with cancer. We intend to apply the insights gained from the development and study of *Re-Mission* to inform our future work in cancer as well as a variety of technology-based approaches we will pursue in the areas of obesity, sickle cell disease, major depressive order and autism to help young people grappling with these chronic illnesses.

Clinical Trial of *Re-Mission*: A Video Game for Young People With Cancer

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Background/Problem: Adolescents and young adults (AYA) have historically been under-represented in clinical trials designed to test the effect(s) of drugs and interventions for cancer. Research indicates that treatment adherence and knowledge in addition to a sense of well being (including self effi-

cacy and quality of life) can have a positive impact on health-related outcomes for those with cancer. Video games are increasingly utilized as a means of entertainment and information dissemination to this population. Over the course of several years, HopeLab worked with game developers, oncologists, cell biologists, and AYA with cancer themselves to create a video game called *Re-Mission*. This PC-based game was developed based on empirical needs-assessment studies and theoretical models of behavior change and consists of 20 missions inside fictional cancer patients undergoing chemotherapy, radiation, or immunotherapy. Method/Tools, Results: We conducted a multi-site, randomized clinical trial to test the effect of Re-Mission, a state-of the-art videogame intervention, on adherence, cancer-related knowledge, self-efficacy and quality of life among adolescents and young adults with cancer. Players control a nanobot that destroys tumor cells, battles bacterial infections, and manages side effects with traditional therapies. 375 male and female cancer patients aged 13-29 were enrolled at 34 medical centers in the US, Canada and Australia, and randomly assigned to receive PCs with a popular video game or the same control video game plus Re-Mission. Adherence, cancer-related knowledge and self-efficacy were assessed at baseline and at 1- and 3-months. More than 80% of patients eligible to play Re-Mission did so. Data were analyzed on an intent-to-treat basis using a 2 (Condition) x 3 (Time) repeated-measures ANOVA. Adherence was uniformly high at baseline and not significantly affected by Re-Mission. However, patients cancer-related knowledge (p=.044), self-efficacy to communicate about cancer (p=.025) and manage side effects (anxiety [p=.043], constipation [p=.007]) increased in the Re-Mission group. The overall composite score on the self-efficacy scale also increased significantly over time for the Re-Mission group (p=.021). Conclusion: These data show that a theoretically-based, data-driven intervention delivered in an appealing interactive videogame context can produce significant increases in cancer-related knowledge and self-efficacy. Novelty/Discussion: To our knowledge, this is the first multi-site, randomized clinical trial of this scale designed specifically for AYA with cancer. It is also the first use of a multi-site, randomized clinical trial of this scale designed to test the effect of a video game intervention. We believe the process by which the game was developed and tested as well as the research findings have practical application for the development and testing of other serious games and/or other technology-based approaches to helping young people with chronic illness.

3D Virtual Immersive Scenarios – Bridging the Reality Gap Between Training and Real Life Situations

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This research discusses Phase one of a three phase study looking at the effects of greater task realism in a Virtual Immersive Scenario using 3D stereoscopic video footage to replicate the multiple stressor stimuli of a real situation. A task is designed as having a specific goal with quantifiable components for the successful completion of an objective. In CPR it is the correct definition of task, identification of order of actions, conditional clauses on actions taken and finally critical decision making that defines it as a high human cost task. This complex algorithmic model makes CPR skill acquisition, retention and transference variable in both clinical and non-clinical training. Current training includes text book, resuscitation manikins and more recently computer-generated virtual environments and/or avatars remotely manipulated by the user via combinations of interface and haptic devices. The success of this vicarious user interaction depends on the user's ability to cognitively perceive a computer-generated environment, the degree of visual disturbance/ disintegration produced by a Head Mounted Display and the correlation between surface learning in unrealistic environments and "lack of real world consequence" (Morie et al., 2002). Two High Definition (HD) camcorders were used to film reactions of a small crowd scene upon discovering an unconscious casualty. The edited and rendered footage produced a 3D stereoscopic film that back projected into a Virtual Reality room with a

CAVEÔ like environment producing a Virtual Immersive Scenario. A LaerdalÔ Resuscitation Manikin equipped with a recording device captured participant's compression and ventilation data. Visual/analogue scales of confidence, knowledge, willingness and ability to perform CPR were collected pre study. Witmer & Singers Immersive Tendencies questionnaire (pre study), Presence questionnaire (post study) and participant basic physiological readings (pre and post study) were taken. Video footage of participant behaviour was captured during the testing procedure to compare against the participant's subjective analysis of Presence. Healthy adult participants *n=20* with no prior CPR experience were randomly divided into four conditions to undertake standardized layperson CPR training and testing by a qualified resuscitation officer. Condition A - non immersive training, non immersive testing. The control condition; Condition B - immersive training, non immersive testing; Condition C - immersive training and testing; Condition D - non immersive training, immersive testing. The results of Phase one of the study revealed that in the control condition A all participants *n=5* either failed to request/seek assistance before starting resuscitation *n=3* or verbally requested assistance after resuscitation had started *n=2*. Resuscitation should never be attempted before requesting and receiving confirmation of assistance. Early indications point to enhanced skill acquisition and performance in a combination of immersive and non immersive training and testing conditions. Phase two, currently in progress and Phase three to be held in three months will test the participants in their original test condition. This data will introduce skill retention and confidence transferral data that can be compared formerly with the results of Phase one and latterly in Phase three.

Should Virtual Reality be Classified as a Mind Body Intervention?

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A Mind Body Intervention or MBI is an intervention that "focuses on the interactions among the brain, mind, body, and behavior, and the powerful ways in which emotional, mental, social, spiritual, and behavioral factors can directly affect health," according to the National Center for Complementary and Alternative Medicine. A MBI empowers and "enhances each person's capacity for self-knowledge and self-care." Rooted in this concept are techniques such as cognitive behavioral therapy, guided imagery, hypnosis, biofeedback, meditation, and Pseudoeducation. However, Virtual Reality or VR, which is grounded in this same concept, is missing from the list. VR has been an effective treatment for some of the same diagnoses as other MBIs to include pain, phobias, stress, and posttraumatic stress disorder, and in some instances, with more conclusive results. But it has yet to be recognized by the medical community as a MBI. I believe that VR should be classified as a MBI, because it not only encompasses all the classic characteristics of a MBI, but it yields some rather noteworthy benefits such as a) effectiveness in addressing a wide variety of diagnoses, b) the power to embody many MBIs in a single session, c) a scientific nature that tolerates testing, recording, measuring, and adjusting of variables, simultaneously, in a single setting, during a single session, using a wide spectrum of research instruments, and e) technologically convenient and advanced designs that encompasses mobile, user friendly, computer-generated realistic scenarios as part of its intervention. By classifying VR as a MBI we give those suffering from psychosomatic illnesses one of the most sophisticated, non-invasive, technological weapons available that promotes human performance by instigating the body's natural healing virtues.

Virtual Reality Rehabilitation in Chronic Stroke: Two Case Studies

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Recovery of upper limb function is a major problem, with 30 – 66 % of stroke survivors no longer being able to use the affected arm. Rehabilitation that incorporates virtual reality (VR) may be of benefit but its effectiveness may be dependent on the extent of injury in the cortex and the resultant impairment. The aim of these two case studies was to explore the clinical profile of two participants and their user experience of the VR system. One male (Patient A, 76 years) and one female (Patient B, 60 years) participant received a single VR training session of 30-minutes duration. Both were independently mobile with right cortical damage and time since stroke was 3 and 4 years respectively. In Patient A there was no notable lesion on CT, whereas Patient B had a basal ganglia haemorrhage. Each was medically stable after a first stroke and had no significant speech deficits. User experience was assessed using the Task Specific Feedback Questionnaire (TSFQ), the Borg Scale of Perceived Exertion, the Immersive Tendencies Questionnaire (ITQ) and self reports. Motor activity and function were assessed using the Motricity Index (MI) and the Action Research Arm Test (ARAT). Table 1 presents the results from all assessment measures. Functional scores measured by the Action Research Arm Test (ARAT) were very similar. However at impairment level Patient B displayed less selective movement of the hand compared to Patient A.

Assessment measure	**TSFQ**	**ITQ**
Patient A	28	Negative
Patient B	28	Positive

Assessment measure	**Borg**	**ARAT**
Patient A	2	3
Patient B	10	4

Assessment measure	**MI**
Patient A	77
Patient B	62

In summary, each patient had a favourable experience when interacting with the virtual environment (VE), as indicated by the high TSFQ score. They differed in their likelihood to become immersed in a VE as assessed by the ITQ. Patient B rated the experience at the highest level of perceived exertion of 10 on the Borg scale. The greater level of impairment of hand function with this patient may account for the perceived difficulty in carrying out the virtual tasks.

Simulator Sickness and Its Technical Overview

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Simulator Sickness is a traditional challenge with driving simulation and immersive Virtual Reality. The report of ill feelings associated with the use of simulation devices has been around for a long time. The common synonyms for simulator sickness are “environment sickness” or “cybersickness.” Generally spoken it is an adverse reaction to immersion in a computer generated environment. Simulator sickness is related or is even a subentity of the well known motion sickness. Motion sickness occurs when the body is subjected to acceleration of movement in different directions and under conditions where visual contact with the actual outside horizon is lost. Experiences with driving simulators indicate no correlation between motion sickness and simulator sickness (although some questionnaires exist). Both can result in an array of symptoms including: eye strain, headache, postural instability, sweating, disorientation, vertigo, pallor, nausea, and vomiting. The main theory explaining simulator sickness is the sensor conflict theory (sensory mismatch theory): the body reacts with nausea when visual and vistibular signals provide conflicting information about body´s orientation (Kennedy, Hettinger, & Lillethal, 1988). In other worlds the illusory feelings of self-motion during VR exposure (called vection; Biocca, 1992) induces sickness. Other reasons for simulator sickness are flicker and flame rate of the presented programm. Also fear or anxiety can promote symptoms (airline passengers with high level of anxiety get more sick) The direction of this correlation is not quite clear at this moment as of course the ill feeling of vomiting causes fear and anxiety. Prothero et al. (1999) suggest that motion sickness arises from rest frames selected from conflicting motion cues. Rest frames are defined as “the particular refer-

ence frame (a co-ordinated system used to define positions, angular orientations and motions) which a given observer takes to be stationary". As the visual background usually provides the majority of coherent cues in the environment, it follows that the visual background should strongly influence the visual rest frame which is selected. Prothero et al. (1999) found that providing an independent background which is consistent with inertial cues reduced simulator sickness and ataxia even when the foreground cues (i.e. the VE´s content-of- interest) are not in agreement with the inertial rest frame. An Independent Visual Background consisits of a grid superimposed over the out the window visual display. Regardless of how the displayed image moves during the simulation, the grid stays fixed to the earth-stationary references that help the brain maintain a solid frame reference for orientation. This helps alleviate any confusion the brain might have over what is or is not moving with respect to self-orientation. In addition, post-exposure vection ratings (i.e. "While in the VE did you get the feeling of motion?") were not affected by using an independent visual background (see-through) as opposed to an occluded background. This suggests that an independent visual background can reduce sickness symptoms without detracting from feelings of presence in VE.

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How Social Context Can Limit a Tele-informatics Application

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Suhail Ali and Dr. Eamon Doherty were at Fairleigh Dickinson University and created a Multilanguage menu system for disabled people that could be used in a long term health care facility in the United States. The disabled people could call a toll free telephone number, listen to food choices for breakfast in various languages, and order a meal. There was a consensus that the elimination of paper menus taken from room to room would reduce germs. The disabled people liked that. Those with impaired speech liked the idea of push buttons to select items as opposed to trying to make him/her understood. A person with good speech did not like the food menu call in system because it reduced human interaction which was already limited for them. Another application was designed for disabled people using a civilian version of a reverse 911 system. Its purpose was to call a list of the disabled person's relatives and friends up and remind them to visit and prompt them for driving directions from various landmarks around the state. An option for suggesting a holiday gift was discussed. The disabled people who have difficulty dialing or speaking on the phone originally liked the idea of a robotic voice calling friends and family in bulk, but then changed their mind saying such a system was impersonal. Lastly we discuss an informatics system called Chartmaxx that is used at a local hospital and allows medical personnel instant access to medical records up to twenty five years ago and has saved everyone time and money since many test results can be instantly recalled eliminating the need for performing some medical tests. It was our opinion that the social context of informatics systems was more important to disabled people for activities of daily living than to people who use it for work and have a lot of social contacts.

Using Virtual Reality to Treat Social Anxiety Disorders in Adolescents

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Social anxiety disorder (SAD) often occurs during early adolescence. It involves fears of speaking in public, being scrutinized, getting involved in informal speech and asserting

oneself in more formal situations. Those affected with SAD are considerably limited in their social interactions and in their quality of life. Considering the developmental impact of social life during adolescence and low rate of spontaneous remission, it is of utmost importance that affective treatments are offered. Unfortunately, many adolescents do not seek psychotherapy for anxiety disorders. Our study focuses on the treatment of SAD with teenagers using virtual reality exposure (*in virtuo* exposure). The main objective is to document the impact of *in virtuo* exposure on measures of social anxiety and fear of public speaking. As a pilot study, we used a single case design with multiple baselines across subjects. Five adolescents from our mental health clinic received several sessions of *in virtuo* exposure. As the main outcome measure, social anxiety is assessed twice a week from the beginning of the baseline until the end of therapy. Standardized paper-and-pencil test are also administered at pre and post-treatment in order to compare our results with what is found in randomized control trials using more traditional group designs. The results show an important and significant reduction in the intensity of participant's SAD and fear of public speaking. The severity of SAD seems to be an important factor to the effect of the treatment over the other components of social anxiety. Motivation and credibility of virtual reality with this age group are also being discussed.

Impact of Sense of Presence on Distraction in Virtual Reality

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Pain is now considered a complex subjective phenomenon that involves sensorial, motivational, cognitive and emotional dimensions. Recent studies have now shown that virtual reality (VR) can be used to control and reduce acute pain, probably because of it's potential for distracting attention away from the pain. But does the method used to create the virtual immersion matters? The aim of this study is to compare three types of virtual immersion systems, their impact on presence and test which one is the most efficient to distract from potentially painful stimuli. The sample is consist of 30 participants aged between 18 and 30 years old assigned randomly the three following conditions for immersions lasting four minutes each : (a) a head-mounted display (HMD) of minimum quality; (b) a high quality HMD; or (c) an immersive room (CAVE-like system). The minimum quality HMD is an I-Glass SVGA (resolution of 800 X 600, FoV: 26 degrees) and the high quality HMD is an nVisor SX (resolution of 1280 X 1024; FoV: 60 degrees). The Cave-like system is a three-wall rear projection system (10 feet X 10 feet X 100 feet walls). Head tracking for both HMD is provided by an I-Cube from Intersense. Motion tracking in the immersive room is provided by an IS-900 from Intersense. The procedure consisted on visiting of a virtual apartment. During each immersion, a background noise of 60 hertz / 80 dB was present. After each immersion, participants had to answer questions about their interest about the experience, the extent to which they were able to ignore the background noise, how involving was the VR immersion, etc. The Immersive Tendency Questionnaire and the Simulator Sickness Questionnaire were also filled prior and after the experimentation. This study is still underway and the results will be analyzed late in April.

Virtual Reality Exposure for the Treatment of Mottephobia

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Virtual reality exposure therapy has been found to be an effective treatment for simple phobias. It is especially useful in treating phobias where in-vivo exposure is difficult to do. For example, in-vivo exposure for the fear of storms can only be conducted when the weather is bad, while in-vivo exposure for the fear of flying requires a large amount of time and money. It may also be impractical to do in-vivo exposure in a clinical environment for small animals, insects, and spiders. Keeping the feared objects in the office could

be quite inconvenient. For these reasons it was hypothesized that the fear of moths, mottephobia, and the fear of butterflies are simple phobias that could be effectively treated with the use of virtual reality exposure therapy. A virtual reality environment was created for the treatment of butterfly and moth phobias. The environment is comprised of a large outdoor field with mountains in the distance. A tree is located in the middle of the field as a reference point. The user can walk around in the environment by using a game controller to move forward and backwards. Direction of view and movement is controlled by a position tracker. The number of butterflies and moths in the environment is controlled by the operator. Green, yellow, and blue butterflies are included in the environment along with grey moths. A 20 item questionnaire to asses the level of fear for butterflies and moths was created. Each item was ranked on a scale from 0-100 points, with the total score used as the measurement to monitor the treatment progress. A single patient with a fear of moths was recruited for the study. She had 19 sessions of treatment using cognitive and behavioral techniques. 10 of the sessions used virtual reality exposure therapy. During the virtual reality exposure the patient's physiological signals were monitored. In addition to the physiological data, SUD ratings were collected from the patient during the exposure. The treatment program was found to significantly reduce the patients fear so that it could no longer be classified as a phobia. The virtual environment was found to be very effective in eliciting a fear response during the initial exposure sessions. This was indicated by the SUD readings from the patient and the skin temperature data. The score from the questionnaire was also a good indicator of treatment progress. It decreased from 1670 points to 766 points over the course of the treatment. The results of this single case study have encouraged us to incorporate virtual reality exposure therapy into the treatment program for other butterfly and moth phobia patients.

Integrating Artificial Intelligence and Virtual Reality in the Diagnostic Process – Feasibility Study

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Employing Virtual Reality (VR) technology in the field of rehabilitation facilitates the design of clinical tools, which have potential ecological validity. This property, however, may become a burden when using virtual environments (VEs) for diagnostic purposes. Whereas tests are typically standardized and rigid, contemporary sophisticated VEs encourage natural unstructured behavior of the patient. Constraining the user's behavior may reduce the added value of VR technology. The current study proposes a system which employs VR tools for conducting clinical tests, while drawing on Artificial Intelligence (AI) tools for assisting in the diagnostic process. This is done by using artificial neural networks (NN). Such networks can 'learn' different kinds of human behavior. After being introduced to several patterns of behavior, they are able to generalize and classify new cases. The goal of this study is to asses the feasibility of this system, and test whether noisy data, produced by natural behavior in VEs, will be amenable to meaningful classification of various populations. Various types of populations were asked to perform tasks in the Virtual Mall. In this task subjects are asked to shop for virtual groceries located on different shelves and aisles. The task is fairly intuitive and involves cognitive and motor functions. We have used GestureTek's Gesture Xtreme system as the VE platform. This system is based on projection and video capture of motion, so users are not required to wear any encumbering gear. Thus, it is adequate for many types of populations including people who suffer from stroke or head injuries. These benefits also imply partial and noisy data, since there are no trackers attached to the body. We run the data through a feed-forward NN, using an algorithm of supervised learning, and then tested its ability to generalize. For example, we first provided the system with data from several subjects labeled "stroke" or "healthy"; we then introduced the system to new subjects and tested the system's ability to accurately classify them. To date, data from more than 60 subjects have been included in the analysis. Initial results suggest that the system can differentiate between the healthy subjects and

those who suffered a stroke. This study shows the potential of integrating and harnessing two powerful disciplines, VR and AI. Their implementation may provide the clinician with a way to employ an ecological VE, where the patient may behave naturally. Yet this VE will provide meaningful information about the patient's status. We believe that once the NNs are taught and exposed to many types of behaviors and impairments, they may be able to distinguish between various impairments and their severity levels. This may significantly aid clinicians in performing differential diagnosis and clinical assessment. *The first three authors contributed equally and are listed alphabetically. This paper is part of the M.Sc. thesis of Eugene Mednikov at under the advisorship of Uri Feintuch and Larry Manevitz. We thank the HIACS Research Center and the Caesarea Rothschild Institute for their generous support.

Virtual Humans Entering New Area of Applications

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Virtual humans are at the last frontier surrounding the classical conquest of illusion. It is a big challenge to create those new entities enabling them to express convincing emotions. It is evidently an expensive challenge requiring elite Cg artist. So is it thinkable to open new territories for virtual human outside the astronomical budget of film production? It is not hard to see many potentials applications of virtual humans outside the entertainment area but the problem is the complexity of creating and animating them. Cg artist are the new artisans of the modern world. Mastering 3D is difficult. We will present an extract of a short animation –Kyra- and discus some fundamental issues in this very complex task. Is there a way out of this complexity ? We will first discuss the problem related to the creation of the virtual humans and what must be done so it is ready to talk and move. We will present the original vision of the Darwin Project developed with the support of Hexagram and then supported by a financial angel, Mr David Chamandy. We will discus how Darwin Evolver software try to give access to high end virtual humanoids to a larger group of users outside the 3D elite. Evolver is part of the solution. What about animation ? On the side of digital 3D animation real time issues and artificial intelligence are part of the solution we believes. We will discus some experiment we did with Lena using a comedian with a simple microphone, game pad and joystick to control her. We will touch some deep questions which are hard to resolved for Cg artist. What is a virtual personality? How do we capture the essence of that? There is here a natural bridge between psychology and the arts of representing virtual actors.

AudioMedia: Multimedia for Blind People

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Diverse technology devices are used to convey information to sighted users such as computers, television, internet, and multimedia. The use of these technologies relies heavily on graphical interfaces making more complex their access by users with visual disabilities. This study presents a virtual environment tool, AudioMedia, which allows users with visual disabilities to create multimedia based on audio as a mechanism for information transmission to sighted and blind users. AudioMedia is a tool that combines visual interfaces based on high contrast with auditory feedback in such a way that blind

users can control the whole construction of their multimedia projects and presentations. The design of AudioMedia was based on implementation models previously developed and evaluated with blind users. Consequently the software model shows how the conceptual model that blind users want to convey is computationally represented by AudioMedia and how the interaction with the user is created by using the hardware available. Usability evaluation of AudioMedia was studied with users with visual disabilities (totally blind and residual vision) observing a high user acceptance when interacted with this new tool by highlighting the freedom and easy to use of AudioMedia. Usability evaluators studied the user interaction with the software and applied observation instruments obtaining data that confirms the feasibility of this tool for users with visual disabilities. To study the impact of this software on designing and producing multimedia we implemented a research intervention by using the Project-Based Learning methodology. Six young people ages 19-28 with different vision disabilities levels worked with the software during eight 2.5 hours sessions. Users followed three stages: 1. *Entrance*, they defined their projects and were also trained on concepts and processes concerning the project learning methodology; 2. *Project development*, users met in teams, shared ideas, and planned their projects by searching information, defined the topic, chose the multimedia to be used, and elaborated a project plan; 3. *Multimedia presentation*, users presented their project results by using AudioMedia. This process involved users with visual disabilities to exercise diverse socio-cognitive processes such as: recollection, classification and synthesis of multimedia information, team collaboration, and public final project presentation. Our initial results indicate that the use of an audio-based tool such as AudioMedia can stimulate the participation of users with visual disabilities in diverse contexts of interaction with sighted users by improving their skills to communicate, inform and present information, and thus helping them to integrate and include more fully to their society.

Does Sleep Affect Learning During a Virtual Reality Exposure Therapy for Specific Phobia?

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Evidences for a relationship between rapid eye movement (REM) sleep and memory has been found in a large number of studies over the past thirty years. These studies have been using learning tasks such as declarative (paired associated, learning stories, word recognition) and non declarative (words priming, procedural learning) memory tests. Results have shown that REM sleep deprivation impairs learning on some of these tasks. These studies also showed increased period of REM sleep following intensive learning sessions, more particularly when the material is complex and emotionally charged (stories, films, etc.). Learning also occurs during the cognitive-behavior therapy (CBT) of phobias. Indeed, CBT involves the processing of emotionally charged information in order to learn new associations between the threatening stimuli and their consequences. In addition, the person learns how to control the anxiety elicited by the feared object. The present case study aims at verifying if exposure to the threatening stimuli, which is a task oriented towards a more emotional learning than cognitive restructuring, also solicit REM sleep mechanisms. The sleep of a man suffering from aviophobia was recorded for four consecutive nights. EEG (C3, C4, O1, O2), EMG (sub-mental) and EOG were recorded and scored according to the standard method using 20 seconds epochs. The first night was an adaptation night used to rule out sleep disorders such as sleep apnea, periodic limb movement during sleep or bruxism. The second night was the baseline night. On the third day, the subject underwent an intensive CBT using virtual reality exposure (total duration of three hours of cybertherapy). Consequently, the third night of recording was the experimental night. The fourth night was a follow up night. The subject had an additional three hours of cybertherapy on the fifth day. Clinical observations as well as questionnaires administrated before and after CBT confirm the success of the therapy. Sleep recordings showed that REM sleep significantly increase after CBT, but not the night immediately following the therapy session. Indeed, REM sleep percentages were 21.49% for the baseline night, 21.27% for the experimental night, and 31.49% for the follow

up night. These results suggest first that REM sleep seem to be involved in the consolidation of psychological and emotionally charged information. Moreover, these results suggest that there may be a delay in this particular consolidation process. This is in accordance with the concept of "REM sleep windows" suggested by Smith (1985). This author suggests that REM sleep window is "a time after acquisition when there are increases in REM sleep over normal levels", and that theses windows varies "with the strain and type of learning task and the number of trials per session". More subjects are needed to validate these results.

Mental Training with Virtual Reality in Post-Stroke Rehabilitation: A Progress Report

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Mental practice (MP) with Motor Imagery (MI) is a training method consisting in mentally simulating a movement, with the goal of improving performance. In recent years, several authors have proposed MP with MI as a potentially valuable technique for promoting functional regain in people suffering from post-stroke hemiplegia. The benefit of mental practice would be to repetitively activate cerebral and cerebellar sensorimotor structures damaged by a stroke, thereby engaging compensatory networks to promote motor rehabilitation. However, mentally simulating a movement can be a demanding task, especially for brain-injured individuals. This article reports progress of a research project[5], which is evaluating the use of computerized technology to guide mental practice in the rehabilitation of upper-limb hemiparesis after stroke. The experimental protocol includes two phases, each during 4 weeks. During the first month of intervention, the patient undergoes three computer-enhanced mental practice sessions per week at the rehabilitation center, using a custom-made virtual reality system called "VR Mirror". The system allows to record motions of the non-affected arm, and present these visually as if performed by the affected arm. In particular, training procedure with VR Mirror consists of the following steps. First, the therapist shows the patient how to perform the exercise with the healthy arm. When the patient then performs the task, the movement is registered by tracking sensors positioned on the patient's forearm and wrist. Then, a 3D reconstruction of the movement acquired by sensors is superimposed over the (unseen) paretic limb. After watching the virtual limb on the screen, the patient is asked to mentally rehearse the movement he has just observed, taking a first-person perspective (imagery response times are collected). Last, the patient has to perform the movement with the affected arm. During physical execution, the system tracks the movement again, and measures its deviation from the movement performed with the non-paretic arm. Using this measurement, which is done in real time, the system provides the patient with audiovisual feedback describing performance on the task.The procedure described above is repeated 5 times within each practice session, for each targeted exercise (flexion-extension of the wrist; intra-extra rotation of the forearm; flexion-extension of the elbow). At the end of the laboratory training phase, the patient used a portable display device to practice at home. The portable display stores a sequence of movies depicting these motor exercises. After viewing these movies, the patient is asked to take a first person perspective, and to imagine executing the movements with the impaired arm. This sequence is performed three times a week, for four consecutive weeks. Pretreatment and posttreatment measures include the Fugl-Meyer Assessment of Sensorimotor Impairment, and the Action Research Arm Test (ARA). Performance on the specific tasks is also evaluated through response times and sensors data.

Flow in Real and Virtual Environments

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So far, virtual reality (VR) experience has been mainly investigated from the perspective of presence, broadly defined as the feeling of "being there" in a mediated environment. Typically, this research has been conducted in laboratory settings to assess how the manipulation of specific system variables (such as the perceptual fidelity of the displays, the ease of interaction, the length of exposure to the virtual environment and several others) affects the "feeling of reality" perceived by participants, as measured through self-report questionnaires and psycho-physiological responses. In this article, we introduce an alternative theoretical and methodological approach, which aims to compare the experience profile associated with "virtual" and "real-life" activities, focusing on its cognitive, affective and motivational components. In particular, our goal was to assess whether the use of VR is associated with *flow*, an optimal experience characterized by the perception of high environmental challenges matched with adequate personal skills, high concentration, enjoyment, engagement, loss of self-consciousness, focused attention, and intrinsic motivation. 42 students (27 females and 15 males), aged between 19-24 years (M = 21.0, SD = 1.4) volunteered to participate in the study. Quality of experience associated with real and virtual activities was assessed by means of the Experience Sampling Method, a procedure based on repeated on-line assessments of the external situation and personal states of consciousness, as real daily events and situations occur. ESM taps how people daily invest their attention and resources, what they do, what they think of, and how patterns in subjective experience relate to life conditions. Each participant received a booklet of self-report forms and an electronic pager that emitted a beeping sound at random intervals. The participants carried the questionnaires and pager during all the hours of the week they were tested, receiving five to eight signals a day during waking hours. When the pager beeped, the participants were to fill out a report. The week of observation included two VR sessions in non-consecutive days at the Psychology Laboratory. For data analysis, experiential variables were aggregated into 4 dimensions: Mood, Engagement, Confidence, and Intrinsic motivation. Flow was identified on the basis of a) perceived balance between opportunities for action (challenges) and personal skills, and b) significantly positive values of all the experiential dimensions. Results showed that VE use was a high challenging activity that participants often associated with optimal experience (22% of self-reports). Reading, TV and the use of other media used both in the context of both learning and leisure activities were associated to optimal experience in lower percentages (respectively 15%, 8% and 19% of self-reports). Implications of these findings for VR research and practice are discussed.

Study of Enforced Collaboration during Computerized Story-Telling to Enhance Social Communication of Children with High-Functioning Autism

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Autism is a complex developmental disability that begins in early childhood and persists throughout adulthood affecting three crucial areas of development: communication, social interaction, and creative or imaginative play (Baron-Cohen & Bolton, 1999). Deficits in social interaction constitute a major characteristic of children with autism (Bauminger et al., 2003) and range from a lack of awareness of others (for those with the most severe social impairment) to abnormalities in peer relations (for those who are less impaired) (Volkmar et al., 1997). MERL's DiamondTouch Hardware (http://www.merl.com/projects/DiamondTouch/) is a multi-user touchable interface that detects multiple simultaneous touches by two to four users (Dietz & Leigh, 2001). Each user sits or stands on a receiver (a thin pad) such that touching the table surface activates an array

of antennas embedded within its surface (capacitive touch detection). Zancanaro et al. (2003) have developed a Story-Table interface based on the Diamond Touch technology, which enforces collaboration between children while telling a story. The application is multimodal in character, providing visual stimuli, responding to touch commands, and enabling the recording of narratives. The interface has been evaluated with normative children in two trials followed by a user study which demonstrated that forced multi-user operations were a powerful means to facilitate cooperative behaviors (Cappelletti et al, 2004). We hypothesized that use of the Story-Table by children with HFA will take advantage of their interest in using computerized technologies, yet add an important dimension, namely communication and interaction with peers (Gal et al., 2005). The objective of this paper is to present the results of a pilot intervention A-B-A study using the Story-Table with four pairs of children with HFA, aged 8 to 10 years, to document its ability to facilitate cooperative (verbal and non-verbal) interactions with peers during story-telling situations. These children participate in an educational program that is adjusted to their needs in a mainstream setting. The pairs of children knew each other before taking part in the study. The children were tested prior to (pre-A) and following (post-A) the intervention (B) with a low-tech version of the Story-Table interface and with an assembly game (Discovery Toys MarbleWorks). The structured intervention consisted of 8-10 20-minute sessions which took place at their school (3-4 times per week for 3 weeks). During the intervention, the pairs of children were instructed to create and narrate a story with respect to a background picture and associated figures that they had jointly selected. All pre- and post-tests and intervention sessions were videotaped for subsequent analysis. Outcome measures included (1) a behavioral checklist which documents positive and negative social interactions as well as autistic behaviors and (2) an analysis of the language usage of all interactions and of the narratives. The results, to date, have demonstrated that the participants readily learned to use the Story-Table technology and appeared motivated to create and tell narrations. Initial examination of the pre- and post-tests and intervention sessions indicates that this technology is promising as a technique for enhancing cooperative social behaviors.

Interaction Analysis and User Based Tests: Ergonomic Issues for VR Based Therapy

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This contribution is part of the Italian MIUR-FIRB-NeuroTIV project. In this study we offer the work done by Licent (Laboratory of Communicative Interaction and New Technologies) at the NeuroTIV project. Method: This study, aimed at verifying the efficacy of the VR environments in the anxiety disorders' cognitive-behavioral treatment (CBT) and defining guidelines for the design of VE, is based on the analysis of interactions between therapists and patients (8 sessions for each patient, 72 sessions) and on outpatient-based tests (12 subjects). The first level analysis, conducted with the support of Atlas.Ti 4.2 for quali-quantitative analysis, is aimed at investigating practice habits for the use of VR in the framework of therapeutic protocol, with special focus on VR scenarios and their ergonomic aspects. On the other hand, in user-based tests, outpatients are considered as 'expert users': their contribution is relevant in order to evaluate and improve the structure and the navigability of VR scenarios. The adopted perspective is intended to improve the whole interactive process, abandoning both artifact centered and user–artifact centered interaction in favour of a *'situated and context sensible' ergonomic analysis*. This approach gives evidence of how people, in specific social situations, are able to solve complex tasks producing shared meanings and achieving their goals during interaction. The considered virtual environments were the Panic Disorders and Agoraphobia VR modules developed in the framework of the project: a metro station, a square, a mall and an elevator. Main results: Results from a preliminary analysis of data focused on ergonomic elements, in order to obtain hints on how patients use VR and what could be done to smooth the therapeutic process, could be clustered around 2 topics: "breaking points" and "narrative tips".

Breaking points are elements that break down presence's experience, such as hardware issues, or software failures. Hardware issues seem to be perceived as a "personal failure": patients think they have to learn how to use hardware. To avoid this, designer could, as well as try to solve any hardware problem, implement a "sand-box" room, where patients can learn how to use input devices and become acquainted with output devices, as HMD, without being exposed to therapeutic protocol elements of VE. This room could be used to fire up an introductory sequence, fading in the VE, in order to avoid interruptions and breakdowns during the following phases of the process. Narrative tips are objects, places or in general elements that patients and therapists could use as stimulus for starting up a contextual narration of the "what, where and when" of the VE experience. Such tips are, for example, standing out avatars, or up-to-date graphic elements, as placards or signs. Further investigation is needed to explore how the VR environment level of interactivity influences the quality of the immersive experience and the role of the interaction and communication style of the therapist in VR based therapy and how this affects the VR experience mainly from the patient's, but also from the therapist's point of view.

How to Improve the VR Based Therapy Design Process with the Support of a Psychosocial Integrated Approach: Interaction Analysis and User Based Tests

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The present contribution is part of the Italian MIUR-FIRB-NeuroTIV project which main objective is to prove the technical and clinical viability of using Virtual Reality Therapy in clinical psychology by means of portable and shared VR Systems. In this study we offer the work done by Licent (Laboratory of Communicative Intyeraction and New Technologies) at the NeuroTIV project. Method : The activity carried out by Licent research unit is aimed at verifying the efficacy of the VR environments in the anxiety disorders' cognitive-behavioral treatment (CBT). The study is based on the analysis of the therapist/patient interactions (8 sessions for each patient, 72 sessions on the whole) and on user-based tests (12 subjects), carried on at the end of the therapeutic cycle/protocol with the support of the Atlas. Ti 4.2 software for quali-quantitative analysis. 8 categories for the data analysis were defined on the basis of the elaboration of recorded material made by 4 independent researchers. Focus groups including therapists involved in the research were also carried out. The first level analysis is aimed at investigating how VR is used and integrated in the framework of the therapeutic protocol, with special focus on VR scenarios and their ergonomic aspects. On the other hand, in the user-based tests, outpatients are considered as 'expert users': their contribution is relevant in order to evaluate and improve the structure and the navigability of VR scenarios. The perspective adopted is intended to improve the whole interactive process, abandoning both artifact or user–artifact centered interaction in favour of a *'situated and context sensible' ergonomic analysis*. This approach gives evidence of how people, in specific social situations, are able to solve complex tasks producing shared meanings and achieving their goals during interaction. The virtual environments considered were the Panic Disorders and Agoraphobia VR modules developed in the framework of the project. Main results: Data collected were analysed with reference to two different dimensions. From a strictly ergonomic point of view, main results are related to: 1) the improvement of VR training sessions for patients and their integration in the framework of the therapeutic protocol in order to avoid interruptions and breakdowns during the successive phases of the process; 2) Specific functional characteristics of the audio, video, scenarios' architecture, avatars. With reference to the sense of presence, following aspects are under investigation: 1) how the VR environment level of interactivity influences the quality of the immersive experience and final effects on the VR based therapy process; 2) the importance of the narrative interactive experience: for example, a detailed description of the situation and of the environment made by the therapist seems to suggest the opportunity to include

visual sequences in the initial and in the final phase of the navigation in order to enhance and to modulate the immersion in the VR environment while, in some cases, more generic descriptions allow patients to explore the environment and to act more spontaneously; 3) the role of the interaction style and of the communication style adopted by the therapist in VR based therapy and how this affects the VR experience mainly from the patient but also from the therapist point of view.

Presence: Head Mounted Display vs. Translucid Screen

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Among others, two displays are used when exposure to virtual worlds is required: Head Mounted Display (HMD) and Translucid Screen (TS). The higher sense of immersion brought about by these two devices takes advantage over traditional media displays. In fact, both HMD and TS enable a superior sense of presence in the virtual worlds. However, the difference on the degree of presence between them is not well documented. This article presents and discusses a study that measured presence using a HMD and a TS. 69 subjects were exposed to two different neutral virtual worlds (20 minutes each world), one using a HMD and other a TS. Presence was assessed through Slater-Usoh-Steed questionnaire (1994). Significant differences (α=.05) were found between HMD and TS. In fact, results from Paired Samples T-Test ($t(68)=-5.49$, $p=.00$) revealed that presence with HMD ($M=3.23$; $DP=.61$) was significant higher than the one with TS ($M=3.01$; $DP=.51$). Cybersickness was found on 21.7% of the HMD subjects and on 27.5% of the TS subjects. On both groups, presence was significant inferior on subjects with cybersickness.

Virtual Reality and In Vivo Exposure for Fear of Flying: A Phase II Replication Study

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Background: Fear of flying is a prevalent problem that affects people in many ways. Like other anxiety disorders and phobias, a hallmark symptom is avoidance. Treatment generally involves exposure therapy. Exposure may be delivered via imagination, in vivo, or virtual reality (VR). This study utilized in vivo and VR based exposure with a wait list control group. Method: Participants who met DSM-IV criteria for an anxiety disorder in which flying was the primary feared stimulus were recruited from the greater Atlanta area through advertisements. Participants were randomly assigned to VR based exposure (VRE) (n = 25 completers); Standard (*in vivo)* exposure (STE) (n = 25 completers); or Wait List (WL) (n = 23). Data were collected at 6 and 12 months post treatment. Both treatment groups were provided with 4 sessions of anxiety management training followed by exposure either in VR or at the airport. Evaluations included willingness to take an actual flight immediately post treatment, standardized questionnaires, anxiety ratings on the test flight, self evaluations of improvement, and overall satisfaction with treatment. Results: No differences were detected between the two exposure-based treatments on relevant measures and each treatment was superior to the WL control group. Follow up evaluations indicated that participants in both treatment groups maintained therapeutic gains at follow up. Conclusions: The results of this controlled trial add evidence to that from our first trial which reported similar findings. Both trials support the use of exposure as a viable treatment modality for fear of flying. In the post 9-11-2001 flying environment, security concerns and delays in airports are the norm. The use of VR based exposure allows professionals to offer an effective behavioral treatment for flying fear in their practices. New innovations

in VR and next steps in anxiety research will be discussed. Discussion: Future directions for anxiety research and the additional stimuli in the VR airplane environment will be discussed. Research Status: Completed. This Study has been accepted for publication :Barbara Olasov Rothbaum, Page Anderson, Elana Zimand, Larry Hodges, Delia Lang and Jeff Wilson (2006) Virtual Reality Exposure Therapy and Standard (in Vivo) Exposure Therapy in the Treatment of Fear of Flying Behavior Therapy, 37,80-90.

Exploratory Investigations of Multimedia Human Computer Interfaces for Autism

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Our research aims at providing design guidelines for software intended for specialized education for autism. Our study focuses on autism with average or above average IQ, referred to as high functioning. Pragmatic difficulties are attributed to people with autism: they tend to miss out context when interpreting speech. According to different authors (Russell, 1996), autism would be linked to an executive dysfunction that impacts the ability to plan actions, imagine alternative solutions and inhibit inappropriate responses. Experimental studies have emphasized the usefulness of computer education for autism. Yet, there have been few studies on the behavior of people with autism as users of a computer. We therefore performed an exploratory investigation of HCI issues that would be relevant for autism. Our experimental protocol focused on the study of two dimensions: 1) the domain of learning targeted by educative games and 2) the media and modalities used in the HCI. We contrasted two learning domains: “dialogue understanding” which seemed relevant given the pragmatic difficulties reported in autism and “spatial planning” which involves visuospatial skills considered unaltered in autism. We assumed that performances of subjects with autism would be close to those of subjects without autism in spatial planning, but that they would differ in dialogue understanding. We designed two software games for each learning domain: one for training purpose and one to evaluate subjects' skills before and after training. These games were tested with 10 teenagers diagnosed with high functioning autism according to DSM IV (APA, 1994). We tested several HCI modalities that were specific to each learning domain (e.g. text, synthesized speech, facial expressions images…). During evaluation phases, we also controlled for the impact of multimodal as compared to minimalist interfaces. The experiment comprised 13 sessions, at the rate of one session per week. We replicated the experiment with a control group of 10 children without autism. A software platform was developed to control HCI modalities and to log users' actions. Moreover, we annotated video recordings of two sessions with the subjects with autism. Contrary to initial assumptions, results lead to the conclusion that the clinical group performed poorer than the control group on spatial planning tasks, despite the asymmetric cognitive profile in favour of visuospatial skills attributed to autism. This difficulty could derive from executive functions involved in planning a solution and complying with arbitrary rules, such as orientation constraints in a graph. We also observed that HCI features enforcing the task’s arbitrary rules (e.g. not allowing crossing an arrow in the wrong way) could be helpful regarding the management of executive functions. Results suggest that the multimodal interfaces tested during evaluation did not help subjects with autism more than the minimalist interfaces, whereas it was the case for the control group. Users with autism might not be able to take advantage of multimodality which could induce cognitive overload.

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Failure to Influence Presence by Manipulating Narrative Content

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Presence is a popular topic in virtual reality. It is a common belief that presence is related to treatment outcome, at least for the treatment of anxiety disorders. But the mechanisms linking presence, anxiety and treatment outcome remain unknown. Mantovani et al. (2004) suggested that the narrative context provided to the subject before the immersion in virtual reality has an impact on presence. But their experimental manipulation confounded the manipulation of the narrative context and the induction of emotional arousal. In order to discern the impact of the narrative and emotions induced by the context of the immersion we tried to manipulate narrative and emotions. Our hypothesis was that anxiety felt during the immersion in virtual reality would increases the feeling of presence. The study involved 30 participants, assigned randomly to one of three experimental conditions: (1) Minimal instruction (which can be summarized by: visit the Temple of Horus, in Egypt. If you see medical emergency kits let us know because some were lost during our last visit) (2) Neutral narrative (which can be summarized by: while you were visiting the Temple of Horus an accident happened to a tourist and you have to help her by finding lost medical emergency kits), and (3) Stressful narrative (which can be summarized by: while you were visiting the Temple of Horus an accident happened to the child of a tourist and you have to help. You have to find medical emergency kits before she dies. Be careful because there is a dangerous and armed man inside the Temple). Participants were immersed three times in virtual reality: once in a control environment, once in the Temple of Horus environment (the experimental immersion) and once again in the control environment. Following the immersions, participants were asked to complete different questionnaires and short measures of anxiety and presence. We found significant differences in anxiety between the conditions after randomization, but the experimental manipulation did not induce anxiety in the participants. A general impact of narratives may be reflected in the statistically significant increase in presence from the control environment to the experimental environment, but there were no differences among the three conditions. In our opinion, the failure to induce anxiety is worth reporting to the scientific community, at least as an example where narrative may not induce the expected emotions. In addition, a significant number of participants were subjected to cybersickness during the experiment. These results are discussed in the light of different factors relating to presence and the planning of further studies using different methodologies.

The Effects of Active Navigation on Object Recognition in Virtual Environments

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Background & Significance of the Problem: There has been growth in the interest in VEs as tools for acquiring spatial knowledge and these interaction systems appear to have significant potential as aids to human learning. In general, the visual information which is essential for learning in virtual environments can be acquired in the course of active navigation of an environment and during passive one. Evidence from some experiments generally suggests that active navigation has potential benefit for acquiring spatial knowledge while other studies show inconsistent results. In the present study, therefore, we examine the relative effectiveness of active navigation and passive navigation in the efficient acquisition of spatial knowledge by controlling for the previously mentioned limitations. Methods/Tools: 54 participants (19 males and 35 females) were randomly allocated into one of two navigation conditions (active and passive navigation). The 3D visual display was presented through HMD and participants used joysticks to navigate VEs. The VEs consisted of exploring four rooms (library, office, lounge, and conference room), each of which had 15 objects. 'Active navigation' was performed by allowing participants to self-pace and control their own navigation within a predetermined time limitation for each room. 'Passive navigation' was conducted by forced navigation of the four rooms in random order. Total navigation duration and objects for both navigations were

identical. After navigation, all participants were asked to complete the recognition task with 60 old items, which had previously been shown during the navigation, and 60 new items, which had not been presented before. Recognition for objects was measured by response time and the percentage of correct, false, hit, and miss responses. Results: The active navigation group had longer overall reaction times than passive navigation group, though this difference was not significant. But the analysis revealed a significant difference between the conditions in hit and miss response percentages for object recognition. The active navigation group made significantly more hit responses ($t(52)=4.000$, $p= .000$) and fewer miss responses ($t(52)=-3.763$, $p= .000$) than did passive condition. Conclusion: These results suggest that active navigation allows more accurate recognition of spatial objects and more efficient spatial learning than does passive navigation. Spatial encoding and the memory mechanism underlying active navigation remain to be investigated through further studies. Novelty: This study suggests that active navigation plays an important role in spatial cognition as well as provides a better explanation about the efficiency of learning in 3D-based programs.

Analysis of VR Based Head-Motion to a Virtual Avatar: Characteristic of Schizophrenia

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Schizophrenia is one of the most devastating psychiatric disorders, because it seriously affects the higher mental functions, such as thinking, feeling, and perceiving. In particular, disturbed social functioning is a common problem among individuals with schizophrenia. Clinical observations suggest that schizophrenia patients often have an impaired capacity to enter into and maintain interpersonal relationships their surroundings. Recently immersive environments have been used to investigate the psychopathic patients' cognition and behavior. Virtual Reality (VR) can offer an effective immersive environment. Some studies using VR reported social skill training for schizophrenia as well as cognitive therapy for autism. This study developed a system for measuring schizophrenia patients' behavioral characteristics in a Virtual Environment (VE) to examine their social behavior. The eye-gaze is one of the important factors considered in a social behavioral study. Therefore, this study measured the head-motion because there is a correlation between the head-motion and eye-gaze. Head Mounted Display (HMD) makes direct measurement of the eye-gaze difficult. The system was implemented in 3D Game Studio A6 as windows-based application program to present VE and a 6DOF tracker to measure the head-motion. In the VE, participants meet each avatar whilst performing 6 tasks. The participants have a conversation with the avatar after being introduced. The level of head-motion data was measured while the participants were watching the avatar during the introduction. The data was analyzed using MATLAB 7.1, and the head-motion data was sampled every 0.01sec. The head-motion data was transformed into a frequency domain using a Fourier transform. Only the data less than 1Hz was considered, because a high frequency appears to be an almost physically impossible band. In addition, the mean degree and standard deviation were determined. The result showed that there was a difference in the mean degree between the normal group and schizophrenia patients group (normal mean degree 4.24, patient mean degree 7.19). The standard deviation, normal group and schizophrenia patients group were1.62 and 0.96, respectively ($p=0.01$). In addition, the schizophrenia patients group showed more movement in the low frequency domain than the normal group. In the high frequency domain, the normal group showed more movement than schizophrenia patients group. It is possible that schizophrenia patients have a more fixed eye-gaze than normal participants. This suggests that schizophrenia patients have difficulty in watching or observing other people on account their anxiety or cognition deficits.

Applications of Multimedia Technologies to Mental Health: Review

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Recently, a panel of 62 distinguished mental health professionals using Delphi methodology tried to outline how future changes will impact psychotherapy, psychologists, and patients. According to their answers, technological interventions were judged to be in the ascendancy within the use of VR and computerized therapies. Nevertheless, this data refers only to psychotherapy, multimedia technologies offer a series of powerful and valid applications on Mental Health. The objective of this study is to quantitatively review the published literature to assess the current application possibilities of the different multimedia technologies to the mental health field, that addresses the questions: What kind of technology is used?, What is the purpose of the application? Who is the first beneficiary of the current application?. The search covered eleven literature databases (ACM Digital Library, IEEE Xplore, MEDLINE, PsycINFO, PubMed, ProQuest, Science Direct, Web of Science, Emerald, Annual Reviews, Blackwell On line) and employed 22 single search terms and concepts about computer input/output devices; human±computer interfaces; and media type and their Boolean combinations with mental health keywords. Articles not written in English were excluded. The study began with a qualitative review of 281 cited references with the following screening criteria: (1) published in an indexed journal , (2) describe the multimedia technology applied, (3) and describe the subjects involved in the experience. The areas identified to discus the results are: (i) mental health research; (ii) primary prevention, (iii) secondary prevention on mental health disorders (iv) diagnosis; (v) treatment & therapy opportunities, (vii) self-help & assessment (vi) teaching & training.

Teaching Immunology Concepts Using the Features of Computer Video Games

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Background/Problem: Knowledge about the operation of biological systems has exploded in recent years. Unfortunately, much of this new knowledge is inaccessible to many students, obscured by an opaque vocabulary. A recent study by the American Association for the Advancement of Science found that high school biology textbooks fail to make important biology ideas comprehensible and meaningful to students. The study found that "for many biology concepts, the textbooks ignore or obscure the most important ideas by focusing instead on technical terms and trivial details (which are easy to test)."[1] New learning strategies have the potential to dramatically improve methods of learning biology.[2] Learning sciences research suggests that learning by doing with understanding produces better transfer than mere doing alone.[3] Challenge-based simulations can provide students opportunities to receive feedback and revise their thinking, a critical part of the learning process.[4,5] Video game developers have instinctively implemented many of the recommendations of learning scientists, including highly realistic simulations of complex phenomena and progressive challenges with constant feedback regarding mastery of a subject/topic. Methods/ Tools: To address the need for better approaches to teaching complex subjects such as biology, we developed a highly interactive educational game for teaching immunology that implements many of the features of current video games. The game will be used to supplement immunology taught as a part of introductory biology courses given to high school students and some freshmen college students. Our goal is to make basic immunology concepts understandable to diverse learners who will be strongly motivated to master the complexity because of the interesting, high-stakes challenges presented by the game. The central challenge of the game is to teach rules to a set of players that represent important elements of the innate immune system (e.g. macrophages and neutrophils). The project is funded by a National Science Foundation grant and involves a multi-disciplinary team of learning scientists, immunologists, computer scientists and video

game designers and educators. The game will be evaluated in four high schools with approximately 225 total students during March and April 2006. This project evaluation will focus on four key questions: Does use of the instructional game improve the performance of students on tests now given by instructors in applicable courses? Does the system improve understanding in areas of immunology that are particularly difficult to master? Does the system increase student interest in science and their interest in a career in science? Does the effect of 1-3 depend significantly on sex, ethnicity, or other characteristics of the learners? Novelty/Discussion: This research project will benefit research teams working to develop biomedical simulations and groups interested in designing and testing new approaches to instruction using strategies enabled by powerful interactive simulations. The research will provide important insight regarding the motivational aspects of games and simulations and contribute to our understanding of which features of interactive games are important for learning and why.

Changes in P300 Amplitude in Smokers in Response to Cigarette-Craving Cues

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Smoking has long been known to be harmful to the smoker's health. It is difficult to quit smoking, and it is thought that this is because smokers have an irresistible desire for nicotine intake. Craving can be regarded as an important mediator of continued substance use, and relapse after abstinence (Anton, Moak, & Latham, 1996; Kosten, 1992). Changes in P300 amplitude were used as an indicator of reactivity to smoking-related stimuli in smokers. P300 amplitude used to increase for smokers to be exposure smoking stimuli. P300, a component of event-related brain potentials (ERPs) elicited by smoking-related (craving), antismoking (aversive) and neutral stimuli, was investigated. P300 amplitude to antismoking stimuli, shown previously by smoking stimuli, was recorded in smokers (N = 10) and nonsmokers (N = 10). Task stimuli consisted of 10 pictorial stimuli for craving, 10 neutral pictorial stimuli, and 10 aversive pictorial stimuli. The craving stimuli were pictures of a cigarette and smoking activity. The neutral stimuli were pictures of everyday life. The aversive stimuli were posters about antismoking activity. The symbol '+' was presented on the center of the screen for 3 s at the beginning of each trial, followed by the task stimuli, which were presented for 0.5 s, with an interstimulus interval of 1.5 s. Each trial consisted of one presentation of the symbol '+', followed by 10 craving stimuli, 10 aversive stimuli, and 10 neutral stimuli. Participants were given four trials within 4.5 minutes. EEG data were recorded at F3, F4, C3, and C4. Three-way repeated measures ANOVAs were computed on the P300 amplitudes. The factors were group (smokers, nonsmokers), stimulus (craving, aversive, neutral), and electrode location (F3, F4, C3, and C4). The main effects of stimulus were significant, but the group effects did not show significant interactions with other factors. An interesting observation was the similarity between P300 waveforms for craving and aversive stimuli in smokers, relative to those for nonsmokers. These findings could indicate that the antismoking-related response is similar to the smoking-related one. By previously cigarette craving regarding the research result which it makes from virtual reality there are subjective reports or fMRI research results (Lee, J. H., et al., 2003), it will be meaningful that whether cigarette craving and in vivo procedures bring the effect from the cerebrum from ERPs.

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Evaluation of Group Performance in a Mediated Environment

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Biosensors are an enabling technology that improve our understanding of emotional and behavioral response patterns, and enhance empirical evidence for the way the mind and body work in synchrony. Individual performance has been extensively described utilizing biometric data. In addition to individual characteristics and task traits; however, groups may express unique biologic patterns or a collective flow that is indicative of group performance. Group interactions are continuously modified based on the constant sharing and streaming of mutually relevant information. A group's idea formation, leadership, affect, cohesion, flow, motivation, efficacy and problem solving change in a continuous system of reciprocity. The research hypothesizes that there are group patterns of physiological change that can be detected through objective assessments to reflect group dynamics and dynamic communication within groups of variant performance levels. Using a nested mixed-model design, this study aims to evaluate group performance in a collaborative gaming environment. Analyses of biometric and psychological self-report data will be used to detect group patterns that correlate with team gaming performance and other group dynamics, including cohesion, flow, and group efficacy. Thirty-nine experienced computer game players (all male) were recruited from a post-secondary institution in Hawai`i. The sample was mostly college educated (means years of education=15, SD=2.5); single (87%), in very good health (71%), and with a mean age of 25.9 (SD=6.9). Most participants identified their ethnicity as White (70%), Native Hawai`ian (10%), or Japanese (10%), with 42% reporting two or more ethnicities; 23.7% of Hispanic origin. Participants complete a series of baseline questionnaires designed to gather information about each individual's motivation, leadership style, self-efficacy, and outcome expectations. Participants were randomly divided into 10 groups of three, and each team engaged in four one-hour sessions of collaborative, multi-player computer game play (CounterStrike). Participants wore a SenseWear® armband and a LifeShirt® ambulatory monitoring system during game play for continuous collection of low-level physiological data, such as energy expenditure, heat flux, heart rate, respiration, and galvanic skin response. Follow-up questionnaires assessed individuals' perceptions of several group dynamics and cohesiveness. This presentation will provide descriptions of the project outcomes and implications related to leadership orientation, situational motivation, group efficacy, perceived cohesion, self-efficacy, and flow. Multiple regression and mediational analysis were used to explore the association between individual and group performance, physiological response patterns, and other group dynamics across time. Data will be presented to better elaborate the relationship between psychological and physiological predictors of group performance, and implications for future application of these findings will be discussed. Understanding the synchronization of group physio/psychological patterns portends development of new strategies for team composition, dynamic feedback, and communication enhancement.

Physiological and Momentary Assessment for Identifying Tobacco Use Patterns

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Cigarette smoking is the leading cause of preventable disease and death in the United States, contributing to the deaths of more than 430,000 people each year. Approximately 70% of smokers report that they want to quit, and almost 41% have made at least one quit attempt in the past year. While a number of evidence-based pharmacological and behavioral interventions have proven effective for smoking cessation, only about 4% of smokers who try to quit smoking each year succeed. Approximately 70%-80% of smokers relapse after a single quit attempt and require multiple attempts before remaining tobacco free. A new generation of applied sensor technology, though not yet in the mainstream, is emerging in support of a pre-

vention-oriented, consumer-driven model of healthcare. Research with sensor technologies supports the utility of biosensors for the detection and prediction of arousal associated with specific behavioral events. Through real-time physiological monitoring and momentary assessment of behavioral events (e.g., smoking a cigarette), commercial sensors have the ability to capture data that can be used to create algorithms for the identification and prediction of arousal patterns associated with cravings and addiction. The primary objective of the current three-phase research is to analyze biometric and behavioral data and detect the physiological antecedents that prompt smokers to use tobacco. In Phase 1, 12 smokers were recruited from a post-secondary institution in Hawai`i. The sample averaged 32.7 years of age (SD=10.4), were college educated (mean years of education=15.8, SD=2.6), and predominantly male (67%), White (89%), and unmarried (78%). All participants reported being in good or very good health, and 63% were employed full- or part-time. Participants' smoking history will be discussed including average tobacco consumption, nicotine dependence (Fagerstom score), number of quit attempts, and quit methods. In addition to completing baseline questionnaires about self-efficacy to quit smoking, decisional balance, and readiness to change, participants wore non-invasive armband sensors continuously for seven days as a means of collecting low-level physiological data, such as energy expenditure, sleep/wake states, heat flux, and galvanic skin response. Participants also pressed an "event button" on the armband each time they lit a cigarette. Biometric and psychological data were analyzed during Phase 2 to generate statistical algorithms predictive of an outcome event — in this case, cigarette smoking. Development and testing of the algorithms, the methodology and analyses involved, as well as future applications of these findings will be discussed. Phase 3, which is ongoing, will test the validity and specificity of the algorithms created in Phase 2. There exist real opportunities to develop innovative treatment approaches by integrating contemporary advances in technology with our understanding of the biological substrates and behavioral mechanisms of cravings and addictions. The information gained from our research is a requisite step for the development of portable behavioral health interventions that will endow consumers with greater control over maintaining their own health. The development of new sensor technologies will tailor treatments to individual biometrics and daily routines with the delivery of personal clinical information at the most opportune moments for effective intervention.

Virtual Reality and Interactive Games to Treat Fear of Falling in Multiple Sclerosis

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Patients with multiple sclerosis (MS) may experience several disorders. In particular, poor balance and motor impairments contribute to develop fear of falling that may lead to poorer quality of life. While the fear is an appropriate response to multiple sclerosis's motor symptoms, it often leads to activity restriction and needs to be addressed. This fear is both objective (due to the motor symptoms of MS) and subjective (because of the psychological component of the fear which the patient develop). In fact, because of the fear of falling, MS patients tend to function in daily life below their real physical capacities. We hypothesized that new technologies such as virtual reality and multi-media interactive exercises may act on the phobic component through the stimulation of the perception-action loop. We established a protocol to test the responsiveness to treatment with these new interactive and immersive tools. Patients recruited in the study have mild to moderate MS. The Fear of Falling Measure (FFM) was used to assess the degree of fear. The intervention consists of one session per week during 10 weeks. Patients were invited to start each session with virtual navigations and to end with performing interactive perceptive and motor exercises. During virtual navigations, patients are equipped with a head-mounted display coupled with an electromagnetic sensor system and immersed in a virtual environment in which they can move

forward by pressing a mouse button. They have to turn on their own vertical axis in order to change the direction of heading in the virtual environment. The navigation in virtual environments aims to reinforce the perception of fluid walk and to increase their confidence about walking normally. Interactive exercises are practiced with Sony PlayStation® games. We use Eye Toy and the Dance Mat. With the Dance Mat, lower limbs movements have to be performed according to the task visually suggested on a large screen. With Eye Toy, upper and lower limbs movements have to be performed according to the auditory-visual context presented in the game. The visual feedback of the body of the patient, which is projected in the screen, may redress self-confidence on performing different motor movements. Initial results from this ongoing study indicate that fear of falling can be successfully reduced in MS patients. So far, the majority of patients demonstrated improvements in self-efficacy and confidence in mobility. Theoretical considerations will then be discussed.

Treating Phobia to Small Animals Using Augmented Reality

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Virtual Reality and exposure in vivo have been used extensively for the treatment of several psychological problems, but Augmented Reality has not been exploited in this field. We have recently presented an Augmented Reality system for the treatment of cockroaches and spiders using visible markers [1]. With this system we treated ten patients, four with a phobia of spiders and six whit a phobia of cockroaches. We applied the AR system using “the one-session treatment” guidelines form the treatment developed by Öst, Salkovskis and Hellstroöm [2]. In all cases, the treatment significantly reduced the participants’ fear facing their target animal. Before the treatment, none of them could approach spiders or cockroaches. After the treatment, all were able to kill several live spiders or cockroaches. One important step in the treatment is where the patient has to search for a possible animal hidden behind whatever object. This stimulates the anxiety of patients because they do not know behind which object is the hidden animal or if there is one or not. Using visible markers is very easy to know if animal/s is/are going to appear, because in the moment the patient sees the marker, the animal is there. We realized that the marker were visible was a negative aspect of our system and this is why we have developed an Augmented Reality system markerless. The system works in the same way as the visible marker system does, but in this case the markers are not visible. The video stream is captured using a FireWire camera (colour image). We have used DragonFly Camera. We have used the Daeyang i-Visor (DH-4400VPD) as visualization system. We have used the IR Bullet Camera (715nm IR filter) to obtain the infrared image where the invisible markers are detected. We have used the IR invisible Ink Writing Pen – 840 nm Peak to draw the invisible markers. The infrared and colour cameras are situated in known positions, so the transformation matrix from the position of the infrared camera to the position of the colour camera is easy to obtain. Both cameras capture the image of the real world. The infrared image is analyzed to identify the position and orientation of the marker. Later, using the above-mentioned transformation matrix, the real position where the virtual objects have to appear over the colour image is obtained. The cockroach/spider appears over the invisible marker in the colour image. In this way, we know the position where the animals have to appear, but the user can not see it. Now we are testing if the sense of presence and reality judgment in normal users (without fear) is the same using the visible and the invisible marker system.

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An Augmented Reality Book for

Storing Past and Future Events

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The use of Augmented Reality to develop applications for entertainment and education has been exploited extensively. In this paper we present an Augmented Reality book for remembering past events and to plan future ones. We think it is possible to use this system to have a memory book from past events and to think about future plans. The user can include not only photographs but also objects and videos. Our system runs in a PC AMD Athlon with 1 Gb Ram and under Microsoft Windows XP. The video stream is captured using a USB camera. We have used Logitech QickCam Pro 4000. We have used 5DT HMD (5DT Inc., 800 H x 600 V, High 40º FOV) as visualization system. The system has been developed using Brainstorm eStudio. Braintorm eStudio is commercial software (www.brainstorm.es). Brainstorm eStudio is an Advanced, Multiplatform Real Time 3D Graphics presentation tool. Brainstorm eStudio can be defined as an interface that the programmer can use to create 3D complex visualizations without using OpenGL, only using tool options. We have included ARToolKit into Brainstorm eStudio as a plugin writing in C++. So, in this way we have included AR options into a 3D graphics presentation tool with the advantages that this presents. The registration is achieved using markers. The elements that are recognised using markers are: the type of elements (option space) and the elements (database space) to be included into the book, the selector, the drain and the book. Option space and database space have 4 markers. We have used 4 markers because the user can cover till 3 markers and the system will recognise the other marker. If the system recognises one marker, it has enough information to proceed. If the system had one marker and if the user covered it, the system would not be able to recognise it and it would not work properly. The book has another marker to indicate the page of the book. The memory book works as a photograph album. In a photograph album, the user chooses a photograph and puts it in the desired place of the selected page. In the memory book is nearly the same. The user utilizes a selector to choose the elements and he also puts them over a page of the book. The user can choose among videos, objects or images. These elements appear over a page with 4 markers (option space). Once the user has chosen the type of element he wants, he/she selects the desired element. These elements appear over a page with 4 markers (database space). The user can remove an element from the book. He/She puts the selector over it and he drags it over the drain.

Efficacy of Sensory Integration Treatment Based on VR-Tangible Interaction for Children with Autistic Spectrum Disorder

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Background & Significance of the Problem: Children on the autistic spectrum disorder have difficulties in integrating for motor and sensory experiences. So it may be important to address in therapeutic interventions for children with autistic spectrum disorders. There are some advantages of sensory integration therapy. It is possible that unstrained therapy in role play situation and can induce social skill training by holding intimacy with friends. However it has low efficiency in place, duration of treatment and in cost effect. Virtual reality technology is an exciting tool for allowing children with autism to practice behaviors in role-play situations, while providing a safe environment for rule learning and repetition of tasks (Parsons & Mitchell, 2002). However, some ethical and technical concerns surround the use of fully immersive virtual reality technology (i.e. the use of head-mounted displays [HMDs]). HMDs can be extremely expensive and people may experience ‘cybersickness’. Moreover, HMDs place some limitations on the child’s interaction with another person. Methods/Tools: Our treatment system is composed of three programs. The first is ‘sensory integration treatment’. With this scenario, children with autism experience vestibular, proprioceptive, and somatosensory activities, such as swinging, spinning, and rotating. Second is ‘social

skill training. It is consist of social skills training program such as eye gaze. Third scenario is a measuring program for coordination ability. This involves breaking virtual balloons with a real stick, which measures the visuomotor coordination. Our VR–tangible interaction system consists of a Pentium IV PC, a projector, a screen (200 × 150 cm), an infrared reflector, and a digital camera and tangible devices. Twelve autistic children (mean age = 6) and twenty normal comparisons (mean age= 5.6) were participated twice per week, total of 10 sessions in this study. First of all, basic data about participants were collected for clinical test of this system. Next, we gathered experimental data while all participants experience the program. Therapist and assistants were interviewed after all of sessions. Results: Clinical test of this system well completed and data were gathered but still in data analysis. Therefore, to demonstrate efficacy of VR – tangible interaction system on this abstract is not available. We will analyze the effect of this system for autistic children. And we will also compare the performances of normal comparison groups and autistic groups in the visuomotor coordination program and the social skills training program. Novelty: This study suggests that VR tangible interaction system has possibility about clinical approach for autistic children.

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Development of VR System to Train Assertiveness Social Skill for Psychiatric Patients and a Clinical Pilot Test

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Background/Problem: In a general sense, social skills are all the behaviors that help us to communicate our emotions and needs accurately as well as allow us to achieve our interpersonal goals. Social interactions can be broken down into a three-stage process requiring a different set of skills at each stage. Indeed, good communication requires accurate social perception (receiving skills), cognitive planning ability (processing skills) and an effective behavioral response (sending skills). Social skill training tools for receiving skills and processing skills were previously developed based on virtual reality (VR) techniques. In this study, VR program, which is called an assertiveness skills training program, was developed for sending social skills. Overall, a training program has been developed for the three-stage process for developing socials skills. Method/Tools: A HMD-based VR system was developed to make assertiveness training more realistic. The narrative-based contents were constructed by a psychiatrist and social worker that was derived from daily-occurring assertiveness situations in the home, friends and in job relationships. The contents can be divided into “Positive assertiveness training” and “Negative assertiveness training”. Moreover, it also can be divided into “family relationships”, “friend relationships” and “job relationships”. In total, 12 narrative-based VR assertiveness training modules were developed. The subjects consisted of 15 schizophrenic patients (6 males and 9 females) and 15 controls (7males and 8 females). This study measured the VR data, questionnaire data, and symptom data. The VR data included whether there was reinforcement or failure, the length of the expression time, the reaction time and the percentage of those watching the avatar (while listening to the avatar, and while communicating with the avatar). Questionnaire data included emotional arousal, valence, assertiveness scale, self-efficacy scale, presence etc. The symptom data was measured using the PANSS (Positive and Negative Syndrome Scales). Results/Conclusion: The VR parameter can measure the quantitative aspect of assertiveness skills. According to the analyzed results, the schizophrenia subjects did not perform as well as the normal subjects in terms of the percentage of those watching the avatar while listening to the avatar (control 59.53%,

patient 36.55%) and in the percentage of those watching the avatar while communicating with the avatar (control 68.25%, patient 47.22%). The number of reinforcements or failures in the schizophrenia and the control groups was 2.60 and 1.33 per subject, respectively. Indeed, the schizophrenia subjects required almost double the number of reinforcements. However, there were similar expression and reaction times. According to the results, schizophrenia subjects did not perform as well on the assertiveness test as the normal subjects. In addition, the VR program induced sufficient emotional arousal (2.88±1.07) but the emotional valence was appropriate according to the emotional contents (positive: 2.48±0.95, negative: -1.63±1.13). Novelty/Discussion: A VR three-stage assertiveness social-skills-training program was developed. This program is different from the social phobia program because it includes an understanding of social situations and allows the subject to make decisions based on their feelings.

Investigation of Social Problem Solving Ability in Schizophrenia Using Virtual Reality

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Background/Problem: Patients with schizophrenia usually lack the social skills necessary for daily encounters with others, and have an inability to communicate effectively with people, an inability to confirm and express their feelings, and a difficulty in understanding interpersonal boundaries. They sometimes solve their problems in an unsuitable manner or they may have few solutions. In this study, a Virtual Reality system was developed to measure the social problem solving ability according to the state of illness of the schizophrenia patients. Method/Tools: A project-based VR system was developed because schizophrenia patients feel a great deal of anxiety when wearing a Head-mounted display. Narrative-based contents were constructed to assist schizophrenia patients achieve the appropriate goal in being able to assess their social problem solving ability. A survey was carried out on 50 normal people to select 8 complicate social problems among the many daily-occurring social problems and to determine their difficulty. The virtual environment and virtual avatar matched with 8 complicated situations were constructed using 3D-MAX and were converted for rendering in an A6 engine. The behavioral database, which consisted of 15 avatars, approximately 40 apparels, around 70 actions and 6 facial expressions, was constructed to make a flexible and dynamic avatar. In addition, eye-blinking and lip-synching was roughly implemented to make the virtual avatar appear more realistic. The VR system was designed to give the users the information required in problem solving because the aim was to measure the pure social problem solving ability excluding the user's cognitive aspects such as memory. After having VR experience in each content, a Q&A panel asking questions about the complicated situation appeared and user could select their own solution about a given social problem using an 8-button joystick. The reaction time for responding to the Q&A panel and problem solution in the given social VR situation was extracted from the proposed VR system and used to assess the subject's social problem ability. After experiencing in each session, the schizophrenia patients answered the following questions: computer experience scale, immersive tendencies questionnaire, virtual reality questionnaire, social problem solving index, positive and negative syndrome scale, and the KWIS. Results/Conclusion: According to results, schizophrenia subject's selections showed a larger distribution than the normal subjects. In addition, the schizophrenia subjects did not perform as well on the VR social problem solving ability score as the normal subjects (difference 20.56 point). In particular, the normal and schizophrenia subject's mean score was 45.11 point and 24.95 point, respectively. In addition, correlation analysis revealed the VR social problem solving tool to have partial correlation with the classical social problem solving tool (Social Problem Solving Inventory). Novelty/Discussion: This study attempted to produce a more realistic and dynamic situation using a VR medium, which could be difficult to construct using

other media such as text, pictures or video. However additional research into the usability and validation of the proposed VR system will be needed.

A Short Feedback Questionnaire (SFQ) to Enhance Client-Centered Participation In Virtual Environments

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Over the past two decades clinicians who work in rehabilitation have adopted a "client-centered" approach which, among other elements, emphasizes the important role that client feedback plays in the intervention process. This feedback enables clinicians to help clients achieve a better match between their abilities, and the intervention tools used to improve their functional ability. In recent years, virtual reality (VR) technologies have begun to be used in rehabilitation due to their well-known assets (e.g., Rizzo & Kim, 2005). Client feedback during the VR-based rehabilitation process is even more important than during conventional therapy due to the additional complexity of the setting and its potential impact on the client (e.g., encumbrance, side effects). Indeed, there are still factors whose importance to VR-based rehabilitation is still in doubt (e.g., level of "presence"). Several presence questionnaires have been developed. One of the most frequently used is Witmer and Singer's (1998) 19-item questionnaire that is divided into four subscales: involved/control, natural, interface quality and resolution. Due to its length, this questionnaire is less suitable for use within the constraints of clinical intervention, especially when multiple virtual environments are used or with clients who suffer from cognitive deficits. Other questionnaires are typically either too long or focus mainly on the sense of presence and realism. The purpose of this presentation is to: (1) present the Short Feedback Questionnaire (SFQ) developed for research and clinical purposes based on Witmer and Singer's (1998) Presence Questionnaire (PQ) and (2) provide psychometric data from studies with patients and control subjects after experiencing a variety of virtual environments run with different VR systems (GestureTek's Gesture Xtreme (GX) VR, Sony's PlayStation II EyeToy, a virtual street crossing desktop VR system and the STISIM desktop Driving Simulator). The subjects included healthy participants (n=134), participants who had a Spinal Cord Injury (n=18) and participants who had a stroke (n= 43), all divided into groups according to type of virtual environment. The SFQ consists of eight items graded on a 5-point scale. The first six items assess the participant's (1) feeling of enjoyment, (2) sense of being in the environment, (3) feeling of success, (4) feeling of control, (5) realism of the environment and (6) whether the feedback was understandable. The seventh item queried the participants' discomfort and the eighth item queried their perceived difficulty of the task. The SFQ has been found to be suitable for use in different virtual environments and with various clinical populations. Initial results showed that internal consistency reliability of the SFQ ranged between α=.70 to α=.81 for different virtual environments. The concurrent validity of the presence part of the SFQ with the PQ showed significant moderate to high correlations ($p<.005$) ranging from r=.55 to r=.74 for the different virtual environments. The SFQ appears to be a reliable and valid tool for obtaining user's responses to virtual environments for both research and clinical purposes. These data play an important role in matching VR protocols to clients' therapeutic needs. The implications of the results will be discussed.

Performance Analysis in a VR-Based Assessment of Cognitive Planning

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Research status: Completed Case-Control study. Cognitive planning deficits affect patients with brain damage and interfere with

their capacity to manage everyday life activities. Owing to the dramatic need of detection and to the lack of ecological validity of the traditional psychometric tests, therapists are looking for more appropriate evaluation tools. In an earlier study, we reported a VR-based assessment of cognitive planning, built on the model of scripts and in the purpose of precise performance evaluation. We designed a Virtual Supermarket in which participants can carry out a task close to daily activities: a test of shopping list. The virtual system allows us a further analysis of the participant's performance thanks to various data recorded during the assessment session. We are now reporting the results of a study carried out in the context of Parkinson's disease. The study is based on a case-control design where the case condition is Parkinson's disease (PD). Thirteen patients with PD and eleven age-matched healthy volunteers, meeting inclusion criteria, constituted our convenience sample. The participants got familiarized with the Virtual Supermarket and the task thanks to two preliminary sessions. Then, without any time limitation, they were engaged in the assessment session, during which various measures were recorded (e.g. positions, actions). The patients were also submitted to the traditional psychometric evaluation of executive functions. The virtual system allows the therapist or the participant to review the performance from an upper point of view. We analysed the performance in the Virtual Supermarket according to three categories: (a) semantic knowledge related to the task, e.g. the number of good actions; (b) information processing speed; and (c) temporal and spatial organization. The results showed a lack of difference in the semantic knowledge related to the task between the patients and the controls. However, specific impairment was observed in patients in the sequential unfolding of the task. An analysis of reaction times suggested the expected alteration of information processing speed in patients. Moreover, the performance in the virtual supermarket revealed a significant alteration of the temporal and spatial organization of the patients. Finally, the participants appreciated the visual review of their path in the Virtual Supermarket, which helped them to better understand their real life behavior. This study shows the usefulness of our VR-based tool in the evaluation of cognitive planning. Thanks to various measures of the virtual performance, it allows us to detect and specify an alteration of cognitive planning. The path review is useful for both the patient and the therapist. It seems that the virtual system becomes the medium of a new indirect relationship between the patient and the therapist. This analysis of the virtual performance in three categories represents a new step in the use of our collected data. It leads to the characterization of the performance alteration in the designed task of shopping list, and so to an objective assessment of cognitive planning deficits.

Smokers' Attentional Bias to Smoking-Related Cues in Eye Movement

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Background/Problem: Smokers have attentional biases toward smoking-related cues, and such cues elicit craving [1]. Smokers also feel anxious during nicotine deprivation, and anxiety may exacerbate attentional biases toward aversive cues [2]. Therefore, deprived smokers will show attentional bias to smoking-related and aversive cues. To identify this attentional bias, we monitored participants' eye movement. Methods/Tools: We examined the attentional bias of smokers (N=14) and a control group of nonsmokers (N=16) towards smoking-related and aversive cues. Using an eye-tracking device, we measured eye movement when smoking-related, aversive, and control cues were presented simultaneously. We analyzed the number of initial fixations, and gaze duration, to identify the attentional bias. Results: Smokers initially fixated their gaze on aversive cues. A 2X3 repeated measures ANOVA (group and picture type) showed a significant main effect of picture type. And, they maintained their gaze longer on smoking-related cues, in comparison to the control group. Conclusion: These results suggest that smokers gazed at smoking-related pictures longer than nonsmokers did, but there was no difference in initial fixation. Gaze duration could therefore be a sensitive measurement tool for identifying attentional bias. Novelty: Present study suggests that gaze duration in eye movement could be a sensitive tool for

ascertaining attentional bias. Based on this result, we can confirm more precise and object characteristics of craving in virtual reality when virtual stimuli are presenting. As well when HMD and eye-tracker are combined, it will be more ecologically valuable to certificate the role of attentional bias and craving.

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Application of Virtual Reality-Cue Exposure Therapy for Reducing Alcohol Craving

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Background and Significance of the Problem: During abstinence from alcohol, craving is elicited by the cues and contexts previously associated with alcohol, which contribute to relapse. To prevent the craving and relapse experienced by alcoholics, cue-exposure therapy (CET) has been used to extinguish the association between alcohol and alcohol-related cues and contexts. Methods/Tools: This study applied CET, using a virtual reality (VR) system, to eight members of an Alcoholics Anonymous group, in eight sessions. Cues and contexts most likely to elicit an urge to drink were selected through a preliminary survey in order to compose VR-CET scenarios: a glass, bottle, food, and a bar were judged to be the most tempting for people in alcohol dependence and abstinence. Using these cues and contexts, a Japanese-style pub and a western bar were created. Each session was administered for 30 minutes by a psychiatrist and included an introduction, immersion, VR navigation, interviews about feelings, and self-report questionnaires about cravings. The eight sessions consisted of initial and closing sessions, and person-, object-, and situation-focused sessions. Results: A reduction in cue-elicited craving after VR-CET was reported. A mean score of 15.75 (SD = 10.91) on the Alcohol Urge Questionnaire [1] in the first session decreased to 11.57 (SD = 6.88) in the final session. Novelty: This study suggests that using virtual reality can enhance the efficacy of CET so as to promote craving for alcohol and then to desensitize conditioned reactivity to alcohol.

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The Relation Between Anxiety and Feeling of Presence During VR Immersion

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Using virtual reality (VR) with people suffering from specific phobia is becoming an evidence-based and efficient form of exposure treatment. Traditional exposure is characterized by an increase in anxiety when the feared stimulus is presented, followed by a progressive reduction over the course of the exposure exercise. This is often called the “habituation curve”, or the “anxiety curve”. It is also thought that the subjective feeling of presence in the virtual environment is an important ingredient in making VR exposure work. However, it is not known if the feeling of presence remains stable within and between sessions. The stability of the feeling of presence is especially important since Robillard, Bouchard, Fournier and Renaud reported in 2003 that anxiety and presence correlate significantly when phobics are immersed in virtual reality (VR). How does this relationship hold over time, especially if anxiety fluctuates within sessions and decreases between sessions? The goal of this study is to assess changes in anxiety and presence while measured within therapy sessions as well as between therapy sessions, when people suffering from fear of flying re-

ceive VR-based exposure therapy. Our hypotheses are that anxiety will show the traditional habituation curves found during exposure therapy: anxiety will decrease within sessions and between sessions. Given the lack of previous data about presence, no specific hypotheses are suggested for within and between sessions. We also expect anxiety and presence measured within and between sessions to correlate significantly. The sample consists of 22 adults, 15 female and 7 male, diagnosed with flight phobia according to the *Structured Clinical Interview for DSM-IV.* Our analyses are based on data collected during the first four sessions virtual exposure therapy. Each of these immersion lasted up to 60 minutes (only the first 30 minutes are analyzed). Every five minutes during the immersions, therapists asked participants to rate on a 0 to 100 scales their level of anxiety ("how anxious do you feel?") and feeling of presence ("how much do feel you are really there in the virtual environment?"). A first set of repeated measures ANOVAs is used to compare levels of anxiety and presence within each of the four exposure sessions. A second set of repeated measures ANOVAs is applied on the first five minutes of immersion from each session. A correlation between anxiety and presence is calculated for each session as well. As expected, the results show that anxiety decreases significantly within sessions [F values range from 3.59 to 7.25, all $p < .01$] and between sessions [F= 3.98, $p < 05$]. The feeling of presence increases significantly within the first session [F=2.4, $p < 05$], marginally within the second session [F=2.26, $p = .056$] and remains stable over the last two sessions [F=1.83 and 1.21, *ns*]. The feeling of presence doesn't change significantly between sessions [F=.3, *ns*]. Finally, anxiety and presence correlate significantly [r=.41, $p < .025$]. Our results show that the relationship between anxiety and presence is more complex than anticipated by many researchers. Presence can remain high even if anxiety is getting lower from one therapy session to the other. Other implications are discussed as well.

Manipulating Optic Flow Modifies Walking Trajectory in Persons with Stroke

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BACKGROUND: Optic flow (OF) is a predictable pattern of visual motion projected at the moving eye during self-motion. By providing information on the speed and direction of self-motion, OF may contribute to the central nervous system (CNS) control of locomotion. We have previously shown that manipulating OF speed has been shown to influence gait speed in healthy subjects. After a stroke, walking speed is usually markedly reduced, due to a hemiparesis and possibly altered sensorimotor integration. Whether OF speed is perceived adequately and can be manipulated to enhance walking speed after stroke is not known. AIMS:The main objective of this study was to compare the changes in walking speed in response to different speeds of OF in persons with stroke (patients) vs. healthy controls (CTLs). It was hypothesized that a modulation of walking speed in response to OFs of changing speed would be present in the patients, but to a lesser extent than in the CTLs. METHODS: Patients (n=9) and CTLs (n=9) were evaluated while walking on a self-paced treadmill while viewing, in a helmet-mounted-display (Kaiser), virtual scenes controlled by Caren-2 (Motek) and Tarsus real-time engine (Vicon) systems. In the first paradigm that was tested, subjects walked at comfortable speed for 5 minutes in a virtual corridor. OF speed was varied sinusoidally (0.017Hz) from zero to 2 times the subjects' comfortable gait speed. In the second paradigm, subjects walked in a 10m virtual corridor at comfortable speed with a matching OF speed (control trials). For the test trials, OF speeds ranging from 0.25 to 2 times the subjects' initial comfortable gait speed were randomly presented. Subjects were instructed to walk the 10m distance within the same time as in the control trials. RESULTS: In the first paradigm, cross-correlation analyses revealed that gait speed was modulated out-of-phase with respect to optic flow speed, the strength of this modulation being weaker in the patients (r= -.35±.10) than in the CTLs (r= -.42±.20). Walking speed responses lagged behind the changes in OF speed by an average of 4.3s and 6.4s, respectively, in patients

and CTLs. In the second paradigm, linear regressions also revealed a negative relationship between walking speed and OF speed, so that subjects walked faster when exposed to slower OFs. Similar gait speed vs. OF speed slopes were observed between patients (-.17±.19, R^2=.04 to .95) and controls (-.17±.15, R^2=.01 to .73). CONCLUSIONS: Persons with stroke present with an altered modulation of walking speed in response to continually changing OF speeds. However, the fact that patients could still use OF speed and voluntarily modify their walking speed accordingly suggests that manipulation of OF speed through virtual reality technology could be used to promote faster walking speeds after stroke.

Virtual Reality Distraction for Children Receiving Minor Medical Procedures

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Distraction strategies aim to divert a patient's attention away from a painful or anxiety producing situation and focus that attention onto another task. Virtual reality (VR) has been demonstrated to provide effective distraction during medical procedures associated with high levels of pain and/or anxiety (wound care/physiotherapy for burns patients, post-operative physiotherapy, dental procedures). Less is known about the usefulness of VR distraction for minor medical procedures where pain may be relative low but anxiety and distress high. Distraction interventions in the form of listening to music, blowing bubbles, playing with interactive toys, reading interactive or musical story books and watching movies have been used for children undergoing venipuncture (blood sampling, intravenous catheter insertion), with variable results. The aim of this study was to determine of VR was more effective in reducing pain and distress in children undergoing minor procedures compared to watching an animated movie. Children attending a Pediatric Emergency Department, requiring venipuncture or wound care procedures were randomly allocated (block randomization) to receive VR or animated movie distraction. Children were asked to provide self reported pain intensity (Colored Analogue Scale) and affect (Facial Affective Scale) scores pre, post and maximum during the procedure. Parents and staff were also asked to provide scores for their perception of the child's pain and anxiety (Visual Analogue Scales) at these time points. Parents were asked to score their own anxiety (Visual Analogue Scale). Children's distress behaviors were scored during the procedure (Brief Behavioral Distress Scale) and children were monitored for any adverse effects (Malaise Scale). Parents and staff were asked to comment on the effectiveness of the intervention (Visual Analogue Scale) and children completed a presence and enjoyment questionnaire post procedure. Eighty eight subjects (51 males, 37 females, mean age 11.3±2.9) were recruited, with 44 children in the VR and movie intervention groups. Using Mixed Modeling Analysis, no significant difference was found between interventions for children's self-reported pain and anxiety or parent's perception of children's pain and staff's perception of the child's pain and anxiety. Parent's perception of their child's anxiety was significantly higher ($p=0.02$) when children were using the VR compared to watching the animated movie, however, children using VR displayed significantly lower behavioral distress ($p<0.001$). Children using VR had significantly higher scores for level of enjoyment, interest/ involvement and presence, than children watching the animated movie ($p<0.001$). Virtual reality was perceived by both staff and parents to provide more effective distraction ($p<0.0001$). The results indicate that VR is at least as effective as and significantly more enjoyable than watching an animated movie. Although VR is a novel distraction technique for patients, parents and staff, further research should focus on the development of more age appropriate and interactive virtual environments. A cost-benefit analysis is required in order to determine if VR will be a beneficial and cost effective distraction tool for use during minor medical procedures in the Pediatric Emergency Department. *This research was supported by a Channel 7 Children's Research Foundation Grant.*

The Impact of Perceived Attitude of

Virtual Agents on Beliefs and Physical Reactions of Social Phobics Immersed in Virtual Reality

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Pertaub and Slater have already shown that the behaviour of virtual agents can induce anxiety in people suffering from the fear of public speaking. The goal of this study is to test if changing the narrative context surrounding the immersion (positive vs negative virtual agents) without changing the behaviour of the virtual agents will have an impact on social phobics' anxiety (subjective and objective), beliefs and feeling of presence. Our hypothesis is that simply presenting virtual agents in a negative manner (arrogant, superior, judgemental and unfriendly) will induce anxiety, activate negative beliefs about oneself and increase the feeling of presence, compared to presenting the virtual agents in a positive manner (warm, interested, friendly and nice). The sample consists in 20 adults diagnosed with social phobia according to the *Structured Clinical Interview for DSM-IV.* Participants are randomly assigned to two either the Negative or the Positive virtual agents. Note that the virtual agents are exactly the same in both conditions and behave identically. Both groups are immersed in the same virtual classroom and are invited to give a talk for 20 minutes where they discuss their phobia, their personal difficulties, their physical reactions when anxious and have to answer questions from a virtual agent. During this task, participants' heart rate is measure using a Procomp+ system. Post-immersion, they filled-in some questionnaires related to social anxiety and sense of presence: Fear of Negative Evaluation (Watson & Friend, 1969), Social Anxiety Thoughts (Hartman, 1984), Liebowitz Social Anxiety Scale, 1987), State-Trait Anxiety (Spielberger, 1983) & Presence Questionnaire (Witmer & Singer, 1998). Participants also receive 15 weekly sessions of cognitive-behavior therapy in groups of four or five. All exposure exercises are conducted *in vivo* (no immersions in virtual reality). Post-treatment, participants perform the same experimental task as at pre-treatment. This portion of the study is still underway. Repeated measure ANOVAs will be used to compare differences between conditions at pre-treatment and assess the impact of therapy on patients' reactions to the virtual audience. We expect our results to show that the behaviour of virtual agents is not the only factor that can induce anxiety and presence. Clinicians can, and probably should, manipulate how the patient perceives the virtual agents in order to induce different level of fear when using virtual reality in the treatment of social phobia. We also expect participants' reactions to change after therapy, showing that using a virtual audience could be used to measure treatment outcome.

Speculations on the Construction of an Interactive Environment to Assess Sexual Interest and Coping Skills in Sexual Offenders

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This is basically a video version of the *Situational Competency Test* that was developed in the 1980s to assess coping skills in treated sexual offenders. Video game technology provides an as yet unexploited medium for the construction of an interactive environment for this purpose that would be unlike anything currently on the market. What we envision is situation resembling a city street or park through which the subject is required to move. As he progresses he is confronted by situations and persons who would pose a high risk for the commission of sexual offenses. The situations could be areas where a sexual offense could be easily committed and, depending upon the cues present in that situation, he must make a choice on what to do next. The virtual persons that confront him (children or adults) might offer provocative suggestions to which he must respond. The models then respond in kind to whatever he says or does. Each of these junctures could be considered choice points where a number of options are available to the subject. The situations and virtual persons con-

tain an array of responses to whatever the subject says and/or does. Our expectation is that it would be possible to score the quality of the subject's behaviour at each of the choice points, thus yielding an evaluation of his sexual interest or his ability to deal with high risk situations. Several video game examples will be presented to illustrate the type of environments we have in mind.

Differences in Brain Connectivity in Relation to the "Feeling of Presence" in Schizophrenia during a VR Experience

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Presence is often thought of as a sense of 'being there' in the virtual environment (VE), and it is one of the most important factors in estimating a VE. Although the VE might have same contents, each user's experiences and perceptions can be different. These differences can influence not only the presence score but also the brain activity in perceiving information. Many studies have examined presence, but there is no report on the direct correlation between presence and the brain activity. The aim of this study was to determine the brain region influenced by the feeling of presence during a VR experience by performing covariance analysis of the brain activity related to inference and the subjective presence score. The connection between these areas was investigated using correlation analysis. The VR experience block had an avatar telling either an ambiguous or clear story about something it just experienced. The subjects were asked to watch and listen to the story for 30 seconds, infer why the avatar told that story for 20 seconds and respond to an O/X question for 10 seconds. For the fMRI experiment, the 12 ambiguous tasks and 12 clear tasks were arranged randomly. Fifteen normal right-handed healthy subjects and thirteen right-handed schizophrenia patients were recruited. The fMRI conducted with 1.5T machine (GE Medical System). After the fMRI experiment, subjects were asked to complete a presence questionnaire developed by Bob G. Witmer. The mean presence score was 107.86 (SD=15.51, range=80~132) for the normal subjects and 102.69 (SD=18.71, range=79~142) for the schizophrenia. The fMRI data analysis results revealed several brain areas to be related to the presence score. A positive correlation is shown in the right lingual gyrus, right cuneus, left lingual gyrus, right fusiform gyrus, left inferior temporal gyrus, anterior cingulate and right posterior cingulate of normal subjects. However, there was no brain area related to the presence score in the schizophrenia. Correlation analysis revealed two different circuits in the normal group. One circuit involved the left lingual gyrus, right lingual gyrus, right cuneus, left inferior temporal gyrus and right fusiform gyrus, and the other involved the right lingual gyrus, right cuneus, left inferior temporal gyrus and anterior cingulate. The former might be a circuit for perceiving information, and the latter might be a circuit for monitoring and integrating information. But, in the schizophrenia group, there was no correlation between the anterior cingulate and the other areas except for the left inferior temporal gyrus in the circuit for monitoring and integrating information. This might be because subjects with schizophrenia are less able to integrate or resolve ambiguous information. This study revealed that the brain activity during a VR experience can influence the subjective feeling of presence in a VE, and this is the first study to investigate the correlation between the presence scores obtained and the brain activities and their different connections in subjects with schizophrenia.

Sociosexual Uses of Internet Among French-Speaking Gays from Québec: Results from a Quantitative Research

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Objectives : Unknown before the middle of

the 1980's, the mediatization of sexuality through Internet has been accompanied by the development of numerous studies, particularly among gay populations. By providing new forms of sociability, Internet has contributed to changes in their sexual practices, strategies of communication, patterns of socialization and encounters. The study of sociosexual uses of Internet in Québec is still in its infancy and we will present some results of a recent quantitative research. Methodology : Following a qualitative study among gay men from Montréal and Québec, an online questionnaire was developed with 62 questions organized in 5 sections (socio-demographic information; social, romantic and sexual uses of Internet ; encounters with other users ; psychological and sexual impacts of Internet use, health and well-being). Between February 2003 and October 2004, 932 French-speaking gay men from Québec, aged 18 years and more, have answered a self-administered and anonymous questionnaire. Results : Data dealing with sexual activities online during the six months preceding the study show the following tendencies: 39,5% of participants have often or very often viewed pictures with sexual content ; 30,8% have often or very often had masturbatory activities online and 28,4% have often or very often exchanged messages with sexual explicit vocabulary. Other sexual activities online are less frequent : sexual ads (often or very often: 14,7%) ; webcam use (often or very often: 13,6%) ; romantic ads (often or very often: 12,7%) ; reading or publication of sexual stories (often or very often: 10,9%) ; transmitting nude pictures (often or very often: 10,4%), buying sexual material (often or very often: 2,3%), viewing direct sexual performances (often or very often: 1,6%). Apart of sexual activities online, 74,2% of participants have encountered men offline mainly for sexual purposes. As to impacts of Internet on their sexual life, 50% and more agree that the use of Internet has contributed to develop their sexual experiences, to ameliorate the expression of their sexual desires, to encourage them to have a more active sexual life, to accept their sexuality and their sexual orientation. Conclusions : Despite the many sexual possibilities linked to Internet, this technology is mainly used for sexual encounters, viewing of sexual material and masturbation online while other activities are less frequent. Furthermore, the use of Internet seems to contribute to a better sexual life. Comparisons with a heterosexual population could help to better understand variations in sociosexual uses of Internet.

Virtual Patient/Clinician Platform for Tele-Rehabilitation Application and Case Study

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Healthcare is one of the fastest growing sectors of the economy and providing cost-effective healthcare service to an aging population with a declining number of hospitals is a formidable challenge. Through recent technological advances it is now possible to migrate some of the services from centralized locations into the home. We describe a prototype architecture that we built to support novel, pervasive and easily deployable information technology applications in healthcare segment where outpatient treatment can be a cost-effective alternative. Our proposed architecture is conceived as a flexible platform that allows application builders to rapidly design, create and deploy applications that require the transmission of delay-sensitive media streams such as audio, video, and haptic data. As an initial example we applied our framework to tele-rehabilitation where a therapist remotely monitors the exercise regimen and progress of a patient who, for example, previously suffered from a stroke. We have designed a virtual patient/clinician interactive platform called ACTIVE+ based on our innovative audio streaming protocol [9, 10]. The new ACTIVE+ platform was devised to distinguish among different characteristics (e.g., bandwidth and processing requirements) of different streaming data and handle them accordingly. The ACTIVE+ architecture dynamically maintains and optimizes a peer-to-peer overlay streaming network so that time-sensitive data, e.g., a remote voice stream representing verbal instructions given to a patient by a clinician during rehabilitation, can be delivered in a timely fashion. We are excited by ACTIVE+'s capability to provide a general and flexible platform that presents a universal

interface to its applications such that multiple media channels can be allocated, each with potentially different characteristics. We are using neuro-rehabilitation as our application case study to investigate the effectiveness of the ACTIVE+ approach. We have designed an exercise environment which can be host to a progressive set of training tasks from precise fine motor movements to reaching movements that involve full arm and shoulder activity. We are leveraging our earlier work that makes use of the PHANToM haptic device, which is a small, desk-grounded robot that can simulate the sense of touch on a virtual object through force feedback. By using the ACTIVE+ platform, the therapist can remotely monitor both the actions and progress of the patient and, if necessary, provide the needed assistance through the voice channel. The metadata stream that contains the haptic information and user feedback are stored and analyzed later. We conducted a preliminary trial of our ACTIVE+ prototype starting in 2005 and a subset of the results were reported in McLaughlin et al. (2006). As a work in progress, our prototype received a positive feedback with average user rating of 4.5 on a scale of 1 to 7. Our proposed virtual patient/ clinician application is the first of its kind that is using a peer-to-peer based streaming network. Its main benefits are that no expensive, centralized infrastructure is required and the whole system is easy to deploy and scalable. Our innovative work shows that it is becoming feasible and cost-effective to utilize this type of heterogeneous network to conduct certain healthcare tasks remotely.

VR Tools for Development and Training of Advanced Prosthetics

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The Revolutionizing Prosthetics 2009 and Revolutionizing Prosthetics 2007 programs are part of a large scale and high profile effort currently underway in conjunction with the United States Defense Advanced Research Projects Agency. This ambitious endeavor seeks to revolutionize the field of upper-extremity prosthetics within the next few years by facilitating the collaboration of expertise and experience throughout the field. Each aspect of the project, from new surgical techniques to electromyography (EMG) signal processing to prosthetic fitting/fabrication and training, is being investigated, fine-tuned, and advanced. By project end, we will be anxious to produce what past decades of fragmented prosthetic research and development has strived to accomplish. One of the principal components of this advanced prosthetics research is the creation and use of a large scale virtual reality/virtual environment system to be developed in parallel with all other aspects of the project. Virtual environments involving human upper-extremity movement are anything but new and are found in widespread use from gaming and animation to many scientific and clinical applications. For limb-deficient individuals, virtual reality lends itself naturally to their prosthetic fitting and training as an adequate virtual system can provide them with physiologically appropriate visual feedback that is essential in their mastery of control paradigm. Again, this is not a new concept and many researchers involved with virtual environments will be aware of groups and institutions implementing uses in the field of prosthetics. The advanced prosthetics program has called on many of these groups to come together and implement a complete virtual environment to accompany many of the other prescribed aspects. Described in this discussion is the virtual reality contribution being made to the advanced prosthetics effort by the Rehabilitation Institute of Chicago and the University of New Brunswick. The joint effort involves a small number of dedicated people and supports many of the major building blocks of the advanced prosthetic effort, including: advanced signal processing that includes EMG pattern classification; and tools for prosthetic training and evaluation. It will be demonstrated where and how the virtual system endeavors will lend to different aspects of the advanced prosthetics programs. We shall illustrate some of the past research and work done by these two groups, show the current progress, and describe the existing systems. Additionally, we will demonstrate some virtual environment performances by our unique limb-deficient patients (those who have benefited from targeted nerve reinnervation surgeries) and we will define what lies ahead for virtual environments in the advanced prosthetics programs.

Virtual Reality Treatment for Agoraphobia: A Mexican Case Study

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The mental health services, as well as other fields, are benefiting from vigorous advances of information and communication technologies. Beginning several years ago, innovative applications of treatment systems based on virtual reality technologies have been published in literature pertaining to the field of psychology. The literature on the field, describes the results derived to these systems are promising on the treatment of posttraumatic stress, anxiety and fears, obsessive compulsive disorders and non suicidal depression among others. For this, it is doubtful that new angles will continue to emerge to fortify these systems, making them simpler and counting with more varied applications to different mental health problems. Upon the scarce research and technological development in the field of Psychology in Mexico, it is important to count with the possibility to carry out actions that generate the necessary knowledge for the empirical validation of treatment protocols that incorporate new virtual reality technologies to the psychological rehabilitation. In particular in our country, the research on the field is almost inexistent and its applications are incipient. That's why the development and assessment for the practice training programs and the possibility of granting attention at the same time to the mental health professional community using innovative therapeutic modalities, it's fundamental as well as the technological development. This current project in collaboration with the IXTLI Virtual Reality Visualization Observatory with the Virtual Teaching Laboratory of the School of Psychology of the National Autonomous University of Mexico is developing virtual reality scenarios for agoraphobia exposure treatment, testing their cultural and social contextualization (markets, Sunday's gathering places, etc.) and their therapeutic effectiveness. This poster will describe the data obtained by the assessment of presence level in this VR Mexican scenarios and the evaluation for the psychological services effectiveness provided this via addressed to agoraphobic patients. For its appraisal several indicators will allow to prove the effectiveness of the present proposal, the planned assessments include the treatment effectiveness, the therapeutic alliance, the user satisfaction related to the treatment and the chosen milieu. The service demanding, the incidence of the risk behavior and the therapist' reports will be general indicators. The opportunity that psychologists can count with empirical evidence of this innovative therapeutic modality using virtual reality will strength their formation and the incipient application in Mexico, allows to provide to the mental health professional with specialized knowledge that fortify his or her competence level and modernizing as a professional on these new models granted services.

The Use of EEG-Based Inverse Models for both BCI Design and 3D Visualization of Brain Activity in VR

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Brain activity study, visualization and identification are very active theoretical and practical research topics, especially in the fields of NeuroFeedback (NF) and Brain-Computer Interfaces (BCI). The most common way of measuring the brain activity is ElectroEncephaloGraphy (EEG), which provides only scalp measurements. In order to overcome this limitation we have proposed the use of inverse models for both brain activity visualization and BCI design. Inverse models are methods that can reconstruct the activity in the whole brain volume, using only measurements from the scalp. Therefore a more physiologically meaningful information can be obtained from EEG such as the activity in Regions Of Interest (ROI) within the brain. We have developed a platform that enables a subject to visualize, on-line and in real-time, his/her own brain activity in a 3D immersive virtual environment. Thanks to the LORETA inverse model [Pascual-Marqui94], the subject could focus his/her attention on the activ-

ity in any part of his/her brain, hence providing an interesting NF. We have also conceived a BCI based on the sLORETA inverse model [Pascual-Marqui02]. The aim of a BCI is to identify specific "brain patterns" and translate them into a command for an electronic device such as a wheel chair or a hand prosthesis. We have worked on the data set IV of the "BCI competition 2003". The goal of the competition was to compare the accuracy of identification algorithms for BCI. For data set IV, we had to identify left or right finger movements intention, only thanks to EEG signals. Using the activity of two ROIs as features, Common Spatial Pattern (CSP) as a spatial filter, and a simple linear classifier, we have obtained the same accuracy as the winner of the competition. This proves the suitability and efficiency of inverse models for BCI design.

The Butler Project: A Cognitive and Emotional Tele-Assistance System for Elderly

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The ageing of the population is increasing dramatically in industrialized countries. The number of elderly people increased seven times in the XX century. Therefore, it is understandable the growing interest in subjects related with this age group. The goal of this interest is not only to increase the life time, but also the quality of life of the elderly. Because of this, several changes in the concept of ageing are being addressed. There is and emphasis in considering ageing from three different perspectives: Biological, psychological, and social. Elderly is considered now as another phase in the life term, a phase with many positive aspects that can be lived satisfactorily. New technologies can assist in improving quality of life in our elderly. This is the main objective of the Butler Project, concretely the development and the clinical validation of a system based on a number of tele-assistance tools. This system is designed to conduct early diagnosis, intervention, and continuous follow-up of the physical, cognitive, and emotional state of elderly people. This system is aimed to improve quality of life and prevent social isolation by promoting social support. The technological solutions used in the Butler system are based in the several advantages offered by telecommunication and Virtual Reality techniques. In order to offer the elderly a support tool, the system includes virtual environments that offer audiovisual stimuli designed to induce positive emotional states (joy and relax) and to learn useful techniques in order to reduce negative emotional states (relaxation, mindfulness, etc.). Moreover, it also includes e-mail, chat, and videoconference applications designed to help them to keep existing social relationships (children, grandchildren, friends, etc.) or to provide new social relationships with other users. Finally, an Internet application provides the user the possibility of creating an individual memory space with several audiovisual stimuli related with their own life that even can be shared with other users, creating in this way a collective memory space. On the other hand, in order to offer the psychologist an early detection and diagnosis tool, the system includes an Internet application that screens the user's general state. Then, depending of the assessment, the Butler system assists the user: it offers some of the mentioned tools, or it advices to perform a certain activity to improve a negative mood; or even if the system detects a severe emotional problem it can warn other people (family members, medical staff, etc.) about it. The Butler system has been designed to be used in both geriatric hospitals and the user's home. Our team has finished the design of the Butler system and we are about to conduct a clinical trial to validate its use. The aim of this presentation is to describe in detail the technical and clinical features of the Butler system.

A Photographer's View of Presence

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This abstract is offered not as a scientific presentation but as a way of broadening our perspective of behavioral therapy. I suggest that an understanding of the components of presence observed in non-clinical settings may be useful to broaden an understanding of the components of presence observed in clinical settings, both those that are augmented by Virtual Reality (VR) technologies and even those that are not. I intend to support this idea by sharing information and illustrations about the power of photography in non-clinical settings. Via the medium of photography, one can enter another's world, observe it, capture it, recall it, and give that moment to the photographic subject as a reminder. I will identify several important technical and non-technical elements that contribute to a positive photographic outcome, a "great shot", if you will. In the interest of time, I will develop, and then illustrate, only three or four. Several technical factors that determine a photographic "exposure" are length of exposure to light (time setting, normally measured in fractions of a second), amount of light exposed at a given time (a lens' aperture "opening", measured in F-stops), and the sensitivity of a camera's sensor or of the film used (measured as an ISO setting). Several non-technical elements (issues of judgment) are composition, focus, photographer's cognitive understanding, psychomotor skill and judgment, even a photographer's "presence" in the scene being photographed. I suggest that a clinical outcome is determined in part by these same elements. A clinical encounter has a "time setting" (appointment duration). A clinical encounter will reveal varying amounts and levels information revealed during that encounter, e.g., "light exposed". A therapist may demonstrate varying levels of capability or proficiency based on his / her training, skill, and experience. My hope is that the audience will receive insights from this non-clinical look and be encouraged in their quest to become yet more effective as professionals delivering care to patients in need. My plan is to capture and share some moments from CyberTherapy 11 and to share them as a tribute to the growing field of Virtual Reality (VR)-augmented behavioral therapy.

Impact of Immersion, Narrative Context and Affective Connotation on Subjective Sense of Presence, Physiological Arousal and Vocal Acoustic Parameters in Virtual Reality

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Research carried out in recent years by an the interdisciplinary community of psychologists, computer scientists, engineers, philosophers and HCI scholars has substantially contributed to better defining the concept of sense of presence and to identifying factors which might influence it. Understanding how to enhance the sense of "being there" of a user when immersed in a virtual environment can be in fact very valuable in order to improve the design of VR applications in many domains, from healthcare to training applications, from entertainment to product design. At the moment, although there is no one single theory of presence that all researchers in the field agree upon, general consensus is emerging on the idea that "sense of presence" should be conceived as a complex construct, potentially influenced by both technological features and psychological processes [1]. A research question that is attracting growing attention concerns the relationship between sense of presence and emotion. Moreover, the challenge is on developing multimodal measurement protocols used for the study of presence and related phenomena, broadening analyses from purely self-report measures to physiological and behavioral measures. The present study was carried out as part of the EMMA project ("Engaging Media for Mental Health"-IST-2001-39192), a project funded by the European Commission with two main goals: from a theoretical and basic research point of view, the study of the relationship between

presence and emotions; from an application point of view, the design and development of presence-enhanced "mood devices" for clinical and non-clinical populations. Main objective of the present research is to investigate the influence of immersion, narrative and affective connotation on subjective sense of presence, physiological arousal and vocal acoustic parameters in a virtual reality experience. 40 undergraduate students, aged 21 to 25, took part into the study. Experimental design consisted of a 2x2x3 mixed design, including two between-subjects variables (Variable 1: immersive *vs* not-immersive condition; Variable 2: presence *vs* absence of narrative context) and one within-subjects variable (Variable 3: affective connotation – neutral *vs* anxious *vs* relaxing- of the virtual environment). Dependent variables were sense of presence, measured through ITC-SOPI questionnaire and UCL scale; emotional experience measured through Positive and Negative Affect Scale (PANAS), State Trait Anxiety Inventory (STAI) and Visual Analogue Scale (VAS); psycho-physiological parameters (heart rate, GSR, respiration, EMG, peripheral temperature); and vocal acoustic parameters (fundamental frequency and voice intensity, rhythm and Long Term Average Spectrum). Results from the study showed that affective connotation plays an important role in influencing sense of presence in the VR experience. In particular, anxious and relax environments differed significantly from the neutral environment, eliciting significantly higher levels of Spatial Presence environments ($F_{2,74}$=8.74, p<.001), Engagement ($F_{2,74}$=10.23, p<.001), and Ecological Validity ($F_{2,74}$=7.34, p<.001). Narrative context also showed to play a role in enhancing sense of presence. Physiological and vocal acoustic measures were correlated with the level of emotional involvement and were influenced by the affective connotation of the environment.

MYSELF Project: Exploring the Role of Affective Computing in Enhancing Web-Based Training

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Affective computing is an interdisciplinary research domain usually defined as "computing that relates to, arises from, or deliberately influences emotion" (Picard, 1997). Being able for a computer system to express and recognize emotions while interacting with the user might be a crucial feature, with important applications in many domains, such as e-learning, e-health, entertainment, etc. As far as educational and training applications are specifically concerned, there is a growing recognition that emotions and affect play an important role in learning. The continuous monitoring of learners'/ trainees' motivational and emotional state and subsequent tuning of learning process is therefore becoming an important issue in web-based training applications, which could be interestingly addressed by exploiting affective computing potential. This paper presents the work carried out in the MYSELF project-"*Multimodal elearning System based on Simulations, Role-Playing, Automatic Coaching and Voice Recognition interaction for Affective Profiling*"- (www.myself-proj.it). The project was funded by the European Commission and involves 14 partners from 6 different EU countries. Main goal of Myself is the development of a web-based platform with affective computing capabilities for individual and collaborative e-learning simulations. The focus of these simulations is on training social and relational skills in different professional contexts (health-care, banking, commerce, etc.). As far as affective computing features are specifically concerned, three main issues are at the moment investigated. First of all, the *design and implementation of a 3D virtual tutor provided with emotional expressive synthesis abilities*. Research on human-like agents and Embodied Conversational Agents showed that anthropomorphism is not a benefit in itself, unless it is coupled with adequate expressive, conversational and interactive abilities. We designed the tutor LINDA (Learning INtelligent Dynamic Agent), a 3D model developed with Poser 5 and animated with specific attention ìto the multimodality and time synchrony of emotional expression. We are currently testing the effectiveness of Linda's emotional ex-

pressiveness and its implications for impression formation in the user throughout the learning experience. Second issue under investigation is a *multimodal emotional recognition system* able to provide to the platform information about the emotional and motivational state of the user; much work has been now carried out in the affective computing domain to perform the detection and inference of emotional state from physiological correlates, facial expressions, vocal-non-verbal features (such as F0, intensity, etc.), verbal speech content, questionnaires/self-report measures and the detection of behavioural events (e.g. mouse-clicking). We built a multimodal database as a basis for training and testing algorithms and decision systems. This system will be coupled by a cognitive architecture modelling affect allowing to consistently personalize the learning path according to the user's affective profile and to provide coherent feedback to changes of motivational and affective states of the user during the training experience. Finally, the project aims at the development of *3D interactive simulations and targeted exercises to improve emotional management* in interpersonal relationships, with specific focus on emotional expression, recognition and management. Emotional competence is mainly learnt through experience throughout our life and plays a central role in our personal and professional lives; therefore, the use of interactive simulations can provide a controlled experiential setting to foster its training.

Multicomponential VR-Enhanced Treatment of Emotional Overeating in Obese Subjects: A Controlled Clinical Trial

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Emotional overeating is a dysfunctional eating behaviour that affect many obese subjects. It consists in eating an unusually and large amount of food in response to negative as well as positive emotions. Clinical observations as well as laboratory studies have showed that over-weighted and obese subjects tend to eat more food in response to emotions than normal-weighted subjects and tend to eat in response to emotions even when normal-weighted subjects don't. Even if we cannot sustain that emotional overeating is implicated in the aetiology of obesity, we can say with certainty that in many cases it contributes to its maintenance and increase. In order to clinically approach this dysfunctional behaviour, we developed a new VR-enhanced therapeutic protocol that consists in both pc-based and mobile sessions. It incorporates different clinical components, from progressive muscular relaxation and deep breathing exercises to cognitive-behavioural ABC technique, through some elements of the emotion-focused therapy like developing emotion awareness and inducing good feelings. It is composed by six pc-based and therapist-based sessions, two for each of the three weeks the treatment lasts, and two mobile phases between each couple of sessions. During four of the six pc-based sessions, subjects are immersed in a virtual environment in which they experience relaxation by applying different relaxation techniques, listening to different therapeutic narratives. In the two mobile phases, subjects continue relaxation exercises individually and daily through the support of a mobile phone playing a relaxing video with a relaxing narrative. The goal of this study is to evaluate the efficacy of this procedure in targeting emotional overeating by helping obese subjects to cope and manage the emotions in response to which emotional eating occurs. The primary outcome we expect is the reduction of the behaviour's frequency and we will plan a follow-up in order to detect it after the hospitalization time. The secondary outcome we expect is the improvement of the subjects' perceived self-efficacy in coping the dysfunctional behaviour. The tertiary outcomes we expect are improvements in state emotional dimensions during each session. Self-report and physiological measures will be used. Three experimental groups will allow to evaluate the effect of the VR-enhanced protocol in comparison with a similar procedure not supported by VR and mobile technology and with a waiting list. This study is going to start and the results will be ready in spring, therefore preliminary outcomes will be presented during the conference.

VR-Enhanced Treatment of Anxiety in Obese Subjects: A Follow-Up Study on Trait-Anxiety, Psychological Symptomatology and Generalized Self-Efficacy

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This study is the follow-up part of another one presented last year at Cybertherapy 2005 in Basilea. VR, combined with different relaxation techniques, was used to enhance relaxation in a sample of obese in-patients by visually presenting key images for facilitating the process and enabling participants to practice, and hence master, relaxation techniques in a more realistic context. To accomplish this goal, the Relaxation Island was used, a Virtual tropical island in which participants experience relaxation by applying different relaxation techniques, listening to different therapeutic narratives, within a specific protocol that is composed by two sessions, each implemented on two following days. Three phases composed each session: the first was based on immersive navigation, the second on imagination and the third on immersive navigation again. The techniques aimed to reduce anxiety linked to active negative thinking through progressive muscular relaxation of Jacobson and depth breathing exercises. The aim of this 3 months follow-up study is to explore the long term effects on trait-anxiety, psychological symptomatology and generalized self-efficacy of the treatment described above and implemented during hospitalization. Like in the previous study, to test the hypothesized long term enhancing effect of the specific protocol, we compared three conditions: VR treatment; an usually video exposure, a new age DVD with relaxing narratives - where participants watched a video and had the freedom to imagine any sensory element required - and a control condition. The questionnaires considered were the Trait version of *State-Trait Anxiety Inventory (STAI)*, to measure the level of trait-anxiety, the *Symptoms Check-List (SCL-90)*, to measure general psychological symptomatology, and the *Generalized self-Efficacy Scale*, to measure the level of general perceived self-efficacy. We received follow-up data from 28 subjects and 26 didn't answer (54 in-patients participated in the previous study). Baseline comparisons didn't show any significant statistical difference between responders and non responders. Non parametric analysis were used to test within groups (time) and between groups (experimental conditions) differences. Data show no follow-up change in trait-anxiety in any condition. On the contrary, data show a significant reduction in the SCL-90 Anxiety for the VR group and a significant reduction of the generalized self-efficacy for the comparison group and for the control group, with no change for the VR group. These results follow those obtained in the previous study where the treatment showed to be efficacious in improving relaxation and in reducing anxiety in the short term. Follow-up data strengthen the previous outcome showing a long term efficacy in reducing anxiety.

Implicit Learning of an Embedded Regularity in Older Adults Using an SRT Task in a Virtual Reality Medium

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Implicit learning tasks are used to investigate incidental learning where learning is not fully consciously accessible (Seger, 1994). Implicit learning of embedded regularities (i.e., a regularly occurring predictive pattern) has traditionally employed serial reaction time (SRT) tasks involving simple movement responses, such as a finger key press in response to a visual stimulus. This is a limitation of the research in this field as such tasks are not reflective of the kind of complex processing required for most daily activities (Shea, Wulf, Whitacre, & Park, 2001). This study used a gross motor reaching task in a virtual reality environment to investigate im-

plicit learning of an embedded regularity in older adults (60-80 years). Participants were asked to reach with their preferred hand to contact virtual balls as quickly as possible as they appeared at four far quadrants of a television monitor within a virtual environment. All groups performed five blocks of 84 acquisition trials and one retention trial block. Within each block, an embedded regularity appeared four times intermixed with random trials. Learning is inferred by faster response times for the repeated sequences (the embedded regularity), as compared to the random sequences (Curran, 2001). Indeed, data analyzed to date demonstrate that participants performed significantly faster across blocks F (4, 7) = 18.279, $p < .001$) for both repeated and random sequences and significantly faster on the repeated sequence as compared to the random sequence F (1, 10) = 27.689, $p < 0.001$). This trend appears to continue at retention. Oddly, this significant difference is found as of the first block of trials. Possible learning within this first block will be explored further. To determine whether learning of the repeated pattern was explicit (consciously accessible) or implicit (unconscious), verbal reports were obtained through progressive questioning, visual recognition of sequences, and an adapted method of opposition. Verbal reports data indicate that several participants suspected the presence of a pattern; however, no significant differences were obtained between the recognition of the two types of sequences presented. This finding is similar to Meulemans, Van der Linden, and Perruchet (1998) who, using the same sequence in a finger key press task, did not find that their adults (18-27 years) or children (6 and 10 years) acquired explicit knowledge of the repeating sequence. The novelty in this study stems from the use of the virtual reality modality for the SRT task. The advantages and disadvantages experienced in the use of the virtual reality medium for the exploration of implicit learning of embedded regularities will be discussed.

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Middle School Student Aggressions and the Use of Motion Captures

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This research explored the use of middle school aggressive behaviours captured using Motion Analysis's motion capture technology in a studio. The raw motion capture data containing 3D translational and rotational information of over 20 joints was stored in HTR format using Motion Analysis's software. The raw HTR data was imported into Maya 7.0 as keyframed animation data using a custom MEL script. The animation data was edited using Maya's animation tools to remove bad data points and smooth the animation. A simple scene was constructed as a background for the animations. Finally, the animation was applied to a skeleton, which in turn controlled the animation of a low polygon "stick figure." The animations were rendered as high-resolution (1280x1024) movie clips. Two versions of the animations were created: one containing just the skeletal animation, e.g. bones and joints, and another containing an animated low polygon "stick figure" model of a person. The skeletal animations were rendered using Maya's PlayBlast feature. The "stick figure" animations were rendered as single frames in Maya and then compressed into AVI video format using VirtualDub. We sought to identify whether children could discern the difference between physical aggression and non-aggressive behaviors in both skeletal and stick figure representations using ten common physical aggressive behaviours displayed within an immersive C.A.V.E. (Cave Automatic Virtual environment). Findings and future implications of such work are presented.

Predicting Treatment Outcome for Arachnophobia's Virtual Reality Therapy Through Measures of Fear

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The mechanisms underlying the efficiency of Virtual Reality are still being explored. The aim of this study is to identify variables that may help predict treatment outcome. This study is based on pre-test/post-test with waiting list control group. 15 participants have been treated for fear of spiders, aged 18 to 50 years old. Structured interviews (SCID-I) were performed, questionnaires were administered (*Spider Beliefs Questionnaire*, Arntz, 1993, *Fear of Spider Questionnaire,* Szymanski et al., 1995), as well as a behavioural avoidance test in order to assess the presence of a fear of spiders. In order to obtain efficient exposure, virtual environments must evoke anxiety for participants. We hypothesise that higher levels of fear should favor a positive treatment outcome. Work in progress.

Virtual Reality in the Treatment of Combat-Related PTSD with Warfighters

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Background/Problem: Continuing exposure to potential death or serious injury places military personnel deployed to combat theaters at high risk for developing post-traumatic stress disorder (PTSD). For some, the symptoms of PTSD are transient and recovery occurs naturally. Others, however, fail to recover and would greatly benefit from treatment. Timely and effective treatment of PTSD can leverage combat readiness by improving the probability of warfighters returning to duty, and may also prevent the long-term deleterious effects of the disorder that have been experienced by thousands of veterans from earlier conflicts.[1] Cognitive-behavioral therapy (CBT) has been successfully applied to treat PTSD in civilians and veterans.[2] Recent studies suggest that immersive virtual reality (VR) applications may offer a potent augmentation to CBT for treating PTSD.[3,4] Building on the promising outcomes of the VR research to date, this study investigates the usefulness of VR in a CBT exposure treatment of PTSD in U.S. warfighters returning from combat zones in Iraq. Methods and Tools: The project is a randomized controlled clinical trial using a between group pre-post experimental design that includes both intent-to-treat analyses and analyses of subjects who complete treatment. The treatment utilizes a CBT with graded VR exposure (VRE) protocol that integrates a virtual environment that was developed for the study to treat combat-related PTSD. The experimental group will undergo biweekly sessions of VRE for 5 weeks, and the control group will receive structured minimal attention (MA) for 8 weeks. After 8 weeks of minimal attention, the MA group will begin VRE. Outcome measures include several psychological self-report questionnaires, a PTSD clinical interview, and self-reported ratings of quality of life. Follow-up assessments will be conducted at 6 and 12 months post-treatment. During the treatment sessions, biofeedback will be used to obtain physiologic data such as blood pressure, skin conductance, and heart rate. Results: The first year of this project was focused on developing the computer-based VR environment and system, standardizing the treatment procedures, and training the therapists. Data collection is scheduled to begin during this second year of the study. Conclusions: Although it is premature to discuss study outcomes at this time, valuable lessons learned about the development of computer-based VR applications for psychotherapeutic interventions can be considered. Multiple issues were confronted, including the selection of development tools, design of the environment, sensory experiences, and intellectual property. Novelty/Discussion: Few, if any, randomized controlled clinical trials of PTSD treatment have been conducted with active duty personnel, and even fewer have focused on PTSD resulting from combat exposure. Immersive VR technology can enhance a person's memory retrieval of trau-

matic events with visual, auditory, and other sensory experiences that will, in turn, activate the emotional engagement during therapy found to be related to recovery from PTSD.[5,6] This study will be one of the first to examine the utilization of VR technology in a randomized controlled treatment trial of warfighters with PTSD.

Immersive Panoramic Video: An Alternative VR Environment

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Currently, the primary medium for virtual reality (VR) applications in healthcare is computer graphics (CG)-based. These environments are typically very costly, time-intensive to create (average $100,000), and take one year from concept to final application. Compared to commercial video games, these VR environments have simple graphics and limited interactive capability. While VR developers are capitalizing on gaming software and engines to decrease the development time and expenses, distribution and platform compatibility issues continue to be problematic. Immersive panoramic video is emerging as an alternative. Camera systems ranging in costs from $20,000-$140,000 can produce 360° videos that are user-friendly, and can create a VR application within a few days or weeks. The video environment presents a more authentic representation of the 'real world' that is graphically more accurate than the CG environment. While interactivity is a limitation with video environments, new capabilities are emerging to provide branching functionality in response to the user. Distribution costs and platform compatibility concerns are also significantly less than those associated with CG applications. However, controlled studies are needed that 1) assess the immersiveness of the video VR environment; 2) assess the psychophysiologic effects of panoramic video; 3) compare panoramic video displayed through a head-mounted display (HMD) with a flat-screen display; and, 4) compare immersive video environments to similar CG VR environments. The Pacific Telehealth and Technology Hui's Virtual Reality in Behavioral Health research program is actively investigating the first three questions. Methods: The first study examines the use of video stimulus cues for anger provocation by exposing subjects to the same stimulus content viewed either on a flat-screen or as panoramic images viewed through a HMD. Self-report and physiologic measures taken pre-post, and during exposure are compared between the two groups. Psychometric measures include anger, self-esteem, and presence questionnaires. Physiologic measures include heart rate, blood pressure, skin conductance, peripheral skin temperature, and respiration. The second study uses a counterbalanced design to evaluate the use and utility of panoramic and flat-screen stimulus cues for inducing nicotine craving in individuals who are heavy smokers. Participant responses to panoramic VR cues presented through an HMD are compared to flat-screen images of the same video content. Self-reported nicotine craving and physiological data similar to the first study are used to assess reactivity to the stimulus cues. Results and Conclusions: As these studies are in progress, no results or conclusions can be offered at this time. However, informal responses to the immersive panoramic video experience compared to the flat-screen display have been more favorable. Preliminary results, examples of the panoramic video, and future plans to compare immersive VR and CG environments will be presented. Novelty/Discussion: The immersive panoramic video is an exciting new technology that may provide an alternative to CG virtual environments in the treatment of behavioral health conditions. However, there is a dearth of published research about the healthcare applications of this technology, and a lack of controlled studies about its efficacy in behavioral health treatment approaches. Our studies are among the first research to address these issues.

The Virtual Classroom: An Ecological Version of the Continuous Performance Task

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The Virtual Reality (VR) Classroom is a computer-based program using a head mounted display tracking device and VR reality glasses. The VR Classroom is a continuous performance task designed to test attention in school-aged children. The child is immersed in a three dimensional classroom environment. A continuous performance task is presented on the chalkboard at the front of the class. During the assessment, visual and auditory distracters are presented. Just like the Conners' Continuous Performance Test (CPT), the VR Classroom records reaction times, commission errors, and omission errors. While the child performs the task, a head tracking device monitors head movements, documenting the number of times the child turns away from the CPT task. The precise times when errors occur are recorded, allowing association of errors with specific distracters. The Classroom was developed at the University of Southern California. The child assessed is presented with a standard continuous performance task by presenting letters on a chalkboard at the front of the class. The task last 6 minutes and data are divided in three equal block periods. Instructions are given by the virtual teacher and the child is given a practice time to familiarise with the virtual environment. The Classroom presents the advantage of being more representative of the child's performance in real life settings compared to traditional neuropsychological tests used in diagnosing ADHD. To perform well, the child must sustain attention on the task and avoid distraction by the various visual and auditory stimuli occurring in the classroom. The objectives of this pilot study are : 1) To determine if the cognitive profile of the child with ADHD outlined by the traditional CPT corresponds to the one outlined by the VR Classroom (ecological CPT); 2) To compare performance on the VR Classroom to a standard neuropsychological battery (Delis Kaplan Executive Functioning System (DKEFS) Stroop and Tower subtests, CPT, d2 Test of Attention, Achenbach System of Empirically Based Assessment) and observations through an academic task on the following variables: impulsivity, sustained attention, reaction time, variability of the reaction time and problem planning and resolution. 20 French speaking Canadian children aged between 8 and 12 diagnosed with ADHD (combined subtype) are currently assessed in a Montreal hospital-based ADHD clinic using a standardised neuropsychological battery and the VR Classroom. Children are assessed without medication. Results are to be given at the conference. If the objectives are met, a full-scaled quasi-experimental study will be conducted in the fall of 2006 to compare performance of children with and without ADHD.

Virtual Reality Contexts for the Situated Assessment of Spatial Neglect

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The main characteristic of virtual reality (VR) dwells in carrying spatial information in an analogical mode preserving most of space-time dimensions and interaction modalities that humans usually have in natural contexts. According to this, the spatial nature of virtual environments revealed an advantageous opportunity for the evaluation of residual perceptual abilities and motor-explorative behaviours in patients with cognitive impairment. In particular, it has been suggested that VR can be effectively used to evaluate how cognitive impaired users, such as patients affected by visuo- spatial neglect, are able to explore and memorize the environment in which they are able to interact. Neglect patients present difficulties in attending to stimuli placed in the contralesional space (typically the left hemispace). Several kinds of task can be used to assess and to modulate neglect behaviour. These tasks should address the whole range of cognitive domains in which the disorder could be manifested (perception and mental representation, personal/extrapersonal space, navigation abilities). Since standard evaluation of neglect syndrome is mainly carried out using paper-based tests within the laboratory, the assessment of patient's behaviour impairments in everyday contexts

tends to be overlooked. Drawing on these premises, we introduced a VR-situated approach for the evaluation of neglect patient's perceptive, memory and explorative residual abilities in coping with daily contexts. We designed two virtual environments: a small-scale, closed environment within which neglect patients could position objects and navigate; and a large-scale, open one, which patients explored freely. The main goal of the first virtual environment provided is to evaluate patients' ability in memorizing, recognizing, and replacing objects within all the field of vision. The main aim of the second one is to evaluate patients' exploration strategies and to analyze their description of context they are engaged with. We tested the environments in four brain-damaged patients. They were requested to immersively explore the environments in order to memorize, replace and recognize familiar objects. Patients included in the study were previously evaluated with "paper and pencil" neuropsychological assessment which revealed respectively a neglect syndrome, an overcome neglect, a right brain damage without neglect and frontal brain injury (with slight attentional neglect). Results showed that, compared with standard evaluation (that is mainly grounded on the detection and recognition of motionless target objects) patients' interaction with virtual environments (in which target objects are situated in a dynamical scene) exhibited peculiar explorative behaviours, such as perseverations and /or right-side navigation tendencies, that could be addressed to their specific cognitive impairments. In addition, from a methodological point of view, the introduction of a VR-based assessment allowed to deliver the complexity of stimulus challenges of naturalistic settings, as well as to monitor them in order to identify what constitute patients' main troubles in managing daily activities.

A Virtual Reality-Extended Neuro-psychological Protocol for Route and Survey Spatial Knowledge Assessment

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Spatial cognition research has emphasized the evolutional advantage of this ability in human beings and animals. The same research has furthermore, given evidence of, in all forms of knowledge acquisition (the direct exploration of the environment, the use of simulations of a graphical or verbal nature, the interaction in simulated 3D environment) spatial knowledge can be represented in a cognitive map which can be of the route or survey type. The first consists of representations essentially organised in limited paths through the sequential connection of turns and/or salient points in the space. Survey maps, on the other hand, are representations in which relationships between various points of the environment can be inferred through the reasoning process. The capability of learning spatial relationships in a large scale environment, and of organising them in route and/or survey type, is influenced by a series of characteristics of the specific environment, capable of assuming a role functional with the activities an agent performs, or is going to perform, inside it. In spite of the agreement in considering as essential for spatial cognition organization the kind of environment in which an agent moves, the aims he proposes for himself in the exploration and the kind of interaction he is able to have in his movement and in modifying parts of it, classical evaluation of spatial functions is generally based on "paper and pencil" tests that dodge to assess the ability of being spatially oriented in navigating within a complex environment. For this purpose we propose a matched spatial cognition evaluation protocol in which perceptive, memory and attentional functions (that combined each other are considered the hub for spatial orientation ability) will be evaluated with standardized neuropsychological tests and we upgrade introducing a more situated computer based tools for the assessment of spatial orientation during the interaction with complex environments. Due to their pronounced route and survey intrinsic characteristics we developed two virtual reality tools based on WISC-R Maze subtest and Road Map Test modifying them according to interactive evaluation purposes. VR-Maze consists of 8 mazes, with regular structure and without landmarks, that were provided to subjects according with an increasing complexity order. This test allow us to evaluate human ability of finding the

best route to achieve a target goal while immersed in an empty environment. VR-Road Map Test is a complex large scale environment, in which the experimenter can eliminate, add, or modify landmarks and target objects. These features may be used to evaluate the ability in creating relationships between various points of the environment and in inferring, through the reasoning process, a high level spatial organization knowledge. By providing the possibility to track user's spatial behaviours, a virtual reality-based evaluation allows an effective and objective record of all the experimental variables. It also avoids the intervention of the experimenter that may interfere with the actions of the agent-explorer. The integration of these virtual environments with traditional evaluation methods, may provide an interesting alternative to paper and pencil-based approaches, thereby contributing to improve the study of spatial cognition.

Task Fatigue and Driving Performance: How Important is Length of Simulation?

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While a wide array of simulation paradigms are used to infer internal state through performance measurement, surprisingly little research has focused on the factors of fatigue and simulation length to optimize performance and take into account fluctuations in task immersion. Sustained performance for extended periods of time invariably causes fatigue in the person performing a routine task. To assess the effect of fatigue on driving, the York Driving Simulator was used to measure performance in 10 healthy control subjects and 10 sleep disorder patients (Epworth Sleepiness Scale score >10) on a standardized monotonous 60-minute simulated driving session. Subjects were asked to repeatedly rate themselves on the 7-point Stanford Sleepiness Scale (SSS) every two minutes throughout the duration of the drive to assess the driver's subjective awareness of his or her own fatigue. Measured simulation performance variables included standard deviation of road position (SDRP), i.e. tendency to "weave", speed, speed deviation (SPDEV), and reaction time (RT). All performance data and SSS ratings were grouped in 10-minute blocks and paired t-test calculations were performed in order to determine variation over time in subjective state and performance. Occurrence of off-road incidents (CRASHES) was also recorded for each 10-minute epoch. SSS ratings increased in a curvilinear fashion over the course of the drive, but with respect to objective simulator measures, significant deterioration in driving performance was noted only for variables involving speed modulation. SPDEV was observed to increase over the 60-minute session, suggesting that a subject's ability to monitor and maintain a speed close to the posted speed limit over time (i.e. task vigilance) decreases in parallel to fatigue and sleepiness with prolonged simulator sessions. In particular, those subjects with sleep disturbance showed a notable decrement between the first and last epoch of the drive ($p=.049^*$). In comparing mean speed ($p<.001$) and SPDEV ($p=.042$) for the first and last half of the drive, highly significant differences were also noted. While CRASHES cannot be considered a continuously recorded variable, and represent simulator events with a rare overall base rate, there was a significant trend towards increased collisions (83% of total crashes) occurring once the simulation duration had exceeded 30 minutes, implying a possible role for task fatigue. Other measures of performance recorded by the driving simulator (i.e. SDRP, RT) did not show a significant change over time, even though subjective fatigue increased. This finding has implications for "real-world" as well as simulated driving. In the case of driving, the increased speed deviation observed may be a phenomenon transferred over from driving in the real world, namely increased speed as sleepiness increases to reach the destination quicker, or an attempt for increased perceptual self stimulation to combat fatigue. For simulations incorporating elements of task immersion, the relationship shown here between subjective sleepiness and some (but not all) performance variables suggests that fatigue can differentially affect performance depending on simulation length and the specific variables measured. Being aware of task fatigue appears relevant for design of any simulator protocol to obtain more valid results.

Combined Use of Virtual Reality, Video-Oculography and Vaginal Photoplethysmography in Assessing Women's Sexual Preferences

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With the advance of new technologies, classical methods already in use in psychology and sexology are complemented by the addition of new techniques that seem to be filling certain gaps. The simple measure of the feminine sexual response with vaginal photoplethysmography consists in the insertion in the vagina of a probe measuring the blood volume of that region. Light emitted by the probe is reflected by the blood vessels in the tissue, and this measure indicates the level of arousal. This method has proved its efficiency on certain aspects, but can be improved on others, including the stimuli presented to prompt sexual response with women. Most stimuli currently used are pictures, video or audio tapes. Virtual reality stimuli would improve the efficiency and the realism of the method by adding interactive and emotional dimensions to the sexual stimuli. Also, adding an eye-tracking system directly in the head-mounted display makes it possible to put perceptive and cognitive processes in parallel with the genitally measured sexual excitement (Renaud et al., 2003, 2004). Immersive video-oculography allows to precisely analyze the visual dynamics in relation with geometry and signification of the virtual objects simulating sexual characteristics. Currently used with the penile plethysmography on male participants, including a sexually deviant sample, this sexual preferences evaluation method is being validated with a female sample at the Cyberpsychology Laboratory of Université du Québec en Outaouais. Instrumentation, general method and preliminary results will be presented in this communication.

Attention Rehabilitation With the Virtual Classroom for a 6-Year-Old Boy With Attention Deficit Disorder

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Virtual reality (VR) provides a three-dimensional computer representation of a real world through which a person can navigate and interact with objects to carry out specific tasks. One novel application of VR technology is in rehabilitation for children with attention deficit disorder. Attention deficit disorder is a diagnosis applied to children who consistently display certain characteristic behaviours over a period of time. The most common core features include: distractibility (poor sustained attention to tasks) and impulsivity (impaired impulse control and delay of gratification). The objective of the present paper was to determine whether, by using the Virtual Classroom, a child who had attention deficit disorder could improve his attention capacities. The Virtual classroom simulation was originally developed as a controlled stimulus environment in which attention processes could be systematically assessed in children with attention-deficit/ hyperactivity disorder. The scenario consists of a standard rectangular classroom environment containing student desks, a teacher's desk, a virtual teacher, a blackboard, a large window looking out onto a playground with buildings, vehicles, and people, and a pair of doorways on each end of the wall opposite the window through which activity occurs. A 6 year old boy with attention disorder completed a 5 weeks of training with 2-3 hour individual sessions. The child had to complete many 6 minutes condition during each session. The child was instructed to view a series of letters presented on the blackboard and to hit the response button only after he viewed the letter "X" preceded by an "A". Visual and auditory distractions were included during the session. Outcome was assessed with specific and non specific attention tests requiring attention (Auditory Attention and Response Set, Day & Night Stroop) and an ecological test of attention (TEA-Ch). This assessment was performed twice before and after the rehabilitation programme. Analysis is ongoing. Full results will be reported. The

results of the study will contribute to an understanding of factors which determine significantly the progress of the child using virtual reality. The results will also highlight interventions which could improve outcome for this kind of children and will indicate if the Virtual Classroom may improve sustained attention and inhibition capacity.

Virtual Reality in the Treatment of Pathological Gambling

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Background: Addictions are among the most prevalent mental disorders. Pathological gambling is a behavioural addiction consisting in a loss of control over gambling that lead to important psychological and social problems. One of the most effective treatments for this disorder is cognitive-behavioral therapy, including cue exposure and cognitive restructuring. Virtual Reality (VR) technology could be a valuable tool for applying cue exposure in the treatment of pathological gambling. VR presents some advantages: There is an absolute control over all the events that may occur and the consequences of those events. Also, the treatment takes place at the therapist's office. This allows approaching and practicing in different contexts without leaving the office, and offers the patient the security of being able to work with those risky situations without being in contact with the substance or the addictive situation. In summary, VR could be a helpful tool to improve the application of cognitive-behavioral programs and therefore to increase the number of people who can benefit from the treatment. Our research group has designed a VR program for the treatment of pathological gambling. The aim of this work is to present preliminary data of the clinical efficacy of this program. Method: Four individuals suffering pathological gambling participated in this study. They were referred from an Addictive Behavior Unit. They were assessed and they went through a multicomponent cognitive-behavioral program for pathological gambling, including VR environments (casino, bingo, bar with slot machines) to conduct cue exposure, and VR environments to conduct cognitive therapy. The treatment consists of eight weekly sessions. Results and conclusion: In progress. We have completed the treatment of two patients and we are treating two more. The results so far indicate that VR is useful for the treatment of pathological gambling. The VR scenarios evocated the impulse to gamble in our participants. The comparisons from pre- to post-test showed that the VR treatment program was effective for the treatment of pathological gambling. Novelty: This is the first study showing preliminary efficacy data of the utility of VR therapy for the treatment of pathological gambling.

Use of Virtual Reality to Reduce Claustrophobia During MRI Scans

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Research status: Pilot clinical efficacy study. In progress. Background: Magnetic Resonance Imaging (MRI) is a valuable diagnostic procedure. The patient is placed in a cylinder remaining immobile for an average of 50 minutes. Although MRI scans are very costly, premature termination and "no shows" are common (around 20%). Between 25 and 37% of people going through this procedure reported moderate to severe claustrophobic fear (McIsaac, Thordarson, Shafan, Rachman & Poole, 1998). The essential feature of Claustrophobia is fear and avoidance related to enclosed spaces. It includes fear of suffocation and fear of restriction (Rachman, 1997). These fears could be easily evoked during a MRI procedure. It is important to explore the possibility of reducing claustrophobic fear during MRI scans. Virtual Reality (VR) distraction has proven to be effective in the treatment of acute pain during fMRI scans (Hoffman, Richards et al, 2004). The multiple sensory quality of VR makes this technique a powerful distracter. VR distraction could also be used to draw attention away from such a claustrophobic situation as a MRI scan. The aim of this work is to show pilot data about the utility of VR to reduce claustrophobic fear during MRI scans.

Method: Ten individuals suffering claustrophobia participated in this study. After a clinical interview, filling out the Claustrophobia Questionnaire (CLQ, Radomsky, Rachman, Thordarson, McIsaac, & Teachman, 2001), and going through a Behavioral Avoidance Test in a mock scanner, the participants were randomly assigned to two experimental conditions. In one condition, the subjects underwent a mock MRI scan during 15 minutes while they listened to music (no visual distraction). In the other condition participants underwent a mock MRI scan while shooting snowballs at snowmen, penguins, igloos and robots in SnowWorld, a VR environment. Fear and avoidance ratings were given before, during, and after the MRI scan procedure. Results and conclusion: In progress. We predict that patients will feel less claustrophobic in SnowWorld than in music only, and we predict that the more present patients feel in SnowWorld, the more reduction in fear they will report. Novelty: This is the first study exploring the utility of VR distraction for reducing fear via distraction in a common claustrophobic situation, undergoing a MRI scan. If VR is effective we will be able to reduce the percentage of "no shows" or premature terminations involved in this costly but valuable diagnostic procedure.

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Ocular Movement Dynamics, Emotional States and Presence as Modulated by 3D Sounds Propagated from Virtual Objects

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Virtual sound environments have a significant impact on perceptual and cognitive processing, emotional and presence state (Justus & Bharucha, 2002; Västfjäll, Larsson & Kleiner, 2002; Juslin & Sloboda, 2001). Since Yarbus (1967) we know that oculomotor behaviors are not only influenced by low level (bottom-up) processes but also by high-level processes (top-down) of the cognitive functioning. We do know that sounds, and especially their level of complexity, influence oculomotor behaviors (Boucher, Lee, Cohen, & Hughes, 2004; Krukowski, Begault, Wenzel, & Stone, 2001; Mondor, Terrio, & Hurlburt, 2000; San Martini and al., 1994; Mudd, Conway, & Schindler, 1990). However a complete model of the link between eye movement dynamics, emotional states and presence feeling led by virtual sound stimuli remains to be developed. Participants (N=12) were isolated from surrounding noises and visual stimulations. Recording of their oculomotor responses were made using an eye-tracking device combined into a HMD also providing sound through earphones. They were instructed to locate and scrutinize 3D sounds. Visual search paths as well as emotional states and subjective presence were recorded (Witmer and Singer, 1998; Zuckerman, 1960).Two independent variables were studied. First, four types of sound stimuli were presented in a 3D spatialized sound fashion: white noise, pink noise, pure sounds and fractal sounds. Second, sound sources were either presented in a static fashion or in movement, i.e. following a random path.

Development of MR Compatible AR System to Provide Virtual Stimuli on the Real Hand and its Pilot Study

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Functional Magnetic Resonance Imaging (fMRI) is the most frequently used method in many neuroscience studies. However, those studies have limitations in that the stimuli are far from the events of a real environment. Therefore, Virtual Reality (VR) technology, which can present a realistic stimulus and be used during fMRI scanning, has been developed. Even though VR could give a three-dimensional and ecologically valid environment to the subjects, it could not provide the events experienced in the real world. Therefore, this study developed a MR compatible Augmented Reality (AR) system, which could present a virtual image in the real world using by camera in real-time. This system was composed of a PC, a MR compatible HMD, and a camera shielded by an aluminum case. The MR compatible camera was mounted on the upper and front side of the head coil so that the camera could capture an image in the same view of the subject. Therefore, it captures a real image, and transfers this image to a PC in order to merge it with the virtual image. The superimposed image is then shown on a HMD. For a preliminary fMRI study, a virtual fire was used as the virtual stimuli and superimposed on the subject's left hand image. The virtual fire was presented to the subject's left hand for 20 seconds and removed for another 20 seconds. The on and off sequence was repeated three times. Two healthy right-handed subjects were recruited. The fMRI scan was performed using a 1.5T GE machine. The analysis of the fMRI data revealed the activations that were located contra-laterally. In particular, activations in the right primary and secondly somato sensory areas were observed. This could mean that the virtual stimuli on a real body can influence the brain activity. The AR system has the potential to be used for many other neuroscience studies.

Comprehension by the General Population of Questionnaires Measuring the Feeling of Presence

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Several studies have shown the importance of the illusion of presence in virtual reality. This concept, which can be summarized as the subjective feeling of "being there" in a virtual environment, is thought to exert a strong influence on treatment effectiveness and on the experience of the user immersed in a virtual environment. Thus, it is important to develop good instruments to assess the feeling of presence. Unfortunately, not all instruments currently available have strong psychometric qualities, the most fundamental being that items are clear and well understood. Many of these questionnaires were validated with university students or highly educated professionals being trained using VR. It is possible that the wording of items that is used in these instruments is too complex to be easily understood by the general population. The aim of this project was to determine the extent to which people in the general population understand the meaning of the items from frequently used measures of presence. Our hypothesis was that many items would not be well understood. In order not to exhaust the participants, the number of items tested had to be restricted. The items from the following measures were selected: all 28 items from the Presence Questionnaire, the 8 items of the Kim and Biocca Self-Reported Telepresence Scale, the 4 items of the presence subscale of the Reality Judgment and Presence Questionnaire, and 7 new items. A first set of 2 control items were drawn from the Beck Depression Inventory. This well validated measure was developed to be used with clinical samples drawn from the general population. A second set of 2 control items was developed in order to be objectively difficult to understand (e.g., phrases with triple negatives or that do not make sense). The sample consisted of 50 adults recruited during the weekend in a downtown shopping mall in the city of Gatineau. Participants sat on a chair, wearing a VFX-3D head mounted display, and completed a five minutes virtual flight using the software created by VirtuallyBetter for the treatment of aviophobia. After the immersion, they rated on a 0 to 10 scale how well they understood the meaning of each item. Data were analyzed using descriptive statistics and ANOVAs were performed to compare

ratings of the presence items to those of the control items that were “easy to understand” and “difficult to understand”. Most items were less clear than the “easy to understand” controls but clearer than the “difficult to understand” controls. As much as 72.22 % of the items were significantly less clear than the “easy to understand” controls. For each questionnaire, many items were also considered easy to understand. The impact of these findings on the measurement of the feeling of presence are discussed.

Safe Sex Attitude Measurement and Intervention in an Immersive VR Context

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Background: A major problem in measuring sexual risk behavior is that self-report cannot always capture an accurate record of behavior and lab studies are often too contrived to obtain generalizble results (Loomis, Blascovich, & Beall, 1999). Accurately measuring and intervening with risky behaviors is of the utmost importance to public health; VR allows efficient and accurate measurement of such behaviors. It also provides a unique and effective tool in which the training and practice of health-risk reduction techniques can take place in controlled settings as has been done for training for surgery (Seymour et al., 2002) and for firefighters (Satava, 1995). Other studies have shown that psychological states in a virtual environment (VE) are similar to those in the real world (e.g.,Vincelli & Riva, 2000). The present study, currently in progress, capitalizes on the immersive nature of VR to allow for the measurement and intervention of safe sex attitudes and behaviors. Many researchers have turned to using measures of implicit, or unconscious, attitudes as the best predictor of spontaneous behavior in sensitive domains such as racism (Dovidio et al., 1997). This translates into the embodied attitudes and movements of participants in a VE. For intervention, the VR setting allow participants to safely attempt strategies for safer sex with their partner that could be personally harmful or embarrassing in the real world. Method: This study examines how simple approach-avoid attitudinal measures assessed both in the VE and on self-report measures predict safe sex behaviors. The VE for the study includes a bedroom and a bathroom in a virtual house with one user driven avatar and one computer driven agent in the appropriate gender. The VE was designed using Vizard; users interact with the VE on a head mounted display, joystick and keyboard. In that environment users control an avatar and also interact with computer agent. The main experimental tasks consist of interacting with safe sex-related items such as condoms as well as negotiating safer sex with the agent. Attitude and emotion measures are taken during the interaction with the VE as well as after the user completed the experimental tasks; distance to the object in the VE is recorded as an indirect measure of attitudes. Results: Initial pilot testing of the VE (n=19) has shown that users’ responses were positive on presence and realism (4.2 and 5.0 out of 7, respectively). Ratings of the avatars indicated that participants found them moderately attractive (*M*=5.1), realistic (*M*=4.5), and expressive (*M*=4.5). Attitudinal measures indicated participants had positive attitudes toward both the VE (70 out of 100) and the avatars. Users had no problems navigating the VE, even those with minimal computer experience. Conclusion: This work extends previous research on implicit attitudes as predictors of safe sex behavior (Marsh et al., 2001), as well as the use of VR to provide a safe training environment for difficult behaviors. Future directions of this work include using the VE to condition attitudes through repeated exposures of safe sex and positive outcomes in a variety of circumstances.

Optic Flow in a Virtual Environment: Sustained Influence on Speed of Locomotion

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Generalised psychomotor slowing and persistent slowing of movements are frequent consequences of injury, illness, pain and ageing. Slow movements are also associated with the fear of falling. This adds to the physical burden because slow movements are relatively inefficient both in terms of time taken and energy requirement. Slow walking speeds also give rise to an inability to function effectively in the community. In recent years, rehabilitation approaches have targeted movement speed. However, an ongoing challenge with any rehabilitation approach is the need to engage and motivate patients to actively participate in their rehabilitation. Studies have shown that improvement in movement patterns and efficiency can occur with an increase in walking speed. Moreover, regular ambulation on a treadmill at speeds higher than normal overground walking speed can produce significant improvements not only in walking speed and walking capacity but also in overall physical performance (e.g. timed sit-to-stand tasks). Virtual Reality as a tool of rehabilitation can help engage patients, decrease pain and also improve movement. For example, optic flow (i.e. the expansion of an image on the retina) within a virtual environment can influence an individuals perception of movement and thus their actual movement. The sustainability of this phenomenon is not clear. The objective of this preliminary study was to investigate whether a simple virtual environment could be used to sustain the modulating effect of optic flow on walking speed. Nine subjects, 5 male and 4 female aged between 33 and 57 (mean age 45.6) participated in this experiment. An animated Virtual Environment simulating a moving walkway was created in 3D Studio Max and rendered into a stereoscopic movie using Virtalis StereoWorks. The movie was projected (moving towards the subjects) onto a 5 meter wide screen in front of a self-paced treadmill. The movie was projected at three different speed conditions (0.75m/s, 1.5m/s (average walking speed) and 3.0m/s) in counterbalanced order. Participants walked on the self-paced treadmill and were instructed to maintain 'comfortable walking speed' throughout the 5 minute duration of each speed condition. A significant difference was found between the walking speeds of the subjects at different animation speeds (Two way Anova $p<0.01$), with lower animation speed associated with faster walking speeds and vice versa. This modulating effect was sustained for the duration of each 5-minute test, which suggests that it does have potential for use in rehabilitation and training. This preliminary study used healthy subjects, and further work is proposed to investigate the extent of this modulating effect on different patient groups.

Managing Exam Stress: The Use of Mobile Phones for Enhancing Emotion Regulation

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Exam anxiety is referred to students' emotional reaction to perform an exam and it may interfere with the student's ability to be successful at the university. Exam anxiety involves physical, emotional and cognitive components. All these components may be taken into account for managing and reducing exam stress. A critical issue in exam stress is learning how to regulate one's own emotion. According to Emotion Focused Therapy the emotional regulation process requires the subject to become aware of his/her own emotions. Learning to regulate emotions means to listen to one's own physical sensations and level of arousal, to symbolize emotions and to anticipate the effects of reactions, in order to act more adaptively. Meichenbaum and Cameron proposed Stress Inoculation Training, a clinical protocol for training coping skills in stressful situations. It consists of three main phases: the first one is focused on acquiring cognitive relaxation competences on physical and psychological reactions; the second phase is based on learning coping strategies; finally the third phase exposes progressively the subject (in vivo and also in imagination) to stressful situations (in a controlled setting) in order to practice the previous acquired relaxation techniques. Starting from this background in the present study authors defined a protocol based on Stress Inoculation Training to support students in managing exam stress. The

main aim of this research is to investigate the effectiveness of the clinical protocol applied to the exam stress management. More in details, authors evaluate the role played by the use of video contents (additionally to only audio contents) and of mobile devices (as compared to desktop pc) for enhancing the exam stress management. To support the training we developed both audio and video contents: audio contents consist of a narrative voice that guides the subject in the visualization process, in physical reactions recognition and in coping abilities development; video contents consist of realistic presentation of both a stressful situation (exam) and of a relaxing environment. 30 University students (Faculty of Psychology) that have to perform exam in the following week will be assessed. The protocol is composed by six sessions: session 1 and 2 are based on psycho-physiological reactions to an exam event; session 3 and 4 are based on psycho-physiological reactions and on coping strategies; session 5 and 6 present the stressful situation (exam) in order to evaluate the acquired competencies. Participants will be randomly assigned to one of the following conditions: 1. Audio + video on pc desktop; 2. Audio + video on mobile devices (mobile phones) ; 3. Audio on pc desktop; 4. Audio on mobile devices (mp3 devices). A condition with participants who do not receive any treatment will be also included.The procedure will be the same for all conditions (except the "no treatment group"): participants will be asked to have one session per day for six days before the exam's date and at the same time of the day (preferentially in the evening, when they have finished to study). Each participant will be administered the following questionnaires: the STAI (*State Trait Anxiety Inventory*); the PANAS (*Positive and Negative Affects Schedule*); the COPE (Coping Orientation to Problems Experience); the Generalized SELF-EFFICACY scale (Jerusalem, Schwarzer, 1981). The research is in progress. Final results will be presented at the 2006 Cybertherapy Conference.

Monitoring Daily Life Using Mobile Phones: The Experience Sampling Method.

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Research studies oriented to enhance knowledge about social, psychological, and physiological processes within everyday situations can greatly benefit from the contribution of Ecological Momentary Assessment (EMA) instruments, which repeatedly examine ongoing experiences through self-reports. Among them, Experience Sampling Method (ESM), developed at the University of Chicago in 1976, has been successfully applied in both psychological and medical areas. The main purpose of ESM is to examine the human beings' internal experiences (thoughts, feelings), and their contingent behaviours and context , catching the complexity of daily life. For a given time span, usually one week, participants carry an electronic device emitting acoustic signals 6-8 times a day during waking hours. At signal's receipt, participants are asked to fill out a questionnaire sheet, reporting on their current activities, location, social context, associated subjective experience, in terms of motivational, affect and cognitive components. Through this procedure, ESM overcomes some of the disadvantages of standard approaches because it does not rely on retrospective recall or data reconstruction, but rather involves on-line access and accurate reporting of information. ESM has been extensively validated in different cultures and contexts. Starting from the original format characterized by paper questionnaire supported by signalling equipment, the ESM was thoroughly implemented on electronic devices (PDA) that bring in one all the necessary instruments for the assessment. Further ESM was assessed on the web, and using voice recorders. Each type of data collection has several advantages but also some limits. In this study, we propose mobile phones as a valid alternative technology to palmtop and hand-held computers, promoting ubiquitous and mobile computing applications [5]. In this mobile version, we followed the original ESM protocol. An acoustic signal reminds participants to fill in a standard ESM questionnaire 6-8 times per day for one week. Respondents are asked to

fill out the questions using the phone's keyboard. The study assesses the usability of the ESM implementation on mobile phones. The sample is composed by 20 general population subjects, 10 males and 10 females. All respondents are tested in two sessions: one with a version of the ESM based on paper & pencil, and one with a version of the ESM implemented on 6680 Nokia mobile phones (display resolution:176x220). The order of presentation is randomized, with one group of participants starting with the paper and pencil version, and the other one with the mobile phone version. The sample is also administered the Questionnaire for User Interface Satisfaction (Italian version), and takes part in a structured interview to discuss the features of both approaches, as well as to appraise their user's satisfaction. The research is in progress. Final results will be presented at the Cybertherapy 2006 conference.

A Randomized Controlled Study of Virtual Reality Exposure Therapy and Cognitive -Behaviour Therapy in Panic Disorder with Agoraphobia

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Panic disorder with agoraphobia is a frequent and disabling disorder occurring in up to 4% of the general population. Treatment modalities include medication (with selective serotonine reuptake inhibitors or benzodiazepines) and cognitive-behavioral therapy (CBT). A major component of CBT for panic disorder with agoraphobia is progressive and sustained exposure to situations that individuals with the disorder are afraid of. Traditionally, exposure therapy consists in confronting feared stimuli first "in imagination" and then in the real world. Virtual reality exposure therapy or VRET is an exposure "in virtuo" that may be conceptualized as an exposure in between imagination and reality. Reviews on the use of Virtual Reality Therapy (VRT) in panic disorder with or without agoraphobia can be found in a recent book by Wiederhold and Wiederhold (2005) and in a recent paper by Pull (2005). The study presented here is an ongoing investigation involving the Collège de France and three university hospitals (in Luxembourg, Lyon and Paris). It is a randomized controlled trial comparing the efficacy of traditional CBT, VRET, and a waiting list in patients meeting DSM-IV criteria for panic disorder with agoraphobia. Patients taking psychotropic medication other than valeriane are excluded, as are patients having a score of 17 or above on the Hamilton Depression Rating Scale. Patients who are eligible for the trial receive a two-page information leaflet and sign an informed consent form. Patients in the waiting list are randomized to either of the two active treatments at the end of three months. Follow-up is one year from the date of entry. CBT and VRET are given in 12 sessions of 90 minutes duration. Both types of treatment are provided by the same clinicians who are experienced therapists. CBT includes respiratory control, cognitive restructuring, exposure in imagination to anxiety provoking scenes and interoceptive exposure to anxiety-related physical sensations, and homework involving exposure to real-life situations. VRET includes exposure to 12 virtual environments (taking a subway, walking in a tunnel, taking an elevator, shopping in a supermarket, driving a car on a lonely country road, travelling by plane, entering a movie theatre, driving a car in a city, driving a car in a tunnel, travelling by bus, walking in a crowd, being caught in a sensorial conflict provoking a feeling of derealisation). Virtual environments were created at the Collège de France. VR environments are presented using a head mounted display and tracking head movement (Kaiser Pro view 60 ™). Participants are guided through the VR environments by the therapists. Treatment techniques and guidelines for each CBT or VRET session are described in detailed manuals. Patients are assessed using a number of rating scales, behavioural tests, and neuro-psychological instruments. The main outcome criterion is a decrease of 50 % decrease of the baseline agoraphobia score on the Fear Questionnaire. By the end of 2005, 90 patients had been included in the project. The design of the study, the methodology upon which it is based, the assessment instruments, the technical and methodological difficulties encountered in the trial, as well as first results will be presented at the conference.

Differences in Presence and Reality Judgement Using Different Display Devices in a Clinical Population

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Most authors researching on virtual reality (VR) field agree to consider presence as a multi-component construct determined by two general categories of variables: media characteristics and user characteristics (e.g., Barfield, Zelter, Sheridan, & Slater, 1995). Nevertheless, as we have pointed out in previuos studies (e.g., Baños, Botella, Alcañiz, Liaño, Guerrero, & Rey, 2004), in the user-environment binomial a central role has been given to the media and most of efforts have been devoted for the porpouse of increasingly generate sophisticated technologies to augment the sense of presence. From this approach the role of variables like immersion, interaction and perceptual realism in the sense of presence have been overemphasized leading even, some times, to erroneously define presence as a direct function of immersion (Schubert, Friedmann, & Regenbrecht, 2001). However, it has been stated that the sense of presence is a subjective experience in which the person's characteristics have something to do. In fact, many authors relevant in the field (Biocca, 1997; Schubert, Friedmann & Regenbrecht, 2001) consider that a person feels present in a environment when his/her cognitive processes lead to a mental representation of a space, where the person locates him/herself. Therefore, not only media form characteristics but also users characteristics and media content characteristics should be taken into account. As for media content, previous studies (e.g., Emmelkamp, Bruynzeel, Drost, & van der Mast, 2001) have proven that VR therapy is effective for clinical (mental health) participants by using a relatively cheap hardware and software on stand-alone computers currently in the market. Also several works carried out by our group (e.g., Baños et al., 2004; Baños, Quero, Salvador & Botella, 2005) showed that in clinical populations the user characteristics and the media content seems to play a central role in the sense of presence rather than the formal contents. All these studies support the impact that emotions and clinically significant environments that are relevant to the person have on presence and the reality atribution of users. Therefore, this work examines the differences in sense of presence and reality judgement made by a clinical population suffering from different anxiety disorders. The sample (N=114) included several specific phobias and panic disorder with or without agoraphobia. Three different conditions were used: (1) Immersive virtual reality using a head-mounted display (HMD); (2) Desktop virtual reality using a PC monitor; and (3) videos of different audiences that simulate social situations (e.g., a tribunal, a classroom) using a PC monitor. In order to measure sense of presence and reality judgement, the 7-factor Presence and Reality Judgment Questionnaire (Baños et al., 2005) was used. Results indicate that there are no statistically significant differences in "emotional involvement" and "reality judgement and presence", finding differences in the factors regarding interaction, quality of the software, software easiness and satisfaction with the experience.

The VMall as an Intervention Tool for Stroke Rehabilitation

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Virtual environments have been used with stroke patients as a mean of therapy to decrease motor (e.g., Broeren, et al., 2004) and cognitive impairments (e.g., Brooks, & Rose, 2003; Katz, et al., 2005). Other environments (e.g., Gourlay, et al., 2000) have been used to enhance participation in activities of daily living (ADL) These environments typically support therapy aimed at improving various abilities (motor or cognitive or meta-cognitive) or daily activities rather than incorporating functionally relevant tasks that require the individual to contend simultaneously with abilities in all three areas. The objective of this paper is to present the results of an initial intervention study which exam-

ined the effectiveness of a virtual supermarket (VMall) for the assessment and treatment of motor and executive function deficits following stroke. Seven participants, aged 53-73 years, participated in the study. Five were at a sub-acute stage of rehabilitation (5-9 months post-stroke) and two were at a more chronic stage (27 and 96 months post-stroke). All were relatively independent in Basic ADL but were generally dependant in Instrumental ADL. Three patients had a motor deficit only and four patients had a primary deficit in executive functions (with a mild – moderate motor deficit of their affected upper extremity). The VMall is a virtual large supermarket programmed as an application within GestureTek's Gesture Xtreme (GX) video-capture VR system. The performance of the shopping task provides multiple opportunities to make decisions, plan strategies and multitask, and the various functions (e.g., buying groceries) are activated by using upper extremity movements, mainly of the affected side. Outcome measures included the time to perform and number of mistakes made during a 4-item shopping task within the VMall, a test of executive functioning, the Multiple Errands Task (MET) in the VMall and a real shopping mall, and three assessments of motor functioning including the Fugl-Meyer Motor Assessment, the Wolf Motor Function Test and an ADL questionnaire regarding the number of tasks performed using both hands. A series of single intervention case studies (using an A-B-A design) was used to assess the effectiveness of treatment using the VMall. The intervention phase consisted of 10 sessions over a period of three weeks using both the VMall and other GX game applications. Participants were tested two weeks before and immediately prior to the intervention and immediately following the intervention as well as two weeks post-intervention. The number of mistakes made while performing the MET in both the VMall and a real shopping mall decreased following the intervention for the patients who suffered from executive functions deficit. Participants who suffered primarily from a motor deficit showed improvement in their motor ability and for two of the three subjects there was functional improvement in the affected upper extremity and an increase in the number of daily life tasks performed using both hands. The VMall appears to provide motivating, meaningful and ecologically valid tasks suitable for stroke intervention aimed at both active movement of the weak upper extremity and the use of executive functions.

An Analog Study of Simulation Trauma Severity: Sensitivity of 'Bus-World' for VR Exposure Therapy

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Terrorism evokes a fundamental sense of helplessness. It is estimated that for every physical injury during a terrorist attack, between 10 and 13 people suffer emotional trauma. Typical reactions to terrorism include a wide range of emotional (e.g., shock, fear, anger, depression) and physical (e.g., headache, nausea, sleeplessness) reactions known as 'acute stress reactions'. One out of every four victims does not recover naturally, and may develop an Acute Stress Disorder, eventually resulting in a full-blown Post-traumatic Stress Disorder (PTSD). Cognitive-behavioral therapy involving exposure therapy is an effective treatment for this disorder (Cahill & Foa, 2004). In recent years, Virtual Reality (VR) has been successfully implemented in the treatment of PTSD to conduct exposure to the trauma memories (Hodges, et al., 1999; Difede & Hoffman, 2002). VR treatment enables the exploitation of patients' imagery ability, supplemented by potent visual and auditory computer-simulated stimuli. The sensory-rich virtual environment generates an evocative therapeutic experience which may intensify their personal emotional involvement, even for patients who are reluctant to recreate their traumatic experiences. We developed BusWorld, a simulation of a terrorist suicide bus bombing attack in Israel designed to provide VR-based exposure therapy to people suffering from PTSD (Josman, Garcia-Palacios, Reisberg, Somer,Weiss, & Hoffman (in press), Josman, Somer, Reisberg, Weiss, Garcia-Palacios, & Hoffman, (in press).The severity of trauma provided by the simulation has been graded from Stage 1 (views of a public bus stop with the usual urban din of voices and sounds) through to Stage 12 (view of the bus explod-

ing, flames, bus and body parts strewn all over, real voices of people screaming and emergency vehicle sirens). The objective of this paper is to present the results of an analog study that investigated the physiological and subjective reactions of healthy individuals to this virtual environment in order to evaluate its ability to provide exposure to successively more severe levels of trauma. Thirty volunteers aged 23 to 63 years, without a history of past or present PTSD were tested. The participants were exposed for 90 s to each of four graded stages of Bus-World (Stages 1, 2, 5, and 12). Immediately following each exposure, heart rate was measured and the participants were asked to rate their Subjective Units of Discomfort (SUDs) and to complete the Short Feedback Questionnaire, an abbreviated version of Witmer & Singer's (1998) Presence Questionnaire. All of the outcome measures differed significantly with respect to the severity of simulated trauma. In some cases (e.g., heart-rate) the differences were small from a functional point of view. In other cases (e.g., SUDs, presence) the differences were large and correlated positively with the severity of the simulated trauma; both anxiety and presence increased with the severity of exposure. The results of this analog study have verified the ability of BusWorld to provide graded exposure to trauma for use in VR-based exposure therapy for individuals suffering from PTSD due to suicide bus bombing. The discussion will focus on the importance of conducting analog research as a first step for studies with PTSD clients.

Morphing Sexual Characters: Unlimited Generation

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A series of realistic, interactive and virtual 3D characters depicting different age brackets, racial types and secondary sexual features will be presented. These characters and their emotional expressions are produced from a generic morphing principle. By resorting to this principle, it is possible to create characters adapted to very specific research and clinical needs such as those of sexual preference assessment. This research is done in collaboration with Darwin dimensions.

User-Centered Design Driven Development of a VR Therapy Application for Iraq War Combat-Related Post Traumatic Stress Disorder

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In 1997, researchers at Georgia Tech released the first version of the Virtual Vietnam VR scenario for use as a graduated exposure therapy treatment for PTSD in Vietnam veterans. This occurred over 20 years following the end of the Vietnam War. During that interval, in spite of valiant efforts to apply traditional psychotherapeutic approaches to PTSD, the progression of the disorder in some veterans severely impaired their functional abilities and quality of life. Prior to the availability of VR therapy applications, the existing standard of care for PTSD was *imaginal* exposure therapy. Such treatment typically involves the graded and repeated imaginal reliving of the traumatic event within the therapeutic setting. This approach is believed to provide a low-threat context where the patient can begin to therapeutically process the emotions that are relevant to the traumatic event as well as de-condition the learning cycle of the disorder via a habituation/extinction process. While the efficacy of imaginal exposure has been established in multiple studies with diverse trauma populations, many patients are unwilling or unable to effectively visualize the traumatic event. Virtual Reality offers the ability to systematically deliver relevant stimuli to clients in order to address this problem. We have initiated a project that is creating an immersive virtual environment system for the treatment of Iraq War military personnel diagnosed with com-

bat-related PTSD. Thus far we have created a series of virtual scenarios designed to represent relevant contexts (two city types and a desert road convoy) required for this treatment to be conducted in VR. That is the easy part. The real challenge exists in building a *platform* that gives a clinician, who may have no programming knowledge, the capacity to control the stimulus environment in both *real time* and *offline* between sessions. For real time delivery of stimuli, we have created a "wizard of oz" type clinical interface that lets a clinician or researcher easily introduce visual, auditory, tactile, olfactory and thermal stimuli while the client is in the environment. This interface allows the therapist to gradually introduce and control "trigger" stimuli in the environment in real time as is required to foster the anxiety modulation needed for therapeutic habituation. A more complex offline environment editing interface has also been developed which allows a clinician to substantially modify the activity and look of the environment between clinical sessions. In our view, these interfaces are essential elements for providing state of the art VR exposure in a sound and ethical manner, as opposed to a "one-size-fits-all" approach. User-Centered tests are currently underway at the Naval Medical Center–San Diego, Camp Pendelton and within an Army Combat Stress Control Team in Iraq. This feedback with non-diagnosed personnel is providing information on content and usability that is feeding our iterative design process. A clinical trial version of the platform built from this process will be tested with PTSD-diagnosed personnel beginning in April 2006 and data from the user centered design trials and from initial observations from the clinical trial will be presented at CyberTherapy.

Using Virtual Reality for Cue Exposure in Treatment for Crack Cocaine Addiction: An Open Trial and Manual Development

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Despite experimental findings supporting the use of cues to induce and extinguish cocaine cravings, treatments using cue exposure for cocaine addiction have not demonstrated efficacy. One particular problem related to cue exposure treatment is reliably re-creating conditioned responding and extinguishing cravings to a variety of conditioned stimuli. Consistent with the mission of Stage 1 behavioral treatment development research (Rounsaville, Carroll, & Onken, 2001), the aims of this project are to develop and manualize a virtual reality (VR) based cue exposure intervention for use as an adjunctive treatment in substance abuse counseling. During Stage 1a, the VR technology will be developed and refined using two small open clinical trials (N = 20). At the conclusion of Stage 1a, a treatment manual detailing the rationale and parameters of the VR technology will be completed. Next, a Stage 1b pilot randomized clinical trial (N = 40) will be conducted in order to determine the acceptability and feasibility of this treatment to patients and therapists, and to obtain treatment outcome effect size estimates. This study is currently in Stage 1a. The VR simulation has been refined iteratively using focus groups and open trials. Several environments have been created using the Source game development engine from Valve, the makers of Half-Life2. These consist of a crack house, an apartment, a bar/restaurant and an outdoor, urban street-scene that interconnects the interior environments. All of the characters and many of the models are available for placement in the virtual world through a drag-and-drop interface that allows the experimenter to configure the software before a therapy session with a variety of models, characters and interactions appropriate for the individual client at their stage of therapy. For example, initial treatment sessions for crack cocaine might have only an empty crack house, but in later sessions the crack house might contain many models of drug paraphernalia and characters smoking or dealing crack. These configurations can be saved for later editing and use with other clients. Thus, the VR platform is flexible and can be individually tailored to maximize treatment response. In the first 4 weeks of data collection, we have enrolled 7 participants who meet full diagnostic criteria for cocaine dependence. Self-report and psychophysiological measures of craving are being obtained as participants undergo 10-12 VR sessions as an adjunct to weekly drug counsel-

ing. The initial data suggest that (a) the VR environments are capable of eliciting cravings to use cocaine in all participants, (b) there are individual differences in the intensity of cocaine-related cues needed to induce craving, and (c) repeated exposure leads to habituation to cues that initially induced high cravings. The treatment manual is being written contemporaneously, and by June we expect to have completed one open trial and have begun a second open trial. For this poster, the first wave of clinical data (e.g., craving) will be presented, along with an overview of the process, VR platform, and feedback from participants.

Randomized Controlled Trial of CBT with Virtual Reality Exposure Therapy for PTSD

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We describe a study for which we are currently securing funding and IRB approval. Background: Posttraumatic stress disorder (PTSD) is a common reaction to traumatic events ranging from war to personal assaults. A recent study identified PTSD in nearly 13% of U.S. Army veterans returning from Operation Iraqi Freedom, echoing our findings in U.S. Desert Storm veterans. Untreated or undertreated PTSD is linked to higher rates of depression and other psychological conditions, poorer physical health, missed work, impaired function at work and home, and higher healthcare costs: in 1998 in the U.S. alone, PTSD and related anxiety disorders were estimated to cost $63 billion. PTSD is relatively resistant to therapy, with even first-line treatments failing half the time. Cognitive behavioral therapy (CBT) with exposure therapy is the preferred non-pharmacologic therapy, but traditional exposure therapy requires that the patient recount their trauma repeatedly to their therapist (imaginal exposure), which is often inherently difficult, as avoidance of reminders of the trauma is a cardinal feature of PTSD. Virtual reality (VR) can overcome this obstacle, enabling therapist-guided exposure to progressively more intense trauma-associated stimuli. VR exposure therapy (VRET) has shown efficacy for other anxiety disorders, particularly phobias. Some of our co-investigators documented improvement in an open trial of Vietnam War veterans with PTSD. More recently another co-investigator documented significant improvement in World Trade Center workers after 9/11/01, with CBT/VRET compared to waitlist controls. The “Virtual Iraq” environment is the most realistic and sophisticated yet applied to PTSD treatment, adapted from the Microsoft® X-box game *Full Spectrum Warrior*. It is being used in an open trial of PTSD at the Naval Medical Center San Diego, but it is critical to make blinded comparisons in controlled studies. Objective: To compare the efficacy of 12 weeks of CBT/VRET vs. supportive psychotherapy in conjunction with a relaxation virtual environment, with blinded outcome measures. We hope that this design will serve two purposes: first, to establish a feasible control for CBT/VRET, and second, to give us an initial measure of the efficacy of CBT/VRET. Ultimately, we hope to conduct a trial of CBT/VRET vs. pharmacotherapy in a 2X2 design to assess whether combination therapy is more effective than either alone. Methods: Combat veterans will be screened for PTSD at Walter Reed Army Medical Center, Washington, DC and National Naval Medical Center, Bethesda, MD. Twenty-six who provide informed consent and meet eligibility criteria will be randomized to CBT/VR sertraline or supportive psychotherapy/relaxation VR. An experienced psychotherapist will conduct therapy for both arms, for 12 weekly sessions. A blinded, independent investigator will assess response to therapy, with the gold standard Clinician-Administered PTSD Scale (CAPS) used to compare change from baseline for each arm as well as direct comparisons between the two arms.

Evaluating the Interaction of Blind Learners with Audio-Based Virtual Environments

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Most interactive virtual environment tools are designed with a visual interface without considering the possibility to be accessed by users with visual disabilities. We study efficient ways to integrate these tools to the non visual community to improve their education and adaptation to the real world. In past audio-based projects evaluation measures using usability questionnaires, cognitive tasks and anecdotic forms to register the interaction with virtual environments have been implemented. In particular, when evaluating the interaction with a virtual world in groups of blind users it is almost impossible to register most critical events. For this reason it is critical to design a system to support usability problems, issues detection, and help to better measure the cognitive impact on the users. Different studies have demonstrated that audio signals can help to create virtual environments that can be mentally represented by users with visual disabilities. Actually not all virtual environments can be mentally represented by these users independently of their complexity and the time of interaction. To study this issue we have implemented software to process the data and information produced during the interaction to recreate interactions through simulations, to draw relevant graphics, and to visualize the information from different point of view. This can help to observe with detail a specific interaction session and to process information of various sessions to analyze issues and long term goals. Likewise this allows identifying usability issues and to gather information about cognition. The only requisite is that the software has to allow automatic backups of the data produced during interaction according to a preestablished format. In this study we worked with AudioDoom2, a revisited version of the known software AudioDoom [developed in 1997. This new version considers features such as automatic saving of login files that contain information about the behavior of users during interaction. It also considers uploading new maps and labyrinths from external files. This allows more freedom to study different maps in accordance with the needs of the study. As a result we have observed and studied more fully and accurately different types of mental representation and the complexity of virtual environments navigated by the blind users and thus helping us to define the degree of complexity of a virtual environment (basic, middle, advanced), to create a progressive work plan to help users to increase their auditory perception (audio memory, fidelity, and audio discrimination), and to understand some geometric issues such as the shorter distance to be attained and symmetry. The study has shown that not all virtual environments are represented with high fidelity by users with visual disabilities. We have learned about the characteristics that make a virtual environment to be complex or simple. We need to study when a virtual environment becomes complex based on auditory perception skills of users. Finally, the use of our software will help to identify differences between novice and experts users in their cognitive representation of different labyrinths within the software.

Virtual Reality Intervention for Chemotherapy Symptoms

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PURPOSE: Successful completion of chemotherapy offers a greater chance of tumor non-recurrence and long-term quality of life. However, many patients have difficulty adhering to the prescribed regimen because of related symptoms. Virtual reality (VR) provides a distracting, immersive environment, which blocks out competing stimuli, ameliorates chemotherapy symptoms, and thus, helps patients tolerate their chemotherapy regimen. This study explored VR as a distraction intervention to relieve symptom distress in outpatients receiving chemotherapy and to determine the post-treatment effect on symptom distress after 48 hours. METHODS: Lazarus and Folkman's Stress and Coping Model identifies interactive distraction as an emotion-focused coping strategy utilized by individuals experiencing a threatening situation. VR is an immersive and interactive intervention, which engages several senses simultaneously. Study participants used a head mounted display (i-Glasses SVGA 3D) to display encompassing images and block competing stimuli during chemotherapy infu-

sions. A crossover design was used to determine whether VR was effective in reducing chemotherapy-related symptom distress in patients and whether the effects last for two days. 123 adults receiving chemotherapy for breast, colon, or lung cancer at Duke University Comprehensive Cancer Center were randomly assigned to receive VR during one chemotherapy treatment and no VR (control) during an alternate treatment. The Adapted Symptom Distress Scale-2, the Revised Piper Fatigue Scale and the State Anxiety Inventory measured symptom distress. All instruments have demonstrated reliability and validity in this population. RESULTS: Evaluation of the intervention indicated that patients thought the VR was easy to use, they experienced no cybersickness, 86% liked the VR intervention, and 82% would use VR again. Patients had an altered perception of time ($p<.001$) when using the VR, validating the distracting capacity of the intervention. However, analysis demonstrated no significant differences in symptom distress immediately or two days following chemotherapy treatments. Patients stated that using the VR seemed to make treatment time shorter and that chemotherapy treatments with VR were better. However these positive experiences did not result in a decrease in symptom distress. CONCLUSION: Findings support the notion that using VR can help make chemotherapy treatments more tolerable, but clinicians should not assume that use of VR will improve chemotherapy related symptoms. ACKNOWLEDGEMENT OF FUNDING: This study was funded by the Oncology Nursing Foundation through an unrestricted grant from Ortho Biotech Products, L.P. and Duke University Medical Center.

Injecting Emotive Content into Medical Simulation: Behavioral Health and Beyond

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The use of videogame technologies for mainstream military simulation has increasingly gained acceptance in both the operational and medical communities. In 2004, the Office of Naval Research (ONR) initiated programs using videogame technology to treat acute Post-Traumatic Stress Disorder (PTSD) in active duty personnel returning from Iraq and Afghanistan. The Army's Telemedicine and Advanced Technologies Research Center (TATRC) is currently collaborating with ONR to expand this research into new realms. TATRC and the Naval Research Laboratory (NRL) are also embarking on projects to use gaming technologies to revolutionize military medical care, pandemic planning, medical training, and are also exploring the possibilities of developing innovative techniques for "inoculating" against the effects of acute stress. ONR is currently working with Texas A&M – Corpus Christi to develop an advanced healthcare training application based on videogame technology that will provide accredited training for healthcare professionals. As a first step in this project, the Trauma Center at the National Naval Medical Center in Bethesda, MD has been modeled. The theme that binds these various programs together is the use of entertainment technologies to inject emotional content into simulation. During this talk, a detailed analysis of the current VR-based behavioral health programs will be provided. Additionally, the various medical simulation initiatives will be summarized in the context of the "Serious Games" initiative and a vision for the future synergy of military simulation and the videogame industry will be discussed.

Development of a Virtual Reality-based Power Wheelchair Simulator

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For many individuals with physical and/or cognitive disabilities, the assistive technology provided by a power wheelchair (PWC) offers the means for independent mobility thereby improving their ability to participate in society. Despite the independence afforded by a PWC, third party payers are often reluctant to purchase a PWC for those individuals until the person can demonstrate the ability to

operate it independently. This creates a classic "catch-22" scenario whereby an insurance company won't purchase a PWC unless the individual can operate it independently, but the individual does not have the opportunity to demonstrate this ability because they don't have access to a PWC. Additionally, current methods used to teach an individual to use a PWC are inefficient and potentially unsafe. Ideally a large space is required with different environments to train in. Those users who are new to a PWC may find it difficult to initially operate the wheelchair since they may not have inadequate cognitive and/or physical ability to effectively and safely control the device. The Virtual Reality-based Power Wheelchair (VRPWC) simulator presented here may offer an alternative way to train individuals to use a PWC and provide objective data on the client's ability to successfully operate a PWC independently. The proposed VRPWC offers potential benefits over traditional PWC training methods. For example, the associated VE can be made easier to maneuver through at first, with the difficulty/realism increasing as the clients ability improves. Additionally, the VRPWC simulator can provide quantitative data on the client's performance that can be used to document change and capacity to independently operate a PWC, e.g., for insurance purposes. The developed VRPWC system provides the user with realistic visual and kinesthetic feedback that is highly immersive. A six degree–of–freedom Stewart platform (a form of parallel robot) with a turntable at the end-effector serves as a motion base capable of providing large scale haptic feedback to a user seated in a manual wheelchair mounted on the turntable. The user wears a stereoscopic head-mounted display (HMD) that presents a real-time virtual environment (VE) that can be navigated using a standard PWC control device, e.g., a joystick or puff-and-sip device. A slave computer mounted on the motion base communicates wirelessly with a stationary master computer that generates the visual data for the HMD as well as the control signals required to servo the motion base and provide realistic kinesthetic feedback. The VE and dynamics of the wheelchair are simulated using a software package called Virtools while the real-time control of the motion base is implemented using Matlab/Simulink. The resulting experimental setup is a first step towards the development of a system capable of generating realistic haptic feedback for PWC simulation. The accuracy of the system has been tested in terms of wheelchair stability and found to compare favorably with other published results.

Does Virtual Reality Motivates Children to Do Exposure?

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Anxious disorders are highly prevalent among children and adolescents, and specific phobia appears in the forefront. Exposure-based treatments are the most effective interventions for anxiety disorders in children, but motivation and compliance with exposure is often an issue with this population (Rapee et al, 2000). In order to make therapy less aversive to a child and his relatives, to increase compliance as well as decreasing the drop-out rate, virtual reality exposure (*in virtuo* exposure) offers an interesting alternative to *in vivo* exposure. The first objective of this study is to assess if a combined treatment with mostly *in virtuo* exposure motivates children suffering from arachnophobia to complete their treatment, compared to a traditional treatment consisting only *in vivo* exposure. The secondary objective is to document the efficacy of both treatment methods. In this randomized control trial, 31 participants aged between 8 and 12 years old are randomly assigned to one of two treatment conditions: *in vivo* exposure or *in virtuo* exposure. The treatment is divided in two parts in order to assess to comparative and additive effects of both exposure methods. The first part lasts four sessions and consists of *in virtuo* exposure or *in vivo* exposure (according to the condition they are assigned to). The second part consists of one *in vivo* exposure session for all children, no matter which condition they are assigned to. The addition of one *in vivo* session to the VR treatment allows to consolidate treatment gains and see whether VR facilitates the introduction of *in vivo* exposure. Measures of interest and motivation are taken at each week for the entire duration of the treatment, while efficacy measures are taken at pretest, after the end of each part of the treatment

and at a 6-month follow-up. The results show that children having received *in virtuo* exposure don't have a higher level of motivation toward their treatment and do not comply more to exposure than those who received *in vivo* exposure alone. As for treatment's efficacy, the results show that adding one in vivo session is useful to boost treatment success in children who undergo *in virtuo* exposure. These results have important clinical implications concerning motivation of children in therapy. They are discussed in the light of how to present *in virtuo* exposure to children, who may be more apprehensive toward VR exposure than adults.

The Usefulness of Virtual Reality Stress Inoculation Training for Military Medical Females

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Warfighters face stressors such as sleep deprivation, information overload, exposure to injuries/dead bodies, and anxiety for the welfare of fellow warfighters and family left behind (Lukey, Stetz, & Romano, 2005). Consequently, many warfighters are being medically evacuated out of theater due to psychological stress (Stetz et al., 2005). Researchers as COL Hoge et al. (2004) have recently reported that approximately 18% of warfighters returning from Iraq and 11% returning from Afghanistan (n = 6, 201) screened positive to Post Traumatic Stress Disorder (PTSD). PTSD is a debilitating condition resulting from experiencing trauma, characterized by continuous memories of the traumatic experience (National Center for PTSD, 2005). Military medical personnel are not immune to stress and have a challenging and demanding dual role — that of a warfighter and a first responder. In fact, Deahl (2000) found that many first responders report serious psychological distress, including PTSD. Even though many researchers are studying warfighters' stress (Stetz, Stetz, & Bliese, in press; Britt, Stetz, & Bliese, 2004), there is still a gap in the literature on studies with (1) support personnel (i.e., medics) and (2) females. During a recent interview by Elias (2005), a researcher from COL Hoge's group, also reported finding no statistically significant PTSD symptoms difference between males (11%, n = 300) and females (12%, n = 50) in a sample of warfighters holding violence-prone support jobs (i.e., medics). On the other hand, Foa, Davidson, and Frances (1999) had previously reported that approximately 20% of females and 8% of males who had been exposed to traumatic events did develop PTSD symptoms. Furthermore, some researchers suggest that females might be less likely to be exposed to adverse stressful events but more likely to develop PTSD, if exposed. Thus, an overall increased prevalence of PTSD in females (10% vs. 5% in males, see Kessler et al., 1995) can be accounted for by a significantly greater vulnerability to develop PTSD after exposure. Females also seem to have a longer course of illness than males with a median time to remission being 35 months for females compared to 9 months for males (Breslau et al., 1997). The purpose of this study is not to identify which gender is more prone to PTSD. However, given the premise that males typically grow-up being exposed to more stressful situations than females (i.e., teasing each other, playing rough sports, see Murray, 1999), and the lack of studies on female warfighters (especially, in the medical field), we propose to test the effectiveness of stress inoculation training (SIT) for military medical females. SIT proposes that repeated exposure in stressful, but controlled conditions (i.e., via virtual reality) enables individuals to gradually adapt to stressors and learn how to cope (Wiederhold, Bullinger, & Wiederhold, 2005; Driskell & Johnston, 1998). By conducting virtual reality SIT, or "VR-SIT", the stressors can be applied systematically and paced appropriately for each individual. Our VR-SIT study is currently underway and preliminary findings will be presented at the 2006 CyberTherapy Conference in Canada.

Computer Simulated Standardized Patients for Training Health Professionals on Chemical and Biological Agent Exposures

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Research Status: Research is being performed in response to the Army's Telemedicine and Advanced Technology Research Center's SBIR to prepare the medical community for bioterrorism. This collaborative effort involves a small business [SIMmersion™], Uniformed Services University of Health Sciences [USUHS], and the National Capital Area Medical Simulation Center [SIMCEN]. The start date for Phase II research is Spring 2006. Background: Biological and chemical warfare agents such as smallpox, anthrax, and sarin are candidates for use in terrorist attacks because they have the potential to create widespread panic with serious medical and economic consequences. Since these agents are unlikely to be encountered in events other than terrorist attacks, most healthcare professionals have had negligible preparation for the diagnosis and treatment of medical conditions caused by such agents. A variety of means have been explored to adequately prepare health professionals to care for patients exposed to these agents. We have previously published a book, *Physicians' Guide to Terrorist Attack*, and a series of case-based booklets for Continuing Medical Education, which address a broad spectrum of chemical and biological agents. While these resources have been well-received and should benefit many, others learn less effectively by this static approach or may be less inclined to read this material. We have also conducted hands-on training at medical meetings, during which standardized patients [SPs] simulate exposure to biological and chemical agents. Attendees have the opportunity to learn by interviewing and examining patients, as well as by participating in mock, mass-casualty exercises, followed by discussion. While this approach greatly enhances retention of material, it is very resource-intensive; each time it is conducted, it requires large numbers of personnel, training, and supplies. Methods: SIMmersion's expertise is to develop interactive computer-based simulations featuring characters with whom trainees can hold detailed, unpredictable conversations. These simulations can be used to effectively meet practical training objectives and require only a computer to operate. The partnership between SIMmersion, SIMCEN, and USUHS has produced an interactive, computer-based educational program that enables many users to learn to evaluate patients with potential biological and chemical exposures. The initial, prototype model addresses smallpox and uses chicken pox and Rocky Mountain spotted fever as alternative diagnoses. The realism of the interaction between the trainee and the computer simulated SP is attributed to speech-recognition software, filmed responses of an actor moulaged to depict a character with one of the aforementioned medical conditions, and responses that reflect the user's interaction with the simulated patient over time. Trainees can play the module many times with broad variation based on both chance and statement selection. Results & Conclusions: Anecdotal evidence indicates that the training is extremely engaging and that the use of highly interactive role-play simulations improves training effectiveness and "boost[s] learning retention rates dramatically"[1]. Future research will assess the effectiveness of this simulation technology to train with computer SPs. Discussion: Topics that match well with SIMmersion's simulation capabilities include diagnosis of depression, PTSD, alcoholism, or drug abuse, as well as grievance counseling, marriage counseling, and suicide intervention.

Low-Cost Telerehabilitation Using Force Feedback Joysticks

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Background/Problem: In recent years, many researchers have investigated the use of computerized mechanical devices to automate movement therapy for neurological conditions. Robotic therapy has been found to significantly improve the movement ability of the affected upper limb in stroke patients. However, most of these systems are expensive and not suitable for home use. We have followed the lead of inexpensive systems such as the Java Therapy System, and are developing a low cost robotic system - The Jerusalem Telerehabilitation System - using

a commercially available force feedback joystick, an ordinary home PC and a standard high-speed internet connection. As a preliminary test of our system, we conducted a pilot usability trial with several subjects after stroke or head trauma. The goal was to see if the subjects were able to use the system, and to examine the nature of the data obtained from the trials. We also conducted a usability study with two physiotherapists to test the system for clarity, reliability, and ability of the therapists to run the system independently. Methods/Tools: Using the joystick, the patient performs exercises designed to aid in recovering motor function of the upper limb. The joystick has been programmed to either assist or resist the patient's movements. The system monitors the status and progress of the patient, records the kinematic parameters of his movements, and summarizes the results. There are 2 modes of operation – the cooperative mode, in which therapist and patient are online together and the therapist can guide the patient's movements and the standalone mode in which the patient works by himself, not necessarily online. Results: After a short (less than 1 hour) training session, therapists were able to use the system independently. Also, patient subjects had no problem understanding how to do the exercises; they reported that they enjoyed using the system as an alternative to their regular exercises, and felt safe using it. Tests of the cooperative mode over the internet demonstrated that the therapist joystick was able to guide the patient joystick, with a delay of 30-150 msec. Novelty/Discussion: Unlike the Java Therapy system, which relies on Java applets on a web site, in our system, client programs and data on exercise sessions are stored locally on the client's computer and uploaded to a central server at a later date. Our system also differs from Java Therapy, which uses a commercially available arm support and specially made splint for each individual, in that we have designed and built our own arm support which allows even subjects with little or no control of wrist and fingers to control the joystick without the difficulty of attaching a splint. Use of the support allows the subject to move the joystick via relatively large movements of the shoulder and elbow instead of via small wrist movements. The internet cooperative mode is another novel aspect of our system. Conclusion: Both therapists and patients are able to use the system and we are ready to begin a full-scale trial.

Social Networks and Presence in Second Life

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Massively Multiplayer Online Simulations technologies are becoming a great tool for educators to evaluate various behaviors there were once done in real life environments. The synthetic world of Second Life was used as a platform for this study. Second Life is a 3D synthetic world built by the inhabitants of the world. Prior research documents virtual environments (VE's) are most useful when they are believable to the user. The environment should allow individuals to immerse themselves in an experience that is both functional and easy to relate too. Second Life was developed by its members to depict various representations of real life events. This research investigates human relations and social presence within the synthetic environment of Second Life. We investigated social interactions and social presence of 24 class members who had to work on collaborative teams. It is important to learn how these synthetic worlds can be used to investigate social presence, perception and other aspects related to human cognition and behaviors. With the increased growth of simulations and synthetic worlds, these environments may help researchers to examine influences on human functioning in ways with little effect on the lives of the participants, which very few studies have looked at in terms of how people react in these environments and how they perceive themselves within this environment.

Narratives, Virtual Reality Environments and Identity Semiotics of Pre-Service Teachers

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The current study explored text based and animated narrative vignette (ANV) social simulations to specifically examine pre-service teacher's social cognitions and personal identities. This research sought to address identity semiotics of 20 elementary pre-service teachers through examination of their animated narrative social simulations and their social identity exercises. Content analyses revealed animated narrative vignette simulations provide a psycho-educational outlet to engage in reflective cognitive processes which can engage pre-service teachers in expressions of joy and healing related to positive and traumatic events from childhood school related experiences. This paper discusses how animated narrative vignette social simulations can provide a way of learning about personal social identity involving a critical examination of self using animated narrative vignette social simulations as reflected in past school experiences.

Use of a Computerized Exercise Program in a Rehabilitation Setting: A Pilot Study

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Virtual reality (VR) is increasingly available for use in rehabilitation settings. Practicing different ways to complete an activity may help individuals with planning and problem solving. Virtual Reality can be more engaging and enjoyable than other forms of rehabilitation. Through the use of VR, voluntary control of balance has been improved in neurological patients. The successful integration of VR technologies into rehabilitation has demonstrated the possibilities of practicing challenging, but safe, activities in realistic environments, while being able to control the stimulus and measure the outcome. For the therapist, there is the advantage of having full control over the level of difficulty, allowing the treatment to meet individual needs. The ability to change the virtual environment relatively easily, to grade task difficulty, and to adapt it according to the patient's capabilities are important advantages that contribute to its effectiveness in motor remediation. In addition to allowing for standardization of assessment and retraining protocols, it may also be easier to keep a person's attention for a longer period of time, allowing for increased compliance and fun. Virtual Reality could be a valuable modality for therapists, providing a device to allow use of new strategies in everyday situations, reliable data collection and a training protocol. As new ideas and technology become available, methods need to be found to help integrate them into practice. Identifying barriers and aspects that facilitate their use may help identify valid practices and implement these new techniques into practice. The main objective of this pilot study was to test the feasibility of use of the VR equipment in the general rehabilitation setting by determining 1) the opinion of therapists about satisfaction with ease of use, practicality, intervention value, comments on space required, location, perceived enjoyment and interest of the patient and 2) the opinion of patients regarding interest and enjoyment. Subjects were 12 therapists who agree to participate and one or two patients from the caseload of each of the 12 therapists. Patients with decreased balance participated in four exercise sessions each consisting of up to 40 minutes of exercise started and ended with five minutes of stretching. The sessions included a variety of activities that followed an outline designed to improve balance and endurance. Therapists were asked to measure the activity level of their patients using the Physiotherapy Clinical Outcome Variables Scale (COVS) before they began the exercise program. Questionnaires and focus group comments helped determine barriers, facilitators and other suggestions for facilitating the integration of the technology into practice. This project helps identify factors that contribute towards changing practice in physiotherapy by identifying barriers and facilitators to the use of a new technology. This is relevant to physiotherapy in the current health care climate where therapists are challenged to be knowledgeable about and apply best practices, while there are increasing service demands,

decreasing resources, complicated by increasing information, research, and involvement of consumers.

Acceptance of a Virtual Social Environment by Pre-Schoolers with Autism Spectrum Disorder

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Background/Problem: Impaired social reciprocity is a core deficit of Autism Spectrum Disorder (ASD). We report preliminary trials of an experimental intervention using eye-tracking and virtual social interaction to attempt to increase attention to faces. The goal is to motivate participation, while differentially rewarding progress. This is particularly important because in the absence of continued engagement, training terminates. Method/Tools: Subjects are children 24 to 60 months with ASD. Training is presented by live-action video clips on a monitor inside a kiddie-ride helicopter, showing a 'Virtual Buddy' who addresses the child and offers social praise. Increase in gaze at eyes triggers an entertainment video, while decreasing score triggers additional prompts and cues, e.g., masking of all but the face. Once there is gaze at eyes for at least .5 sec, the Buddy directs the child's attention to particular locations. As soon as the child's gaze begins to move in the indicated direction, a video reward appears at the target location. Among the questions for this preliminary study are: acceptance of the experimental set-up, time and techniques needed to entice children into it and maintain their motivation, how best to schedule 20 sessions per child, children's acceptance of interruptions in the video, maintenance of calibration, management of transitions and children's response to the social display and masking cues. Results: We report on 5 males, mean age 50 months, number of sessions 1 to 15. Initial acceptance of the helicopter was immediate for 3 children. One child required a period of several minutes to accustom himself to the device. As the child peered in, video curtains were parted to allow him to see more of the screen. Once he was seated in the car seat, the curtains disappeared. One child has not yet entered after 2 sessions. Eye-tracking: Calibration was readily achieved and maintained after leaving and returning (within the same day). Engagement: Entertainment videos and toy videos have effectively reinforced participation. On two occasions a child decided he did not want to watch any more video after the break. Transition: Video sessions are terminated by closing the curtains. This plus the offer of playing with toys is usually successful in enticing the child out of the device. On one occasion a child refused to leave the helicopter. Video will be presented showing the data monitoring and acquisition system, which includes gaze coordinates and a multi-window video record of the child's face, the tracked eye, and the screen display with superimposed eye cursor. Data currently being analyzed will be presented representing the effect of training and use of cues on gaze direction. Conclusion: Preliminary results of the feasibility study appear to support the use of an approach of this type with this target population. Novelty: These data represent the first attempt to entice children with ASD to participate voluntarily in training in social attention in a computerized, virtual social environment.

Presence Enhances Relaxation: A Preliminary Controlled Study

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Technologies such as Virtual Reality (VR) that induce presence in a virtual, but still external, perceived world, have great power to evoke emotional experiences that can lead to psychotherapeutically valuable changes in the individual. This reflects the power of presence – seen as the feeling of being located in a perceived, external world – in developing and affecting psychological wellbeing (1). In this sense the feeling of presence allows VR to play an important role in clinical psychol-

ogy, that is expected to increase in the next years (2,3). Until today Virtual reality Environments (VEs) have been incorporated into a variety of clinical and everyday settings to improve mental health and to enhance well-being. Nonetheless many areas in the health field can be still explored using this innovative technology. One example is represented from stress management area, one of the leading mental health problems of western societies linked to several pathologies (4). Following this trend our proposal is to investigate the correlations between the feeling of presence induced by different media and the relaxation process. More in detail, the specific goal of this study is to compare the effectiveness of different media- characterised from different level of presence - coupled with an adequate relaxing protocol in producing emotional modifications. In a controlled studies we compared three different media: Immersive VR (experienced with head-mounted display and head-tracking), DVD (video with relaxing music) and Audio speaker, using the same therapeutic narrative and protocol. A control group without treatment was also included in the study. The sample included 64 university students, randomly divided in the four experimental conditions.

Qualitative and quantitative measures have been used: The *Positive and Negative Affect Schedule* (PANAS) to measure the positive and negative affects (4); The *State Trait Anxiety Inventory* (STAI) to measure the level of anxiety (5); The *ITC-SOPI Presence Questionnaire* to evaluate the level of presence (6); Different physiological parameters (RES, HR, SC). Non parametric test and correlation were used to analyse self-reports and physiological parameters. Within groups analysis - in both VR and DVD conditions - showed a significant increasing of positive emotional state (relaxation), a reduction of negative emotional state (anxiety) and significative physiological changes in respiration rate, heart rate and skin conductance parameters. No significant differences were found from the between groups analysis. This results appear coherent with data referred to correlations between sense of presence and changes in anxiety and emotional state. Considering both the whole group of participants and the four conditions separately, results indicate that the sense of presence experienced from the subjects during the experiment could play a critical role in enhancing the effectiveness of the treatment. In particular ecological presence and engagement, from ITCSOPI Inventory, reveal good correlations with anxiety reduction and relaxation increasing. Further reflections about sense of presence in relaxing virtual environments will be discussed.

Narrative vs Environment: The Role of Media Content in Emotional Induction

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It is well known that media may induce strong emotions. But what are the features of media that are critical in the process of emotional induction? Typically communication literature separates between media form and media content (1). On one side with Media Form we refer to physical, objective properties of a display medium. On the other side we use the category Media Content to refer to the overall theme, narrative or story depicted via a display system. In this research we focussed our analysis on media content: we evaluated the effects of two dimensions of media content - narrative and environment – on emotional induction. In particular, the goal that drove this study was the analysis of the impact of environment and narrative on user's emotions in two different moments: during a virtual reality experience and after it. We manipulated a virtual reality experience using a mixed 2x2 experimental design. More precisely we created two different virtual environments (island and canyon) that were explored by the sample after being exposed to two different narrative backgrounds (positive: the stay on the island/canyon was the prize of a game; and negative: the stay on the island/canyon was the result of a natural disaster). In all the groups the goal of the experience was to escape from the environment by finding a boat guarded by a man. The sample included 80 females with age ranging from 20 to 26 years (M=23+/-1.4), randomly assigned to the four conditions. Dependent measures were the emotional

state of the subject and the level of presence perceived. In particular both qualitative and quantitative measures were used:1) Emotional state: The *Positive and Negative Affect Schedule* (PANAS) (2); *Visual Analogue Scale* (VAS) (3); State dimension of *State Trait Anxiety Inventory* (STAI) (4); Different physiological parameters (Respiration Rate, Heart Rate, Heart Amplitude, Skin Conductance); 2) Presence: The *ITC-SOPI Presence Questionnaire* (5). All these measures were taken at two different times: pre and post the virtual experience. The data from the measures were not normally distributed. So we used in our statistical analysis non parametric tests only. The results highlighted the influence of both narratives and environments on the users' emotions. Main effects: 1) Narration on emotions: the negative narrative had a significant effect on negative emotions and vice versa; 2) Environment on emotions: the experience of the island ("positive" environment) induced an higher level of relax and a lower level of sadness than the one of the canyon ("negative" environment); 3) Environment on presence: the experience of the island induced an higher sense of presence than the one of the canyon. Correlations: 1) There is a significant positive correlation between the "engagement" presence scale and the "positive affect" scale of PANAS; 2) There is a significant negative correlation between the "negative effects" presence scale and the "positive affect" scale of PANAS; 3) There is a significant positive correlation between the "negative effects" presence scale and the "negative affect" scale of PANAS. These data underline the influence of both dimensions of the media content on the emotional experience during a virtual reality session. This result may be critical for the future development of applicative virtual environments because shifts the attention of the developer of both features of media content: on one side, a good clinical protocol may be enhanced by an engaging virtual environment; on the other side, an engaging virtual environment may be enhanced by a meaningful narrative background.

Relationships Develop in Chat: A Web Research

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Today Internet represents a social device that modifies people communication and interaction. The literature about management of personal relationships present conflicting claims. Several studies suggest that these types of relationships are more limited compared to face-to-face relationships. From a different perspective, Joinson (2001) in examining the importance of disclosure, argues that, at the beginning of relationships, disclosing oneself to a new person causes a sensation of trust that enables the interlocutor to disclose in turn. According to this approach, Suler (2004) speaks of the on-line "disinhibition effect." Within this frame, the current research, carried out in a substantially descriptive design, aimed to consider psychological and social features of a particular electronic environment, the Chat room. Basic questions concerned to understand the principal features of online relationships and whether there was a prevailing personality type and a predominant value that drove the behaviors of individuals in Chat. To investigate what kinds of relationships Chat users develop in this environment, the present research referred to relevant studies in this field). An on-line questionnaire set was developed, designed to investigate the personality traits and the prevailing interpersonal values of those participants who set up interpersonal relationships online. The Web research showed that, if sampling control and validity assessment were provided, it could be a valid alternative to a more traditional paper-based procedure. The sample included 158 participants directly recruited in Chat or by e-mail messages and paper messages posted in the main Universities of Milan and by advertisement of the site in the most important Italian searchers. All voluntarily chose to participate and filled out the online questionnaire, composed of four sections: Section one focused on conventional socio-demographic variables of the participants and their employment of Internet and Chat in terms of time; 2) Section two analyzed the level of development of on-line relationships using a specific instrument

"Development of online relationships" (DOR), created by Parks and Floyd; 3) Section three was formed by Italian version of the Eysenck Personality Inventory (EPI), which aimed to examine some personality traits of the participants; 4) Section four aimed to assess the most important clusters of values through the Italian version of Survey of Interpersonal Values (SIV). The analysis carried out included a factor analysis to evaluate the Italian version of DOR questionnaire, several analysis of variance and correlations. The results highlighted that Chat users created deep on-line relationships and they found in Chat a suitable room to disclose themselves. They turned out to form a heterogeneous group of persons who showed some prevalent attitudes. Results put into evidence that Chat users were quite close, fairly introverted, basically nonconformist and independent, rather selfish and self-biased, needing of being supported and encouraged, although they, on the whole, did not reach pathological levels for any personality traits. The data, herein gained, underline that deep relationships developed on-line remained limited to the virtual world. Further research is needed to deepen the nature and the thickness of the border between virtual (Chat) and real relationships.

Virtual Reality Assisted Treatment of Public Speaking Anxiety

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Social phobia is defined as fear of performing in front of people. This is exacerbated when these people are strangers, or are critical. Social phobia can take the form of public speaking anxiety, eating in a public place, talking to people in power, etc. Onset of social phobia typically occurs during adolescence or early adulthood and usually affects school performance, ability to create social networks as well as intimate relationships and the ability to work. This study focuses on a specific social phobia, *public speaking anxiety*, as this disorder causes a considerable degree of difficulty for many people, especially for university students. Research has found that cognitive-behavior therapy is superior to other therapies. A major factor is exposure, with in-vivo exposure superior to imagined exposure. Employing exposure via virtual reality overcomes the difficulties of employing in-vivo and imaginal exposure and conserves resources. The advantages of VR therapy, over imagery therapy, are especially relevant for people who have difficulty imagining situations vividly, or for those who avoid remaining focused in the imagined fearful situation. In addition, the therapist has full knowledge of and control in VR over exposure to the simulated environment enabling the client to deal with relatively controlled levels of anxiety . The aim of this study was to determine whether virtual reality therapy is an efficient method of therapy for public speaking anxiety , and to compare it's efficacy to traditional cognitive behavior therapy. Forty-nine University students and staff who experienced public speaking anxiety participated in this study. After a brief psychiatric screening, they filled out three pre-treatment questionnaires (Fear of negative evaluation – FNE; Liebowitz Social Anxiety Scale – LSAS; Self Statements During Public Speaking – SSPS), and were randomly assigned to one of three groups: Virtual Reality with Cognitive-Behavior Therapy (VRCBT), Cognitive-Behavior Therapy (CBT), and Wait-List control (WL). Treatment lasted 12 weekly one-hour sessions. Upon completion of treatment, they filled out the same three questionnaires. The wait-list control subjects were assigned to one of the treatment groups following the 12 week wait period. The three groups were compared on improvement as measured by the three questionnaires. The three questionnaires yielded six anxiety and coping measures (FNE fear, LSAS avoidance, LSAS fear, SSPS coping, SSPS fear, SSPS total). On all measures the reductions in fear and avoidance and increase in coping was largest for the VRCBT group compared to the WL and to the CBT group. VRCBT proved to be significantly more effective than WL on three measures (LSAS avoidance, SSPS coping and SSPS total) and significantly more effective than CBT on one (SSPS coping). These results indicate the uility of using VR for the treatment of public speaking anxiety.

Simulations and Peer Relational Aggression: A Measurement of Pre-Service Teacher's Perceptions

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Social simulations are becoming an important research tool for educators. These simulations can be used to study a variety of areas from emotions to training. This study examines clinical assessments of emotional states of pre-service teacher's (N = 515) perception and problem solving related to a simulation of a peer victimization incident on a playground. Open ended responses are used to investigate perceptions and problem solving. Participants were asked to respond to this situation as if they were the teacher, and these responses were then coded and analyzed. Consistent with other literature, the participants expressed perceptions were neutral and little focused was place on problem solving, or management of the situation with the victim. Future direction and educational implications are presented.

A Virtual Reality Application for Stroke Patient Rehabilitation

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Virtual Reality (VR) has been shown to be a promising intervention technique to improve motor function in individuals with stroke and other neurological disorders. VR can provide an effective human computer interface, allowing users to interact with a virtual environment (VE) to experience simulated worlds comparable to the real world [1], using various VR peripherals, e.g., data gloves. VEs can provide stimulating audiovisual feedback that promote motor learning and enhance participation in a rehabilitation process. VR based interventions allow the rehabilitation professional to shape the VE and desired tasks according to the abilities of the individual client. This customization of the VE can better engage the client in the treatment session and provide appropriate feedback in order to maximize motor learning. This research in progress involves the development a VR software application that is: (1) readily customizable to individual client needs, (2) provides a highly immersive environment where the client can safely practice common ADLs and improve the motor function required for these activities, while (3) providing quantitative data for the therapist to identify movement limitations and dysfunctions and assess the effectiveness of the VR-based physical therapy intervention. 3D-Studio Max is used to model all objects and animations used by the application and Virtools Dev 3.5 is used to present the VE to the client and regulate the VE behavior. The resulting content is scalable in the sense that it can be delivered to clients via a web browser, a head-mounted display (HMD), or projected onto highly immersive CAVE-like displays. Multiple VE's are being designed to accommodate a variety of activities of daily-living (ADL) and to allow a therapist to customize the associated interventions for each client. In addition, the ability to gather real-time motion capture data allows a therapist to quantitatively document change and to better assist in the diagnosis of movement dysfunction. Client motion is tracked using devices such as a Polhemus FASTRAK system or a ViconPeak MX-series camera-based system. Joint angle data is captured as clients complete specified ADL-related tasks within the VE, e.g., making a virtual cup of coffee within a kitchen setting. Client motion is visualized using virtual limbs that provide patient feedback within the VE. Associated motion capture data is logged in a backend data that can be used to monitor/ document client progress over time. This data can be used as a goal setting tool, allowing the practitioner and client to set goals in terms of range of motion and to verify when these goals have been met. The data collected also provides a way of demonstrating the effectiveness of treatments, which may prove beneficial for insurance purposes. Lastly, the data can be used as a diagnostic tool identifying movement limitations and abnormalities. The application under development has the potential to be a motivational tool for different demographics. For example, children and young adults may engage

more fully in the treatment sessions employing VE's that are more game-like. The scalability of the application also offers the potential to be used in future tele-therapy applications.

From SIT to PTSD: Developing a Continuum of Care for the Warfighter

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The Virtual Reality Medical Center (VRMC) is currently conducting Stress Inoculation Training (SIT) and Posttraumatic Stress Disorder (PTSD) treatment for the United States Navy and Marine Corps, the combined result being a program that supports a *continuum of care* for troops. With SIT, very high stress and cognitive load situations not often encountered in real life can be created in the simulation environment. These scenarios, combined with physiological monitoring, allow military personnel to train themselves to better process stress through techniques such as breath retraining and relaxation. In this way, cognitive skill hardening can be achieved. It is our hope that SIT will help prevent or reduce rates of PTSD in returning troops. Another study that we are conducting entails the development and testing of Virtual Reality (VR) therapy for those returning from Iraq. This VR PTSD treatment program is currently in use at Naval Health Medical Center in San Diego and Marine Corps Base Camp Pendleton. By placing a patient in a virtual Iraqi war setting, and then having him or her slowly experience that situation in a controlled way, the patient should begin to habituate to his or her specific PTSD symptoms and come to reappraise the situation, allowing emotional processing to fully occur. Though the study, funded by the Office of Naval Research (ONR), is incomplete, initial pilot testing indicates that VR therapy produces both subjective (self-report) and objective (physiological) arousal in individuals suffering from PTSD. Finally, we have also deployed a VR system to Iraq under a program funded by the United States Army's Telemedicine and Advanced Technology Research Center (TATRC), with the goal of allowing for the earliest possible intervention and treatment of PTSD.

Developing Objective Metrics for Training Transfer Through the Use of Virtual Environments

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The Virtual Reality Medical Center (VRMC) is exploring training transfer through the use of virtual environments. Currently, VRMC is conducting Stress Inoculation Training (SIT) for the U.S. Army's Aeromedical personnel at Fort Rucker. With SIT, military personnel "experience" highly stressful situations in a virtual environment while being physiologically monitored. SIT participants are then trained how to better process stress through techniques such as breath retraining and relaxation. In this way, cognitive skill hardening can be achieved. SIT is intended to help prevent or reduce rates of Posttraumatic Stress Disorder (PTSD) in returning troops. Furthermore, VRMC is conducting a study, funded by the U.S. Army's Telemedicine and Advanced Technology Research Center (TATRC), to test the efficacy of virtual training in preparing combat medics for real-life combative medical scenarios. This endeavor is an extension of VRMC's Student State Report, a three-year study (completed in July 2005) sponsored by the Defense Advanced Research Projects Agency (DARPA), which proved the effectiveness of a low-fidelity laptop simulator to train military personnel. The 970 participants were a combination of elite units of the U.S. Navy, U.S. Marine Corps, and U.S. Coast Guard. The objectives of the investigation were to examine the effectiveness of virtual reality training simulators in their ability to teach personnel tactical and trauma care skills, enable them to practice stress management techniques, and to improve performance during real-life combat situations. The test group first received training in a virtual combat scenario while their stress and arousal levels were monitored through non-invasive physiological means. The control group did not receive virtual training. Afterward, all participants were tested in a real-world version of this same combat scenario to determine the effectiveness of train-

ing in a virtual environment. The study proved virtual reality training to be an extremely effective and efficient method of preparing military personnel for combat situations.

A Study of Gambling Using a Virtual Casino

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Research Status: The study reported here has been completed, but it is part of a larger program of ongoing research studying gambling pathology using a virtual casino. Background/Problem: As the legalization of gambling continues to spread, addiction to gambling has become a greater social problem. The study of gambling behavior and pathological addiction is hampered by the ecological validity of laboratory studies that do not adequately simulate the natural environment; for many gamblers craving-to-gamble is strongly provoked by the ambience of a casino. Our previous research has shown the utility of VR for assessing craving among drug abusers, so we examined the impact of immersion in a VR casino on pathological gambling. Method/Tools: A virtual casino was created using 3D Game Studio (Conitec). Two of the games (blackjack and slot machines) displayed in the casino are interactive. A startup interface enables the experimenter to preset a number of variables, including the win/loss ratio for a sequence of random plays on the slot machines, payoff amounts, the individual cards dealt to player and dealer, or the icon display on 12 slot machines. Thirty-five problem gamblers, as defined by the DSM-IV checklist for gambling pathology, were recruited from the undergraduate population at Carleton University in Ottawa, Canada. Ostensibly, the machines were programs with the 40% payout rate of a local casino. In actuality the slot machines were pre-programmed to win or loose in a particular sequence. Specifically, half the participants lost $6 of their initial $10 seed money, whereas the other half won an additional $6. Subjective level of craving to gamble was obtained after the 2nd and 18th of 20 spins using a screen overlay rating scale (0-100) which asked "*How strong is your urge to gamble?*" As participants were aware prior to arrival at the laboratory that the session involved gambling, baseline craving was assessed with a random phone call two weeks after the laboratory session. Results: The results, displayed in Table 1 below, demonstrate that the VR simulation was able to significantly increase craving to gamble in problem gamblers ($p < .001$). This effect was qualified by a significant interaction effect of win/loss by time on craving rating ($p = .02$). As expected, winning caused craving to increase more than loosing, especially as gambling persisted up to the 18th spin.

Condition	Baseline	After 2nd spin	After 18th spin
Win	33	62	75
Loose	38	55	54

Table 1. Subjective Rating of Craving-to-Gamble for Problem Gamblers

Conclusion: A virtual casino was used successfully to provoke craving in pathological gamblers. This effect was heightened following a winning sequence. Novelty/Discussion: To our knowledge this is the first use of a virtual reality simulation to study gambling behavior in pathological gamblers. The flexible user-interface and configuration wizard allows experimenters to preset a variety of variables to manipulate the wins and losses for either slot machines or blackjack games and thus control the gambling outcome of the experiment, unbeknownst to the subjects.

Addressing Cognitive and Sensorial Component of Phobias

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Therapies in virtual reality allow to address both the physiological and cognitive components of anxiety disorders. It provides indeed an exclusive way to access separately these two components. The aim of this study was to assess the rate of change on clinical, cog-

nitive, behavioral and sensory variables during exposure therapy in the treatment of space-related anxiety. We recruited 10 phobic patients (4 patients with acrophobia, 2 with agoraphobia and 4 with claustrophobia) who followed a therapeutic trial composed of 3 phases. The protocol consisted of one session per week during 10 weeks. During these sessions, patients were equipped with a head-mounted display coupled with an electromagnetic sensor system and immersed in different virtual environments. The first phase was proposed to provide habituation to the sensorial conflicts inherent to the technique (latency, sensorimotor inconsistency). Three kinds of virtual environments with different sensory information were used (one per session). The objective of the three first sessions is to reduce cybersickness usually experienced at the beginning of the therapy and to improve the level of presence (an important concept which contributes to the effectiveness of the therapy). The second phase consisted in exposure to three environments containing features generating anxiety in different phobias. The chosen environments did not represent the feared situation as described by the patient, but could potentially generate anxiety as they deal with space. The aim was to treat the anxious reactions in situations different from those dreaded. The third phase represents a more classic progressive exposure to the fearful situation. The aim was mainly to address the threat-related beliefs and behaviors. The post-treatment evaluations (Global state, Quality of life, Handicap, Behavioral Avoidance, Fear questionnaire) showed an improvement in overall functioning of all of the measures. The present study suggests therefore that both cognitive and sensorial components addressed through the interaction with different virtual environments contribute to the beneficial effect of virtual exposure.