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Cognitive Behavioral Therapy for Problematic Video Game Players

Transfer of Spatial Knowledge from Virtual to Real Environment

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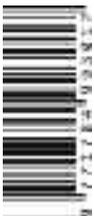
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Wounds of War II: Coping with Posttraumatic Stress Disorder in Returning Troops

EDITED BY:

Professor Dr. Brenda K. Wiederhold, Ph.D., MBA, BCIA

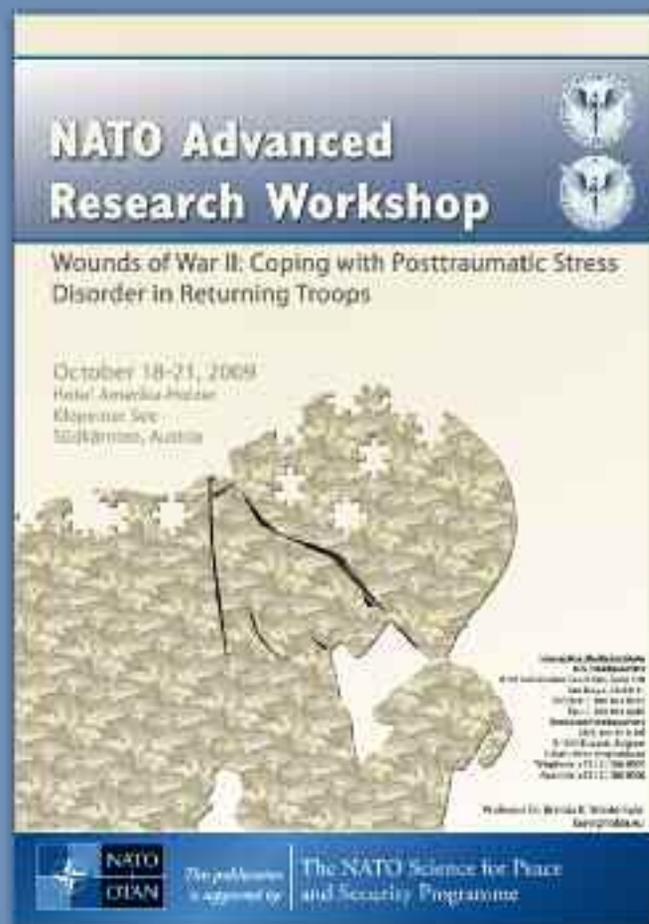
WOUNDS OF WAR II: COPING WITH POSTTRAUMATIC STRESS DISORDER IN RETURNING TROOPS

On October 18-21, 2009 the NATO Advanced Research Workshop 'Wounds of War II: Coping with Posttraumatic Stress Disorder in Returning Troops' drew 30 eminent experts from 14 countries to discuss the impact of war-related stress on participants from current and past conflicts, particularly when it results in increased risk and incidence of PTSD. Held in Klopfener See, Südkärnten, Austria at the Hotel Amerika-Holzer, discussion topics included increased PTSD as a result of missions, as well as how PTSD may be prevented. Often thought of as an "invisible wound of war," PTSD may manifest in very visible ways, affecting behavior, relationships and society. The ultimate aim of the workshop was critical assessment of existing knowledge and identification of directions for future actions. The co-organizers of this workshop alongside Professor Brenda K. Wiederhold included Professor Kresimir Čosić and Professor Dragica Kozarić-Kovacic of Zagreb, Croatia and Colonel Carl Castro from the United States.

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The post-conference book reflects the key topics discussed in the five sections at the workshop:

First Session – Vulnerability

Second Session – Diagnosis and Assessment

Third Session – Training and Treatment

Fourth Session – Technology-Based Training and Treatment

Fifth Session – PTSD and Comorbidity

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Interreality in the Management
and Treatment of Stress-Related Disorders

INTERSTRESS
is a European-funded project
Instrument: CP —
ICT Grant Number FP7-247685



The INTERSTRESS project aims to design, develop and test an advanced ICT-based solution for the assessment and treatment of psychological stress.

Objectives:

- Quantitative and objective assessment of symptoms using biosensors and behavioral analysis
- Decision support for treatment planning through data fusion and detection algorithms
- Provision of warnings and motivating feedback to improve compliance and long-term outcome

To reach these goals, INTERSTRESS will use a new e-Health concept: Interreality. What is Interreality? It is the integration of assessment and treatment within a hybrid, closed-loop empowering experience, bridging physical and virtual worlds into one seamless reality.

- Behavior in the physical world will influence the virtual world experience
- Behavior in the virtual world will influence the real world experience

These goals will be achieved through:

- 3D Shared Virtual World role-playing experiences in which users interact with one another
 - Immersive in the healthcare centre
 - Non-immersive in the home setting
- Bio and Activity Sensors (from the Real to the Virtual World)
 - Tracking of emotional/health/activity status of the user and influencing the individual's experience in the virtual world (aspect, activity, and access)
- Mobile Internet Appliances (from the Virtual to the Real world)
 - Social and individual user activity in the virtual world has a direct link with the users' life through a mobile phone/PDA

Clinical use of Interreality is based on a closed-loop concept that involves the use of technology for assessing, adjusting and/or modulating the emotional regulation of the patient, his/her coping skills and appraisal of the environment based upon a comparison of the individual patient's behavioural and physiological responses with a training or performance criterion. The project will provide a proof of concept of the proposed system with clinical validation.

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EDITORIAL

We are pleased to bring the Fall 2010 issue of the Journal of CyberTherapy & Rehabilitation (JCR) to our expanding audience around the world. Our quarterly published peer-reviewed academic journal explores the uses of advanced technologies for therapy, training, education, prevention and rehabilitation. JCR continues to actively focus on the rapidly expanding worldwide trend of applying groundbreaking technology towards the field of healthcare.

To educate our readers on new advancements in fields such as robotics, adaptive displays, E-health, virtual reality (VR) and non-invasive physiological monitoring as they are applied to diverse disciplines in healthcare, we present comprehensive articles submitted by preeminent scholars in the field. This issue includes topics such as the creation of a virtual aquatic world to aid in education and using night vision during operations to possibly allow greater VR immersion for patients while in surgery.

In the first article of this issue, Wrzesien presents a pilot evaluation of a virtual interactive learning system aiming to teach children about the Mediterranean Sea and relevant ecological issues. The author also considers ways to improve the software after receiving preliminary feedback.

Next, King, Delfabbro and Griffiths show the reader how cognitive-behavioral therapy might be employed to treat addicts of video games and discuss preliminary treatment techniques for such an addiction.

Thirdly, Rodrigues, Sauzéon, Wallet and N'Kaoua present a study comparing subjects' spatial performance on a pedestrian route based on the type of learning environment, real or virtual, the exploration mode used during the learning phase and the type of spatial test administered at retrieval. Through this study the authors hope to further encourage the development of virtual training and rehabilitation programs.

In the fourth article Cowan et al. discuss a serious game for the purpose of teaching orthopedic surgery residents a total knee arthroplasty procedure using a problem-based learning approach. The study assessed user perceptions of the game's ease of use and potential for learning and engagement.

In the following article, Stadie et al. examine the differences in efficacy of reconstructing a 3-D arrangement of objects presented as a real model, a magnetic resonance image (MRI) or a VR model. The findings were then applied to real life scenarios aiming to optimize the visual basis for anatomy training and surgery planning.

In the sixth article, Mosso et al. present results of surgeries performed on rabbits using night vision goggles and list ways in which this could benefit patients in the future, such as allowing for greater immersion and distraction during operations using VR in a dark room.

Lastly, Tse and Ho address the management of chronic pain in the elderly population, focusing on a non-pharmacological method known as multisensory stimulation therapy.

While continuing to provide our readers with the latest scholarly studies presented in an informative and engaging medium, we will continue to offer the newly added Continuing Education quiz (see page 337 for more details) each issue. In addition, we will now be bringing the readers book reviews, the first of which appears in this issue on page 334, discussing "Interface Fantasy: A Lacanian Cyborg Ontology" by André Nusselder.

Although JCR has been receiving international attention from peers, international institutions and international conferences for some time, we are excited to inform readers that JCR is also continuing to become more widely known and recognized by the scientific community, as evidenced by the fact that it is now indexed with PsycINFO, Elsevier, Cabell's, Gale and EBSCO. This recognition will further our cause to inform the wider

community about ways in which healthcare can benefit from the applications of advanced technologies.

I would like to take this opportunity to sincerely thank the contributing authors for their inspiring work and dedication to this field of research. I also want to as always thank JCR's Associate Editors – Professors Botella, Bouchard, Gamberini and Riva for their leadership and hard work, as well as our internationally renowned Editorial Board for their contributions. Thank you also to our outside reviewers for taking the time to ensure the rigorous nature of the articles.

As always, we welcome your submissions, comments, and thoughts on innovation.

Lastly, I would like to recognize what a huge success our 15th CyberPsychology & CyberTherapy Conference, held in Seoul, Korea in June, was. As you know, JCR is one of the two official journals of the International As-

sociation of CyberPsychology, Training & Rehabilitation (iACToR). The annual international conference series agreed, in 2009, to become the official conference of iACToR. So, along with CyberPsychology, Behavior, & Social Networking Journal (CPB&SN), CyberTherapy & Rehabilitation (C&R) Magazine, and JCR, we celebrate our Combined Communications Platform. We are very excited for next year's conference to be held June 20-22 in Gatineau, Canada.

We look forward to the future growth of our cause and thank you, our readers and subscribers, for your continued support.

Brenda K. Wiederhold, Ph.D., MBA, BCIA
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LEARNING ECOLOGY ISSUES OF THE MEDITERRANEAN SEA IN A VIRTUAL AQUATIC WORLD - PILOT STUDY

Maja Wrzesien, David Pérez López, and Mariano Alcañiz Raya¹

The aim of this study is to present a pilot evaluation of the E-Junior application. E-Junior is a Serious Virtual World (SVW) for teaching children natural science and ecology. The application was designed according to pedagogical theories and curricular objectives in order to help children learn about the Mediterranean Sea and its ecological issues while playing. A pilot evaluation on a sample of 24 children showed that students thoroughly enjoyed the virtual learning session, were engaged with, and had fun interacting with the system. Moreover, some suggestions for improvement were given by the participants. The results and their implications are discussed.

Keywords: Interactive Learning Environments, Virtual Reality, Ecology, Serious Games, Children

INTRODUCTION

With climate change and its socio-economical, technical, and environmental impacts, ecological issues have become important topics to teach. Natural science and ecology lessons are often taught to children in the classroom, and the scientific concepts are frequently transferred by a teacher in a conventional way. Although teachers do their best with the available materials, traditional classes of this type do not allow children to interact, observe, or actively explore the environment.

With the development of new innovative technologies, Virtual Reality (VR) systems such as Serious Virtual Worlds (SVW) might be an interesting alternative for some traditional teaching. Certainly, with 3-D graphics and immersive, interactive environments, children can be easily transported from a habitual room space to another world such as the Mediterranean Sea underwater environment. Moreover, the introduction of the gaming aspect in such technologies might bring an additional value. Indeed, in recent years it has been recognized that computer games are enjoyed by millions of people around the world and that they have become an integral part of our social and cultural environment (Oblinger,

2004). Even though there are numerous fields of computer game applications, successful computer games all have one important characteristic in common - the capacity to draw people in (Janett et al., 2008). This effect is hard to achieve for a teacher during the traditional teaching process. Indeed, student motivation continues to be one of the most difficult aspects of teaching (Ames, 1992). Thus, introduction of the gaming aspect in the applications for educational purposes might be an interesting option to consider.

The ability to engage people while playing computer games composed with the educational applications can be found in the systems such as Serious Games (SGs) and SVWs. SGs and SVWs are two of the technologies that have proven to be potentially effective educational tools in numerous application domains (Cai et al., 2003; Holzinger et al., 2006; de Freitas, 2006; Lai-Chong Law et al., 2008). More specifically, games used for educational purposes represent a powerful and effective learning environment for a number of reasons (Kebritchi & Hirumi, 2008):

– Games use actions instead of explanations and create personal motivation and satisfaction.

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– Games reinforce skill mastery and accommodate multiple learning styles and abilities.

– Games provide a context for interactive decision-making.

Therefore, from a research point of view, it is relevant to study the ways in which the SVW could be an effective tool to engage and satisfy students. This study presents a pilot evaluation of the E-Junior system, which aims at promoting interest among children to learn about the Mediterranean Sea and to protect it.

E-JUNIOR

The goal of E-Junior is to introduce children to the basic notions of natural science and ecology of the Mediterranean Sea, and more particularly, to one of the ecosystems of the Mediterranean Sea - *Posidonia oceanica* (a marine plant that grows only in the Mediterranean Sea and that is considered to be of great importance to the environmental conservation of the region). The purpose of the system is to encourage active learning within a highly immersive and interactive environment in a fun, innovative, and easily accessible way. Children have the opportunity to discover information about the *Posidonia oceanica*, engage themselves in collaborative and competitive play, and test their understanding about the scientific concepts that are explained. More specifically, students participate in photosynthesis, they distinguish among different types of animals, sea grass, seaweed and plants, and they judge the positive or negative actions that human beings can have on the ecosystem (see Figure 1).



Figure 1. Students interacting with E-Junior.

Each part of the game is constructed with: (a) a theoretical introduction to the scientific concept that is presented by the virtual tutor, which is a fish that represents the Brown Grouper species; and (b) an interactive-gaming part. To successfully complete each interactive-gaming part, the students must find and collect some elements in the aquatic virtual world according to the rules previously established by the virtual tutor.

The game runs on Intel Core 2 Duo E6000, 2 GB RAM and Geforce 8600 GTS 320 MB computers. The hardware corresponds to stereoscopic projection screens, tracking cameras, and projectors placed in a 6x5-meter room (see Figure 2). Each child uses polarized glasses to perceive a scene stereoscopically and utilizes paddles with an augmented reality (AR) marker to navigate in the aquatic world.

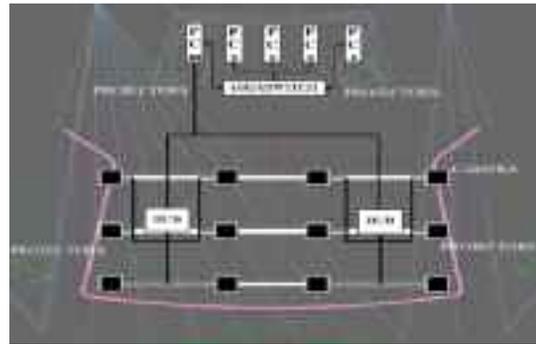


Figure 2. Hardware configuration.

Each student is assigned a fish avatar (a paddle with an AR marker) that represents a different species of fish - Sea Bream, Mediterranean Rainbow Wrasse, Ornate Wrasse, and Painted Comber. With these avatars, each student can explore, experience, and interact with the virtual aquatic world. The Brown Grouper guides the students through the different stages of the game.

Since the literature calls for the use of learning and instructional theories in educational game design (Kebritchi & Hirumi, 2008), E-Junior has integrated the following pedagogical foundations. The first pedagogical foundation was the experiential learning theory of Kolb (1984). The purpose of experiential learning theory is based on engaging learners in direct experience. In E-Junior, players assume the role of Mediterranean Sea inhabitants (fish) and participate in the usual activities of the Mediterranean Sea (i.e. collecting elements in the aquatic virtual

world such as photons, carbon dioxide, oxygen, nitrogen, and phosphorous, and judging the positive or negative actions that human beings can have on the ecosystem, etc.). In this way, children experiment directly with the ecological issues in the Mediterranean Sea.

The second pedagogical foundation was the De la Cruz theory of leisure as an educational tool (2002). This theory defines leisure as an activity that not only improves the knowledge of the learners but one that also lets them gain self confidence, define themselves in relation with others, and connect with each other. By the collaborative and competitive character of E-Junior, this SVW allows players not only to learn and to discover their potential and skills during the game but also to compare them with other players while competing, and to share during collaborative play.

The third pedagogical foundation was Gardner's multiple intelligence theory (1983). According to Gardner, two types of intelligence are the ones most evaluated in schools: (a) logical-mathematical and (b) linguistic intelligence. However, the author considers that there are five other types of intelligence (musical intelligence, bodily-kinesthetic intelligence, spatial intelligence, interpersonal intelligence, and intrapersonal intelligence) that can be explored as different potential pathways of teaching the same information. Therefore, these aspects were taken into account during the design of the E-Junior application allowing the children to move around the room as fish in the water (to stimulate the bodily-kinesthetic intelligence that involves using the whole body to solve problems), to listen to different sounds while interacting with the environment (to stimulate the musical intelligence that implies the appreciation of musical patterns), to collaborate during the game with each other (to stimulate the interpersonal intelligence that allows people to work with others), and finally, to compete while playing (to stimulate intrapersonal intelligence).

In addition, since the literature calls as well for aligning educational contents of computer games with national curricula (de Freitas & Oliver, 2006; Lai-Chong Law et al., 2008), researchers have integrated the Spanish national curriculum specifications (2005) for the third cycle of primary school (10-12 years old) in the E-Junior narratives. More specifically, the curricular specifications for the natural, social, and cultural environment in the Valencian community promote three types of content - first, specific knowledge about the natural, social, and cultural

environment represented by different scientific concepts, second, procedures that teach students to know how to behave, and third, general attitudes. E-Junior was created taking these objectives into account in order to facilitate the execution of educational curricula.

METHOD

PARTICIPANTS

The participants for this study were selected randomly from the list of Valencian primary schools, located on the eastern Mediterranean coast of Spain. The participants for this study were selected in order to form six groups of four children. In total, 24 children participated in this study (10 boys and 14 girls) all aged from 10 to 11 years old. They all attended the sixth grade and had the same learning objectives related to natural science, geography, and ecology. All children gave their verbal agreement to participate in the study. Moreover, the parents of all participants signed a formal agreement form.

MEASURES

The following quantitative and qualitative measures were used in this pilot evaluation: the pre-test questionnaire with questions regarding the biographical information, the post-test feedback questionnaire with the open-ended questions, and the informal observations of children. The questions from the pre-test aimed to obtain students' biographical information such as gender, age, school grade, frequency of computer use, frequency of computer gaming, and enjoyment of computer games. More specifically, the students were asked to write their gender, age, and school grade. The open-ended questions of the post-test feedback questionnaire aimed to obtain students' opinions about positive and negative characteristics as well as improvement proposals for the E-Junior. More specifically, the students answered three questions: (a) what was the thing they liked the most, (b) what was the thing they disliked the most, and (c) what was the thing they would like to improve. The objective of the informal observation of the children was to collect all the possible information that researchers could observe regarding student engagement, attention, implication, enjoyment and other variables considered to be relevant.

For each of the two qualitative measures, the children's answers and the informal observations performed by the researchers were grouped into categories according to their common themes. The categories were created separately by three different researchers, than discussed and

compared in order to create the final categories presented in the results section.

PROCEDURE

The students that participated in the study were chosen from two sixth grade classes from Nuestra Señora de Loreto Valencian Primary School. All the students completed the pre-test questionnaire individually in their respective classrooms, in the presence of the researcher and their teacher. They were then randomly assigned to one of six groups. The week after filling out the pre-test questionnaire, the children participated in the virtual learning sessions (25 minutes) in groups of four on the same day. The AR markers that represented the different fish avatars have been distributed randomly among each group of four. After the virtual learning sessions, each group of children filled out the post-test feedback questionnaire.

RESULTS

POST-TEST FEEDBACK QUESTIONNAIRE

The virtual learning session generally received very positive comments and feedback. The children were clearly pleased with the game. They enjoyed collecting elements to let *Posidonia oceanica* breathe and feed (“[I liked the most] following and catching the oxygen”). Another frequently cited point concerned the interaction with the system. More specifically, the children enjoyed the virtual tutor (the Brown Grouper) and the fish avatars that they could interact with and move through the virtual Mediterranean Sea (“I liked that I could help the fish”). The 3-D effect and the immersive character of E-Junior were also appreciated (“[I liked the most] seeing fish and animals in the water”, “that it was real”). The learning aspect of the application was also mentioned (“[I liked the most] learning about interesting things and how plants live”). Although the children hardly made any negative comments, they frequently mentioned what to them seemed a negative point concerning the length of the speeches made by the virtual tutor (the Brown Grouper). In their opinion, the tutor spoke too much (“[I didn’t like] when the fish was talking and talking to us all the time”, “[I didn’t like] that the fish was talking”). These commentaries were confirmed by the suggestions for improvement made later by the children. The students proposed reducing the speaking time of the fish (“[I would make] the fish stop talking and give us more time to enjoy the game”, “The fish not talk so much”).

OBSERVATION OF THE CHILDREN DURING CLASSES

According to the informal observation of the children dur-

ing the interaction with the game, the students seemed to be deeply absorbed, engaged, and involved. The majority of the students collaborated collectively and helped each other to understand the game rules (“Look at the legend to see what you have to collect”; “You are the photon, you have to go to the right”). Moreover, the children seemed to be quite immersed during E-Junior because they frequently asked if the room was moving and screamed with excitement when the image rapidly changed (i.e. to produce the feeling of immersion into the water). The interaction of the students with the virtual tutor (the Brown Grouper) was also visible and audible. However, their level of attention to what the Brown Grouper was explaining was not very high. Instead of concentrating on the game rules or the theoretical clarifications, the children were running around trying to move their fish avatars and explore the virtual aquatic environment. Generally, the children had a lot of fun. When the virtual learning session was over, they were disappointed when the researcher informed them that the session had ended.

DISCUSSION

This study presents and evaluates E-Junior, a SVW based on pedagogical theories and the curricular objectives of Spanish primary schools. The pilot evaluation showed that the children seemed to be satisfied and engaged in the virtual learning session and had a lot of fun while interacting with the system. According to Prensky (2003) and Lepper et al. (2005), this aspect is crucial during the learning process. This issue should be addressed in the future evaluation of E-Junior. In fact, our ongoing work will consist of evaluating the E-Junior application in a real context. We are planning an experimental two-group comparison design with the virtual learning session as an experimental group and a traditional learning session as a control group. We hope that this evaluation will demonstrate that E-Junior will not only allow students to enjoy the game but also help them learn more about the Mediterranean Sea and its environmental issues.

Although the paper presents a pilot evaluation, the data has already brought to light some interesting information about possibilities for improvement. The most frequent negative comments about the virtual learning session concerned the long concept introduction given by the virtual tutor (the Brown Grouper). Apparently, the children did not appreciate the long description presented before the active form of learning (interactive-gaming part). Thus, some of the lecture parts of the virtual tutor will be transformed into interactive game segments in future versions.

According to observed results children generally appreciate the experience of being emerged in the under-water environment. Thus, from our point of view the applied experiential learning theory in the design of E-Junior was a good choice. In addition, two additional pedagogical theories (De la Cruz theory of leisure as an educational tool, and Gardner's multiple intelligence theory) introduced some interesting points such as collaborative and competitive character of the game. In fact, we can conclude from the observations that the students not only wanted to win (to compete), but also wanted to help each other and collaborate during the game. In our opinion, these positive characteristics reflect the integration of the pedagogical theories during the E-Junior design.

The results of this evaluation have produced some interesting information about the users' interactions with the system. We hope that the planned evaluation will confirm our assumptions and improve the system if there are any issues that decrease the children's level of satisfaction, motivation or learning effectiveness.

CONCLUSION

New, innovative technologies bring many opportunities

REFERENCES

- Ames, C. (1992). Classrooms: Goals, structures and student motivation. *Journal of Educational Psychology*, 84(3), 273-287.
- Cai, Y., Snel, I., Bharathi, B.S., Klein, C., Klein-Seetharaman, J. (2003). *Toward biomedical problem solving in game environment*. Computational Science –ICCS. Springer-Verlag, Berlin, 1005-1014.
- De Freitas, S. (2006). Learning in Immersive worlds. A review of game-based learning. *Rapport prepared for the JISC e-Learning Program* www.jisc.ac.uk/media/documents/programmes/elearninginnovation/gamingreport_v3.pdf
- De Freitas, S., Oliver, M. (2006). How can exploratory learning with games and simulations within the curriculum be most effectively evaluated? *Computers & Education*, 46, 249-264.
- De la Cruz Ayuso, C. (2002). *Educación del ocio: propuestas internacionales*. BILBAO.
- Gardner, H. (1983). *Creating Minds: An Anatomy of Creativity Seen Through the Lives of Freud, Einstein, Picasso, Stravinsky, Eliot, Graham, and Gandhi*. Basic Books.
- Holzinger, A., Pichler, A., Maurer, H. (2006). Multi Media eLearning Software TRIANGLE Case-Study: Experimental results and Lessons Learned. *Lecture Notes in Computer Science* 4556, 559-568.
- Janett, C., Cox, A.L., Cairns, P., Dhoparee, S., Epps, A., Tijs T., & Walton, A. (2008). Measuring and defining the experience of immersion in games. *International Journal of Human-Computer Studies*, 66, 641-661.
- Kebritchi, M., Hirumi, A. (2008). Examining the pedagogical foundations of modern educational

to the field of education. However, the technologies must be carefully chosen and applied in order to help students not only enjoy the aesthetic aspect but also to learn while playing. Indeed, a planned design process (i.e. with respect to the pedagogical theories and curricular contents) is one of the key aspects. Moreover, the evaluations are the best way of confronting the developed application with reality. In this way, by applying the appropriate theoretic foundations and by using children as experimented critics we are sure that the systems will be not only effective but will also provide a lot of fun for players.

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- computer games. *Computers & Education* 51, 1729-1743.
- Kolb, D.A. (1984). *Experiential Learning: Experience as a source of learning and development*. Englewood Cliffs, NJ: Prentice-Hall.
- Lai-Chong Law, E., Kickmeier, D.A., Holzinger, A. (2008). *Challenges in the Development and Evaluation of Immersive Digital Educational Games*. Lecture Notes in Computer Science 5298, 19-30.
- Lepper, M.R., Iyengar, S.S., Henderlong Corpus, J. (2005). Intrinsic and Extrinsic Motivational Orientation in the classroom: Age Differences and Academic Correlates. *Journal of Educational Psychology* 97(2), 184-196.
- L.O.G.S.E. (2005). Accessible on line: <http://members.tripod.com/educac/legislac/logse.htm>.
- Oblinger, D. (2004). The next generation of educational engagement. *Journal of interactive Media in Education*, 8, 1-18.
- Prensky, M. (2003). Digital game-based learning. *ACM Computers in Entertainment* 1(1).

COGNITIVE BEHAVIORAL THERAPY FOR PROBLEMATIC VIDEO GAME PLAYERS: CONCEPTUAL CONSIDERATIONS AND PRACTICE ISSUES

Daniel L. King¹, Paul H. Delfabbro¹, and Mark D. Griffiths²

Cognitive-behavioral therapy (CBT) is rationalized to be a highly appropriate treatment modality for problem and addicted users of video games. Drawing on available empirical research in this and allied areas (e.g., problem gambling), this paper presents some preliminary treatment techniques that may be well suited to the known features, correlates, and consequences of video game addiction. These techniques involve monitoring video game use, setting appropriate goals, and overcoming problem cognitions that intensify and maintain video game use. Specialized knowledge of the structural and situational characteristics that develop and maintain problem video game playing is also provided. While problem video game playing appears to resemble pathological gambling in many ways, some distinct phenomenological aspects of video game playing prevent a direct translation of gambling CBT programs to video game players. It is suggested that further research is needed to provide further guidelines and treatment techniques for video game players who suffer problems with their behavior. There is also need for greater funding for more basic and applied research on problem video game players.

Keywords: Video Game Addiction, Problematic Video Game Use, Problem Gambling
Cognitive-behavioral Therapy

INTRODUCTION

Video game playing is an increasingly popular pastime among adolescents and adults around the world. However, a growing body of psychological literature reports that there may be some risks associated with very high levels of involvement in video game technology. In numerous studies, including large population survey studies (Charlton & Danforth, 2007; Fisher, 1994; Gentile, 2009; Griffiths, Davies, & Chappell, 2004a; 2004b; Grüsser, Thalemann & Griffiths, 2007; Rehbein, Kleimann & Möhle, 2010) and smaller-sized qualitative investigations (Chappell, Eatough, Davies & Griffiths, 2006; Griffiths, 2000; 2010a; Wood, 2008), a significant minority of video

game players have been identified as problem or dependent users of the technology. These “problem” players reportedly jeopardize work or educational activities, social relationships, and personal well-being in order to play video games for periods up to 80 to 100 hours per week. Some researchers have referred to such high levels of involvement in video games as a form of behavioral addiction, comparable to pathological gambling (Griffiths, 2008a).

Whether excessive video game playing behavior represents a unique disorder or a secondary problem arising from underlying pathologies, such as depression, remains

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a subject of debate (Griffiths & Wood, 2000; Shaffer, 1996; Shaffer, Hall & Vander Bilt, 2000). Irrespective of its formal classification, the growing number of excessive users of video games suggests that it is an issue of significance for clinical and educational psychologists (Griffiths, 2010b). However, to date, there have been very few attempts to provide therapy-related information to meet the demand for psychological services among problem video game players. The position of this paper is that, while academic debate on the legitimacy of technology-based addictions continues, preliminary research and theory may guide the development of therapy techniques for excessive and/or problem video game players.

RATIONALE FOR COGNITIVE BEHAVIORAL THERAPY

The cognitive-behavioral therapy (CBT) approach posits that faulty cognitive processes play a role in the development and persistence of maladaptive behaviors. Some studies have employed CBT techniques to assist problem users of the Internet and computer technology (Orzack & Orzack, 1999; Young, 1999; 2007). CBT has also been used with moderate to high levels of success in treatment studies for problem gamblers, who – at least conceptually – bear numerous similarities to problem video game players (Blaszczynski & Silove, 1995; Ladouceur, Boisvert, & Dumont, 1994; Sylvain, Ladouceur, & Boisvert, 1997; Petry et al., 2006). For instance, Fisher and Griffiths (1995) identified multiple structural similarities between electronic gambling machines and video games (e.g., flashing lights, sound effects, bonuses for skilful play, digital displays of winning scores, etc.). Griffiths (1991) went as far as to argue that some forms of video game playing (i.e., arcade machines) may be considered a non-financial form of gambling.

Some playing differences between gambling and video game playing may have implications for the cognitive component of CBT. Unlike most gambling games, video games are not predominantly chance-based and involve a significant degree of skill and planning. Players of video games must be able to process and respond rapidly to in-game information, while negotiating obstacles, in order to make progress and “master” a video game. The emphasis on player strategy and hand-eye coordination means that a problem video game player is likely to hold rational thoughts and beliefs about video game playing and video game machines¹. While video game players may think that, with sufficient skill and practice, there is a strong probability of being successful at a video game, problem gamblers often hold the mistaken belief that their own chances of

winning in the long term are better than the objective odds of the game (Walker, 1992). Some cognitive therapy strategies (e.g., eliminating erroneous perceptions of the game, commonly used to treat problem gamblers) may therefore be less necessary for problem video game players.

VIDEO GAME ADDICTION

The field of technology-based addictions, including addiction to video games, has garnered significant interest from both the scientific and mainstream media community in the last three decades. However, despite this attention, the field has struggled to overcome a number of limitations and theoretical obstacles. There still exists some disagreement within the health community as to whether behavioral (non-chemical) addictions should even qualify as bona fide addictions. This debate has been complicated by somewhat imprecise terminology. The terms “excessive,” “problem,” “dependent,” “pathological,” and “addiction” have appeared numerous times within the psychological literature on video game players – often without clear definition – leading to some confusion as to what these terms actually refer to. Therefore, it is not surprising that the construct validity of video game-related problems has been questioned. Wood (2008) has asserted that reports of individuals who play video games to the degree that it causes harm and/or conflict do not prove that these players are “addicted” to video games, only that they use the technology as an ineffective strategy for dealing with life problems. In order for video game addiction to be treated as a bona fide “addiction”, Blaszczynski (2008) argues that researchers must identify users who report not only problems resulting from sustained repetitive patterns of use, but also impaired control over their gaming behavior. The lack of clinical data (and overemphasis on the “negative consequences” of heavy video game playing) has led to the view that even the most damaging cases of video game overuse may be attributable to poor time management or underlying mental health issues, rather than a primary problem stemming from video game involvement itself (Wood, 2008).

Arguably, however, the distinction between problem video game playing as a primary vs. secondary disorder is irrelevant from a clinical perspective. All forms of problem behavior, including addiction, are typically associated with co-morbid problems like depression – in fact, it would be unusual if an addict’s only problem was their addiction – and therefore any addicted behavior (or merely excessive behavior) would need to be addressed in therapy. Griffiths (2008) has also argued that, if clinicians can accept patho-

¹ It should be noted that many slot machine players also believe their activity to be highly skilful, and that successful play involves speedy reactions, good hand-eye co-ordination, and forward planning (Griffiths, 1994).

logical gambling as a form of addiction (an addiction that does not involve the ingestion of a psychoactive substance), then why should video game playing as a potential form of addiction be treated any differently? There is no theoretical reason that prevents the criteria for addiction being applied to any and all repetitive and psychologically rewarding behaviors. Debating the merits of the addiction concept as it applies to all activities serves only to distract from the real issue: How does a person become addicted to video games? The relative risk of becoming addicted to an activity may be largely attributed to the inherent properties of the activity and the psychological characteristics of the individual. At a basic population level, it is argued that cocaine is more addictive than gambling, and gambling is more addictive than video game playing (West, 2006). Therefore, video game addiction is no less conceptually sound than cocaine addiction, but the actual risk of any given person becoming addicted to video games is relatively, and significantly, lower.

Despite these conceptual issues, it has been stated repeatedly that many people report technology-based problem behavior, most commonly related to the Internet and/or video games (Griffiths, 1995; 2008b; Kaltiala-Heino, Lintonen, & Rimpela, 2004; Nalwa & Anand, 2003). Researchers have proposed a set of diagnostic criteria for addiction to the Internet as a type of impulse control disorder (Beard & Wolf, 2001; Shapira et al., 2003). More recently, a report by the Council on Science and Public Health (see Khan, 2007) recommended that "Internet/video game addiction" be considered by the American Medical Association for inclusion as a clinical diagnosis in the upcoming DSM-V. Addiction to the Internet is arguably a more imprecise concept than video game addiction, given the Internet may be used for many different purposes and activities, including gambling, social networking, browsing, and so on, and thus the Internet may simply enable and facilitate other addictions rather than being the root of the problem behavior. Internet-based disorders have not been officially recognized by either the American Medical Association or the World Health Organization. Despite this setback to technology-based addiction becoming a generally accepted concept, numerous studies of users of mobile phones (Bianchi & Phillips, 2005; Park, 2005; Beranuy, Oberst, Carbonell & Chamarro, 2009), social networking sites on the Internet (Song, Larose, Eastin, & Lin, 2004; Wilson, Fornasier & White, 2010), television (McIlwraith, 1998; Horvath, 2004) and video games (Fisher, 1994; Rehbein et al, 2010) have been conducted on the assumption that the standard

clinical criteria of addiction may be applied to these technological activities.

The precise definition of what constitutes "problem" involvement in video games and other technologies is not just an issue of concern for empirical researchers. Clinical and educational practitioners also encounter difficulties in conceptualizing a client's excessive video game playing behavior. In some cases, a person (or someone close to that person) may seek assistance to deal with an unmanageable video game playing habit (no other life problems or psychopathology are evident). In more complex cases, a person's video game overuse may represent just one of many problem behaviors associated with, and triggered by, an underlying psychological problem. Some research has characterized excessive video game players as persistent procrastinators and time-wasters (Funk, Chan, Brouwer, & Curtiss, 2006), as social loners who prefer online interactions to real life relationships (Chappell et al., 2006), and as depressed/anxious individuals seeking an escape from their problems (Colwell, Grady, & Rhaiti, 1995). However, some authors have noted that excessive video game playing does not always lead to negative detrimental effects and in some circumstances may be socially beneficial for the players – at least in the relatively short term (Cole & Griffiths, 2007; Griffiths, 2010a). These different player profiles – both positive and negative – suggest that there may be various routes to becoming a problem user of video games, in a similar way that Blaszczynski and Nower's (2002) pathways' model has identified multiple routes to problem gambling. However, while empirical studies have found that players report a range of motivations to play particular video games (Griffiths, 1997; King & Delfabbro, 2009b), any such problem video game player typologies have not been examined empirically.

Demographic research suggests that single males, in mid-adolescence to late-twenties, with computing experience, may be at the highest risk of developing a problematic habit with video games and/or other technologies (Griffiths, Davies, & Chappell, 2004a). However, the precipitating factors that lead to addictive involvement in video games have not been clearly documented. Case studies of "addicted" players suggest that habitual use of video games may develop rapidly and, due to the relatively low costs associated with the activity, a regular pattern of video game use may be easy to begin and maintain long term (Griffiths, 2000; 2008b; 2010a). Because video game playing tends to take place primarily in the home, the negative consequences of excessive playing (social isolation,

marital problems, etc.) are largely out of the public view and make it easier for problem players to hide their problems (Griffiths, 2008b). The privacy of video game playing also hinders and/or prevents naturalistic observation or in vivo examination of problem players' thoughts and behaviors (King, Delfabbro & Griffiths, 2009).

Another relevant issue concerning the study of technology-based addictions is the rapidly evolving nature of the technology. Since its inception, video game software has advanced at a highly rapid pace, with new and more sophisticated games being released every month (Spielberg, 2008). The term "video game" itself can be misleading, as video games encompass both online and stand-alone games, playable alone or with multiple other players. Each of these video game types is thought to be appealing for different reasons, and potentially attracts different types of players. New video game features (and even genres) are also being continually developed. Therefore, research on specific video games and their psychological appeal may become outdated within a relatively short time following initial publication. Psychologists who lack knowledge of the structural features and/or capabilities of modern video games may have some difficulty in understanding the changing motivations of those who play video games (King, Delfabbro, & Griffiths, 2010).

CLINICAL STUDIES AND APPROACHES

To date, there have been very few clinical studies that assess the effectiveness of methods of treating problem video game playing. Some preliminary clinical studies have attempted to develop psychiatric profiles of excessive computer users. A study by Black, Belsare, and Schlosser (1999) reported that, in a sample of 21 compulsive users of computers, over half showed a co-morbid Axis I or Axis II disorder. These individuals used computers to alter their mood, either to feel more excited or powerful, or to assuage feelings of boredom, frustration or sadness. Attempts to reduce their computer use provoked strong feelings of anxiety. Interestingly, while computer use reportedly caused problems with work and relationships, none of the users felt that their compulsive computer use was significant enough to warrant any kind of treatment, echoing observations made in case studies of excessive video game players who have not sought treatment² (Griffiths, 2000; 2010a).

Another study by Yang (2001) identified a subgroup of 69 out of 1136 adolescents (6.1% of the overall sample) who met the criteria for video game addiction. These players

experienced a deterioration of friendships, poor health symptoms, and interference with various life activities. Excessive users reported symptoms of obsessive-compulsive disorder, somatization and hostile behavior. Despite these "serious sociopsychiatric problems" (p. 217), Yang did not report what type of treatment, if any, might be appropriate for these problem video game players. In the largest ever study on video game play, a national German study assessed adolescent video game addiction in over 15,000 teenagers (Rehbein et al, 2010). They reported that 3% of the male and 0.3% of the female students were "dependent" on video games and that the data indicated a clear dividing line between extensive gaming and video game dependency as a clinically relevant phenomenon. The study also noted that dependency on video games was accompanied by increased levels of psychological and social stress in the form of lower school achievement, increased truancy, reduced sleep time, limited leisure activities, and increased thoughts of committing suicide.

To date, two (now somewhat old) clinical case studies involving treatment of arcade video game addiction have been published. Kuczmierczyk, Walley, and Calhoun (1987) reported the case of an 18-year old college student who had been playing arcade video games 3-4 hours a day at an average cost of \$5 (US) a day over a five-month period. Using a combination of self-monitoring, GSR (Galvanic Skin Response) biofeedback assisted relaxation training, in vivo exposure, and response prevention techniques, the researchers achieved a 90% reduction in playing behavior. This behavior change was maintained at six- and twelve-month follow-ups. In addition, the patient reported a more satisfying interpersonal life and significantly fewer anxiety symptoms.

Another similar case reported by Keepers (1990) involved a 12-year old boy who played arcade video games for 4-5 hours per day at an average cost of \$30-50 a day over a six-month period. The boy reported stealing money and truanting from school in order to play video games. In therapy, it was discovered that the boy was being physically abused by his father and played video games as a way of coping with strong feelings of helplessness. Following family therapy with the eventual outcome of the boy and the mother separating from the father, the boy's emotional difficulties and excessive playing behaviors reduced significantly. A 6-month follow-up reported no ongoing issues. In both of these cases, the playing of video games was on arcade machines where the player had to 'pay to play'. Behaviors that involve a financial cost may

²Black et al. did not report whether participants later received any treatment for their problematic computer use.

incur more negative detrimental effects – particularly if the person goes beyond their own disposable income and resorts to criminal behavior to fund their activity.

The lack of comparative treatment studies might suggest that, while a small minority of users (i.e., <1 to 3%) meet the clinical criteria for addiction to video games, there is a general lack of demand for psychological services for technology-based addictions. However, limited data suggest that this is not the case. An unpublished study by Woog (2004) surveyed a random sample of 5000 mental health professionals in the United States. Of the 229 completed surveys, two-thirds reported to have treated someone with problems related to excessive computer use in the previous 12-month period. Problem video game playing was most common among 11- to 17-year old clients. The need for further clinical research on video game addiction is evidenced by the growing international development of clinics that specialize in the psychological treatment of computer-based addictions, including: the Centre for Online and Internet Addiction located in Pennsylvania, United States; the Broadway Lodge residential rehabilitation unit located in Somerset, England; the Smith & Jones 12-step (Minnesota Model) clinic located in Amsterdam, Holland; and various government-run clinics throughout China. Each clinic has its own treatment philosophy and treatment techniques, but more popular approaches have included the 12-step approach (modeled on Alcoholics Anonymous), cognitive-behavioral therapy, motivational counseling, and interpersonal therapy (Griffiths & Meredith, 2009). Online support services for video game addiction are also becoming popular. For example, On-line Gamers Anonymous (www.olganon.org) offers self-help, online-based treatment based on the 12-Step Minnesota Model. The site's online community provides practical advice and social support via its online forums. Success rates of these various approaches to treating video game addiction have not been made publicly available.

ASSESSMENT

The first step in dealing with a client presenting problem video game playing issues is to assess the nature and severity of the problem. Problem behavior is viewed in one of two ways: either as a categorical disorder or as an end-point on a continuum of psychological functioning. To date, the primary method for assessing video game addiction has been to use a checklist that measures addictive thoughts, behaviors, and consequences. It has been suggested that the amount of time a client spends

playing video games each week may also assist in framing a diagnosis (Woog, 2009). However, other researchers have argued that usage data is best regarded as background information because judging whether the amount of time a person spends playing video games is “excessive” essentially involves making a value judgement (Gentile, 2009; Griffiths, 2010a). While highly frequent use is generally more common among problem players, a person may spend over 35 hours per week playing video games without meeting any of the addiction criteria. Additional background information may also aid assessment, including: general health functioning (e.g., physical exercise, vitality, and sleep patterns), lifestyle factors (e.g., outside commitments, hobbies, structured activities) and any co-morbid psychopathology (e.g., depression, anxiety, stress).

One method for assessing problem video game playing involves using Brown's (1997) components model of addiction. This model states that addiction is defined by the following six features: (a) salience, meaning the person is preoccupied by thoughts of the activity at all times of the day, (b) tolerance, the process whereby the person must spend increasing amounts of time engaged in the activity to achieve former mood-modifying effects, (c) withdrawal, the unpleasant emotional state or physical effects that occur when the activity is suddenly discontinued or reduced, (d) relapse, the tendency for repeated reversions to earlier patterns of use, and for even extreme patterns of use to be restored quickly after periods of abstinence or regulation, (e) mood modification, the subjective experience (e.g., an exciting “buzz” or tranquilising “numbing”) associated with engaging in the activity, and (f) harm, the conflict between the user and those around them, including work, school, hobbies, and social life. A person who meets some of these criteria may be considered a “problem” user, and those who meet all six criteria may be considered “addicted” (Griffiths, 2008a).

Another method for assessing problem video game playing is to use the Diagnostic and Statistical Manual for Mental Disorders (DSM-IV) classification for pathological gambling (American Medical Association, 1994). These criteria have already been adapted by researchers to identify pathological video game players (e.g., Fisher, 1994; Griffiths & Hunt, 1998; Salguero & Moran, 2002; Gentile, 2009). Using these criteria, the presence of video game addiction may be indicated by five (or more) of the following criteria:

1. Preoccupation with video game playing, including re-

living past playing experiences, or planning the next opportunity to play

2. The need to play for increasingly longer periods of time in order to achieve the desired excitement
3. Repeated unsuccessful efforts to control, cut back, or stop video game playing
4. Restlessness or irritability when attempting to cut down or stop video game playing
5. Playing video games as a way of escaping from problems or of relieving feelings of helplessness, guilt, anxiety, depression
6. After losing in a video game, returning another day to make more progress or get a higher score ("chasing")
7. Lying to family members, therapist, or others to conceal the extent of involvement with video game machines
8. Committing illegal acts, such as theft, in order to finance video game playing
9. Jeopardizing or losing a significant relationship, job, educational or career opportunity because of video game playing
10. Needing another individual to provide money to relieve a desperate financial situation caused by video game playing

Some researchers have investigated video game addiction by adapting the ICD-10 (World Health Organization, 2000) diagnostic criteria for pathological gambling (Grusser, Thalemann & Griffiths, 2007). Additionally, some self-report measures have been developed for identifying problem users of video games. For instance, Yang (2001), Hussain and Griffiths (2009), and King, Delfabbro and Zajac (2010) developed measures of problem video game play (the Problem Video Game Playing Test [PVGT], the Video Game Addiction Inventory [VGAI] modeled on the Exercise Addiction Inventory [Terry, Szabo & Griffiths, 2004] and the Computer-Related Addictive behavior Inventory [CRABI], respectively) modeled on Young's (1998) Internet Addiction Test. These measures were based on standard clinical criteria, with higher scores indicating greater risk of video game-related behavior problems. Lemmens et al. (2009) recently devel-

oped the Game Addiction Scale (GAS). This self-report measure includes items representing seven DSM-based criteria for game addiction that had been identified in earlier research. Despite their ongoing use in empirical research, the PVGT, VGAI, CRABI and the GAS have not been clinically validated so their test score data should not be considered a formal clinical diagnosis.

Client motivation for seeking psychological assistance should also be considered during assessment (Blaszczynski, 1998). Some clients may deny that they have a problem video game playing habit, despite being faced with significant adverse consequences of their excessive behavior. Similarly, some clients may think that their partner or spouse's complaints, rather than their own behavior, are the real problem to address in therapy. If clients refuse to take personal responsibility for their problem behavior, or feel that treatment is unnecessary, then it is unlikely that any productive treatment will follow.

TREATMENT

The cognitive-behavioral approach posits that psychological problems stem from problematic cognitions coupled with behaviors that either intensify or maintain the maladaptive response. Treatment involves identifying problem cognitions and replacing them with new beliefs, attitudes, and strategies that promote healthy behavioral change (Leahy, 2003). While a comprehensive treatment plan for video game addiction is far beyond the scope of this paper, we put forward a basic, and tentative, foundation for therapeutic practice. These techniques are drawn from multiple resources for CBT practice, including treatment handbooks and research papers on treating adolescent problem gambling (Blaszczynski, 1998; Dobson, 2001; Gupta & Derevensky, 2000; Leahy, 2003). In addition, research literature is used to guide those practitioners who may be unfamiliar with the psychological aspects of video game technologies. While the video game addiction treatment stages described are not supported by rigorous, scientifically controlled research studies, this brief program is presented so that further work may validate and expand upon its clinical utility.

MONITORING USE

Monitoring involves steering clients to become more aware of the problems associated with their excessive video game use (Woog, 2009). This involves drawing attention to the adverse consequences of excessive playing, such as loss of sleep due to playing video games, relation-

ship tensions, neglect of other commitments (e.g., work, educational activities, household duties, and/or exercise), frustration at being interrupted when playing, or depressed feelings when not playing. Successful monitoring has two main client outcomes: (a) additional motivation to change because video game-related problems are more salient and tangible, and (b) greater insight into the self-perpetuating cycle of problem video game playing (i.e., excessive play creates problems that the client seeks to escape from by playing video games). The client can then identify situations that trigger or increase vulnerability to play video games (e.g., after a fight with a partner, when homework gets too difficult, etc.). In this way, monitoring information provides the foundation for setting goals that promote healthier involvement in video games.

Błaszczynski (1998) recommends that problem gamblers maintain a log of daily use, taking note of their thoughts and emotions during a playing session as well as during periods when not playing. This technique may be easily adapted to video game playing. Monitoring playing habits enables the client to confront thoughts of denial (e.g., “I do not play video games very often, maybe just an hour or two a night”) as well as develop a greater sense of personal responsibility (e.g., “I need to be more accountable to myself because I am playing more than I intend”). Clients should be encouraged to monitor the number of hours spent playing video games each night, as well as their thoughts and emotions when playing. Given the continuous nature of video game play, a person may lose track of time and subsequently incorrectly estimate the amount of time spent playing (Charlton & Danforth, 2007). Some video games feature a playing counter that records hours played on each day or playing session, which should make the task of monitoring less fraught with human error. In addition to raw playing time, clients could be encouraged to record the number of failures, mistakes, and wasted opportunities made while playing a video game, along with associated times spent reloading the game following a game-ending failure. Loading screens can range between a few seconds to a few minutes. The longest loading times often occur in online games where the player waits in a “lobby” for other players to join the game or for game content to download before the game begins. Loading times are not always tracked by a video game’s internal clock, which means that the player may think they have played for less time than is the case. Therefore, monitoring exercises should aim to provide the client with experiential feedback on how much time is spent in the video game without gaining any satisfaction.

GOAL-SETTING

The overarching goal of therapy is to reduce the amount of time spent playing video games to levels that no longer interfere with the client’s well-being and life functioning. This may include total abstinence from video games, abstinence from specific video games that produce excessive involvement, or playing video games but in a controlled manner. In particular, players of massively multiplayer online role-playing games (MMORPGs) often report the greatest difficulty managing time spent playing as compared to players of other games (Ng & Weimer-Hastings, 2005). This difficulty can be largely attributed to the social obligations and complex reward systems in these games. Total abstinence from online games may be a difficult goal because numerous other players may rely on the client to be available to regularly play the game for mutual benefit. In addition, the client may frequently socialize with other players as part of being a member of a social group such as a “clan” or “guild”. The social elements in these groups provide a sense of identity and belonging for the player, thus making it difficult to completely disconnect from this social network (King et al., 2010). A therapist could assist the client to develop and rehearse ways in which he or she will inform playing partners of their decision to reduce time spent playing, and avoid feeling pressured socially into playing the game. In addition, the client may need to address conflicting negative emotions related to no longer making progress in their favorite video game as a result of meeting goals to reduce excessive playing behaviors. Many players become emotionally attached to their in-game character(s) after spending months playing the video game. Some treatment clinics have recommended that quitting players should delete their video game characters as a way of making their departure more permanent and any potential return to the video game less immediately appealing.

In addition to setting limits on use, clients need to develop practical ways to overcome or avoid any obstacles to their treatment goals (Leahy, 2004). A client may work in a highly stressful job and play video games every night for 5-6 hours as a coping mechanism for stress. In this example, job-related stress triggers the need to play video games. Setting limits on video game use may be effective, but the client should also develop some alternative ways of dealing with stress, particularly activities that foster a sense of achievement rather than an escape from negative mood states. Woog (2009) recommends that clients in the early stages of reducing computer use should: (a) engage in healthy lifestyle choices, such as increasing sleep and eating at regular meal times, (b) stop complementary re-

wards that promote computer use (e.g., buying new computer equipment, reading video game magazines and online forums), (c) minimize deliberate exposure to situations that initiate video game playing, and (d) making video game playing less convenient and accessible in the home environment (e.g., unplugging a video game console and packing it away after use). If a client has concurrent symptoms of depression or other mood disorders, then additional therapy for these psychological issues should also be considered. For instance, problem players with social anxiety issues may benefit from assertiveness or similar social skills training. Similarly, helping the client to find other avenues of social support may reduce feelings of isolation from spending less time playing video games.

Addressing the situational context is also important during the goal-setting stage. Although video games may be played at internet cafes and other video gaming venues, most video games are played in the home environment (Brand, 2009). For this reason, video game playing is largely private, unsupervised, and unregulated. There are no "opening hours" - video games are available to play 24 hours per day, seven days per week, 365 days of the year. Jacobs (1986) argued that, as an addiction develops, a person makes major changes to their lifestyle, including modifications to their environment, in order to facilitate a behavioral repertoire that extends gratification from the activity. For problem video game players, this process may involve arranging the home living space so that all other activities, like eating, sleeping or socializing, are able to revolve around (and without causing interruption or impediment to) use of the centralized video game machine. In therapy, clients need to develop ways of separating the playing experience from other activities in the home environment to avoid continual, uninterrupted use, and/or determine new places to play video games that are more public, visible, and time-limited.

DEALING WITH PROBLEM COGNITIONS

One of the main objectives of CBT is to challenge faulty cognitions that maintain problem behavior and replace them with more adaptive thoughts that promote healthy behavior. However, video game playing mostly involves rational, rather than illogical, thought processes. In a video game, a player must use skill and knowledge of the game to make progress and earn rewards. Studies have shown that the appeal of video game playing for many players includes attempting to reach the highest possible experience level, beating the highest score, and/or finding the best items in the video game (King & Delfabbro, 2009a;

Wood, Griffiths, Chappell, & Davies, 2004). As video games have become increasingly complex, with more sophisticated reward systems that require the cooperation of many players, significantly more thought and planning (and time) are required to master a video game. For example, in the online role-playing game *World of Warcraft*, some players may play five nights a week, over a period of months, in order to acquire one single reward. The proliferation of online forums, magazines, and guidebooks dedicated to video game strategy suggests that players are aware of the procedural steps and time required to find rare game items or reach the next level in a game. King and Delfabbro (2009a) observed that many players attempt to optimize their reward payout in some video games by performing simple, repetitive actions that provide a small, but consistent, reward (a practice known by players as "grinding"). While this behavior may be considered "rational," few players report to enjoy the process of grinding and playing video games in this way has been referred to a "second job" (King & Delfabbro, 2009a).

Because player skill and strategy (or grinding) theoretically allows players to obtain all of the thousands of rewards in a video game, problem players may be motivated indefatigably to acquire every single reward in the video game³. In this sense, the video game may be compared to a slot machine that, with enough time and practice, will almost certainly deliver a jackpot. For problem players, the process of completing a video game may be rationalized as time well spent, in spite of the negative consequences of excessive playing. King and Delfabbro (2009b) found that problem players' motivations to play video games differed significantly from regular players. Problem players were more motivated by the rewards in video games, as well as the release of tension and approval of others when playing a video game than regular players. Problem players also scored higher on a measure of "amotivation" (a feeling of meaninglessness when playing) than normal players.

Cognitive therapy for problem video game players should address the client's thought processes that compel the player to be preoccupied with playing the video game until it is complete. A cognitive therapy exercise may involve the client recording their motivations for playing video games (e.g., enjoyment, learning strategy, and feeling a sense of achievement) and then having the client evaluate, action by action on a playing session-by-session basis, whether the video game regularly satisfied these motivations. Through therapy, clients may reach a self-under-

³Some video games, by design, can never be completed because they have virtually unlimited rewards. These games may be comparable to a slot machine that never delivers a jackpot.

standing that they no longer play the video game for fun or enjoyment, but simply to reach the next level or reward. Psycho-education may also be useful in therapy. For example, a therapist could teach the client that the appeal of video games, like electronic gambling machines, can be explained by the operant conditioning paradigm (Ferster & Skinner, 1957). Video game developers design their video games to reward players at frequent intervals in the early stages of the game, and significantly less so in later stages. Therefore, as the player makes progress, rewards are delivered more infrequently and often less predictably. As a result, many video game players, like gamblers, are motivated to continue playing because the next reward may be “just around the corner” (Griffiths & Wood, 2000). Building the client’s understanding of how fixed and variable reinforcement schedules promote player beliefs and expectancies about reward payout – and, specifically, that video games become less “fun” the longer a player spends in the game – may lead to a critical evaluation of the amount of time spent playing the game without enjoyment.

Despite appearing largely rational, some aspects of problem video game playing may be maintained by irrational, misguided or faulty cognitions. For example, the rewards of competition – like a high score after beating an opponent using superior strategy – has long been recognized as a key appealing feature of video games (Vorderer, Hartmann, & Klimmt, 2003). Like problem gamblers who attempt to overcome the odds and “beat the house”, some problem video game players may become preoccupied with beating a high score held by an opponent. Prior to online video games, video games were predominantly played by a local group of players at a fixed location (e.g., an arcade machine in an amusement center). In this context, the player had only to beat a modest number of opponents in order to become “the best”. In contrast, modern online video games may be played by a global audience of millions at any given time via broadband service.

In online games, player scores are tracked on a global leaderboard that ranks all players in terms of their highest achievements in the game (King, Delfabbro & Griffiths, 2010). This collation of international data makes it extremely difficult for any player to excel at a particular video game. Competitiveness may drive players to become preoccupied with their global ranking in the game, and create a belief that, despite the odds, they will beat all other players at the video game – just as problem gamblers may believe that they are able to beat the casino. While not strictly impossible for a video game player, the

time and skill required to achieve this goal may extend beyond that which the majority of players can devote to the game without creating conflict in other areas of their life.

Superstitious thoughts about video game rewards may also contribute to problem use of video games. An unpublished study by Yee surveyed 380 regular players of online video games and found that players reported a number of irrational beliefs about video games, including: (a) certain video game characters or classes are “luckier” than others, (b) randomly delivered rewards could be influenced by the order in which players approach and reveal the reward, (c) certain items in the video game, such as clothing or weapons on characters, act as a “lucky charm”, and (d) random number generators that determine reward payout or “item drop” operated in predictable patterns, rather than random sequences. While Yee’s findings are of a preliminary nature, they suggest that some video game players may hold irrational and/or superstitious beliefs similar to those among problem gamblers (Griffiths, 1994; Griffiths & Bingham, 2005). These problem cognitions should be addressed in therapy if they relate directly to problem playing behavior (e.g., the client believes that playing uninterrupted for many hours will yield greater in-game rewards).

CONCLUSION

Although technology-based addictions have received increased academic and media attention in recent years, there is still a dearth of both clinical and empirical literature on problem video game playing and addiction. The research base is particularly limited with regard to methods of treating problem users of video games. Based on its many previous applications to treating behavioral addiction, CBT is rationalized to be a highly appropriate treatment modality for video game addiction. Drawing on available empirical research in this and allied areas (e.g., problem gambling), this paper has outlined some conceptual considerations and therapy issues in relation to the known features, correlates, and consequences of video game addiction. While problem video game playing appears to resemble pathological gambling in many ways, there are also some distinct cognitive elements of video game playing that prevent a direct translation of gambling CBT programs to video game players. The current knowledge base on problem video game play indicates that there is a need for more basic and applied research on problem video game players. In addition, longitudinal research is needed to add greater empirical weight to the claim that excessive video game playing represents a persistent and significant psychological problem.

REFERENCES

- American Psychiatric Association. (1994). *Diagnostic and statistical manual of mental disorders (4th edition)*. Washington, DC: Author.
- Beard, K.W., & Wolf, E.M. (2001). Modification in the proposed diagnostic criteria for Internet addiction. *CyberPsychology & Behavior*, 4, 377-383.
- Beranuy, M., Oberst, U., Carbonell, X. & Chamarro, A. (2009). Problematic internet and mobile phone use and clinical symptoms in college students: The role of emotional intelligence. *Computers in Human Behavior*, 25, 1182-1187.
- Bianchi, A. & Phillips, J.G. (2005). Psychological predictors of problem mobile phone use. *CyberPsychology & Behavior*, 8, 39-51.
- Black, D. W., Belsare, G., & Schlosser, S. (1999). Clinical features, psychiatric comorbidity, and health-related quality of life in persons reporting compulsive computer use behavior. *Journal of Clinical Psychiatry*, 60, 839-845.
- Blaszczynski, A. (1998). *Overcoming compulsive gambling*. Robinson's Publishing, London.
- Blaszczynski, A. (2008). Commentary: A response to 'Problems with the concept of video game 'addiction': Some case study examples'. *International Journal of Mental Health and Addiction*, 6, 179-181.
- Blaszczynski, A., & Nower, L. (2002). A pathways model of problem and pathological gambling. *Addiction*, 97, 487-499.
- Blaszczynski, A. & Silove, D. (1995). Cognitive and behavioral therapies for pathological gambling. *Journal of Gambling Studies*, 11, 195-220.
- Brand, J. (2009). *Interactive Australia 2009 report*. Bond University Press.
- Brown, I. (1997). A theoretical model of the behavioral addictions - Applied to offending. In J. E. Hodge, M. McMurran & C. R. Hollins (Eds.), *Addicted to crime?* (pp. 13-65). Chichester, UK: John Wiley.
- Chappell, D., Eatough, V., Davies, M. N. O., & Griffiths, M. D. (2006). Everquest - It's just a computer game right? An interpretative phenomenological analysis of online computing addiction. *International Journal of Mental Health and Addiction*, 4, 205-216.
- Charlton, J. P., & Danforth, I. D. W. (2007). Distinguishing addiction and high engagement in the context of online game playing. *Computers in Human Behavior*, 23, 1531-1548.
- Cole, H. & Griffiths, M.D. (2007). Social interactions in Massively Multiplayer Online Role-Playing gamers. *CyberPsychology and Behavior*, 10, 575-583.
- Colwell, J., Grady, C., & Rhaiti, S. (1995). Computer games, self-esteem and gratification of needs in adolescents. *Journal of Community and Applied Social Psychology*, 5, 195-206.
- Dobson, K. S. (2001). *Handbook of cognitive-behavioral therapies*. New York: Guilford Press.
- Ferster, C. B., & Skinner, B. F. (1957). *Schedules of reinforcement*. New York: Appleton Century-Crofts.
- Fisher, S. (1994). Identifying video game addiction in children and adolescents. *Addictive Behaviors*, 19, 545-553.
- Fisher, S., & Griffiths, M. D. (1995). Current trends in slot machine gambling: Research and policy issues. *Journal of Gambling Studies*, 11, 239-247.
- Funk, J. B., Chan, M., Brouwer, J., & Curtiss, K. (2006). A biopsychosocial analysis of the video game-playing experience of children and adults in the United States. *SIMILE: Studies in Media & Information Literacy Education*, 6, 1-15.
- Gentile, D. (2009). Pathological video game use among youth ages 8 to 18: A national study. *Psychological Science*, 20, 594-602.
- Gupta, R. & Derevensky, J. L. (2000). Adolescents with gambling problems: From research to treatment. *Journal of Gambling Studies*, 16, 315-342.

- Griffiths, M. D. (1991). Amusement machine playing in childhood and adolescence: A comparative analysis of video games and fruit machines. *Journal of Adolescence, 14*, 53-73.
- Griffiths, M.D. (1994). The role of cognitive bias and skill in fruit machine gambling. *British Journal of Psychology, 85*, 351-369.
- Griffiths, M. D. (1995). Technological addictions. *Clinical Psychology Forum, 76*, 14-19.
- Griffiths, M.D. (1997). Computer game playing in early adolescence. *Youth and Society, 29*, 223-237.
- Griffiths, M. D. (2000). Does Internet and computer "addiction" exist? Some case study evidence. *CyberPsychology & Behavior, 3*, 211-218.
- Griffiths, M.D. (2005). A "components" model of addiction within a biopsychosocial framework. *Journal of Substance Use, 10*, 191-197.
- Griffiths, M. D. (2008a). Diagnosis and management of video game addiction. *Addiction Treatment and Prevention, 12*, 27-41.
- Griffiths, M. D. (2008b). Internet and video-game addiction. In C. Essau (Ed.), *Adolescent addiction: Epidemiology, assessment and treatment* (pp. 231-267). San Diego: Elsevier.
- Griffiths, M.D. (2010a). The role of context in online gaming excess and addiction: Some case study evidence. *International Journal of Mental Health and Addiction, 8*, 119-125.
- Griffiths, M.D. (2010b). Online video gaming: What should educational psychologists know? *Educational Psychology in Practice, 26*(1), 35-40.
- Griffiths, M.D. & Bingham, C. (2005). A study of superstitious beliefs among bingo players. *Journal of Gambling Issues, 13*. Located at: http://www.camh.net/egambling/issue13/jgi_13_griffiths.html.
- Griffiths, M.D., Davies, M.N.O. & Chappell, D. (2003). Breaking the stereotype: The case of online gaming. *CyberPsychology & Behavior, 6*, 81-91.
- Griffiths, M. D., Davies, M. N. O., & Chappell, D. (2004a). Demographic factors and playing variables in online computer gaming. *CyberPsychology & Behavior, 7*, 479-487.
- Griffiths, M.D., Davies, M.N.O. & Chappell, D. (2004b). Online computer gaming: A comparison of adolescent and adult gamers. *Journal of Adolescence, 27*, 87-96.
- Griffiths, M.D. & Hunt, N. (1998). Dependence on computer games by adolescents. *Psychological Reports, 82*, 475-480.
- Griffiths, M. D. & Meredith, A. (2009). Videogame addiction and its treatment. *Journal of Psychotherapy, 39*, 247-253.
- Griffiths, M. D., & Wood, R. T. A. (2000). Risk factors in adolescence: The case of gambling, videogame playing, and the Internet. *Journal of Gambling Studies, 16*, 199-225.
- Grüsser, S.M., Thalemann, R. & Griffiths, M.D. (2007). Excessive computer game playing: Evidence for addiction and aggression? *CyberPsychology & Behavior, 10*, 290-292.
- Horvath, C. W. (2004). Measuring television addiction. *Journal of Broadcasting & Electronic Media, 48*, 378-398.
- Hussain, Z. & Griffiths, M.D. (2009). Excessive use of Massively Multi-Player Online Role-Playing Games: A pilot study. *International Journal of Mental Health and Addiction, 7*, 563-571.
- Jacobs, D. F. (1986). A general theory of addictions: A new theoretical model. *Journal of Gambling Behavior, 2*, 15-31.
- Kaltiala-Heino, R., Lintonen, T., & Rimpela, A. (2004). Internet addiction? Potentially problematic use of the Internet in a population of 12-18 year-old adolescents. *Addiction Research & Theory, 12*, 89-96.
- Keepers, G. A. (1990). Pathological preoccupation with video games. *Journal of the American Academy of Child and Adolescent Psychiatry, 29*, 49-50.

- Khan, M. K. (2007). Emotional and behavioral effects, including addictive potential, of video games. *Report of the Council on Science and Health* (CSAPH Report 12-A-07).
- King, D. L., & Delfabbro, P.H. (2009a). Understanding and assisting excessive players of video games: A community psychology perspective. *Australian Community Psychologist*, *21*, 62-74.
- King, D. L., & Delfabbro, P.H. (2009b). Motivational differences in problem video game play. *Journal of Cybertherapy and Rehabilitation*, *2*, 139-149.
- King, D. L., Delfabbro, P. H., & Griffiths, M. D. (2009). The psychological study of video game players: Methodological challenges and practical advice. *International Journal of Mental Health and Addiction*, *7*, 555-562.
- King, D. L., Delfabbro, P. H., & Griffiths, M. D. (2010). Video game structural characteristics: A new psychological taxonomy. *International Journal of Mental Health and Addiction*, *8*, 90-106.
- King, D. L., Delfabbro, P. H., & Zajac, I. T. (2010). Preliminary validation of a new clinical tool for identifying problem video game playing. *International Journal of Mental Health and Addiction*. DOI: 10.1007/s11469-009-9254-9.
- Kuczmierczyk, A. R., Walley, P. B., & Calhoun, K. S. (1987). Relaxation training, in vivo exposure and response-prevention in the treatment of compulsive video-game playing. *Scandinavian Journal of behavior Therapy*, *16*, 185-190.
- Ladouceur, R., Boisvert, J-M., & Dumont, J. (1994). Cognitive-behavioral treatment for adolescent pathological gamblers. *Behavior Modification*, *18*, 230-242.
- Leahy, R. L. (2003). *Cognitive therapy techniques: A practitioner's guide*. New York: Guilford Press.
- Lemmens, J.S., Valkenburg, P.M., & Peter J. (2009). Development and validation of a game addiction scale for adolescents. *Media Psychology*, *12*, 77-95.
- McIlwraith, R.D. (1998). "I'm addicted to television": The personality, imagination, and TV watching patterns of self-identified TV addicts. *Journal of Broadcasting & Electronic Media*, *42*, 371 - 386.
- Nalwa, K. & Anand, A. P. (2003). Internet addiction in students: A cause of concern. *CyberPsychology & Behavior*, *6*, 653-656.
- Orzack, M. H. & Orzack, D. S. (1999). Treatment of computer addicts with complex comorbid psychiatric disorders. *CyberPsychology and Behavior*, *2*, 465-473.
- Park, W. K. (2005). Mobile phone addiction. In R. Ling & P. Pedersen (Eds.), *Mobile Communications: Re-negotiation of the Social Sphere* (pp. 253-272). London: Springer
- Petry, N. M. Ammerman, Y., Bohl, J., Doersch, A., Gay, H., Kadden, R., Molina, C., and Steinberg, K. (2006). Cognitive-behavioral therapy for pathological gamblers. *Journal of Consulting and Clinical Psychology*, *74*, 555-567.
- Rehbein, F., Kleimann, M. & Mößle, T. (2010). Prevalence and Risk Factors of Video Game Dependency in Adolescence: Results of a German Nationwide Survey. *Cyberpsychology, Behavior and Social Networking*, doi:10.1089/cpb.2009.0227.
- Rockloff, M. J. & Dyer, V. (2007). An experiment on the social facilitation of gambling behavior. *Journal of Gambling Studies*, *23*, 1-12.
- Salguero, R. A. T., & Moran, R. M. B. (2002). Measuring problem video game playing in adolescents. *Addiction*, *97*, 1601-1606.
- Shaffer, H. J. (1996). Understanding the means and objects of addiction: Technology, the Internet, and gambling. *Journal of Gambling Studies*, *12*, 461-469.
- Shaffer, H. J., Hall, M. N., & Vander Bilt, J. (2000). "Computer Addiction": A critical consideration. *American Journal of Orthopsychiatry*, *70*, 162-168.

- Shapira, N. A., Lessig, M. C., Goldsmith, T. D., Szabo, S. T., Lazoritz, M., Gold, M. S., et al. (2003). Problematic internet use: proposed classification and diagnostic criteria. *Depression and Anxiety, 17*, 207-216.
- Song, I., Larose, R., Eastin, M. S., & Lin, C. A. (2004). Internet gratifications and Internet addiction: on the uses and abuses of new media. *CyberPsychology & Behavior, 7*, 384-394.
- Spielberg I. (2006). *The challenges of stopping gaming addiction*. Located at: <http://www.treatmentonline.com/treatments.php?id=204> (Last accessed May 17, 2008).
- Sylvain, C., Ladouceur, R., & Boisvert, J-M. (1997). Cognitive and behavioral treatment of pathological gambling: A controlled study. *Journal of Consulting and Clinical Psychology, 65*, 727-732.
- Terry, A., Szabo, A. & Griffiths, M. (2004). The Exercise Addiction Inventory: A new brief screening tool, *Addiction Research and Theory, 12*, 489-499.
- Vorderer, P., Hartmann, T., & Klimmt, C. (2003). Explaining the enjoyment of playing video games: the role of competition. In D. Marinelli (Ed.), *Proceedings of the 2nd international conference on Entertainment computing* (pp. 1-8), New York: ACM.
- Walker, M. B. (1992). Irrational thinking among slot machine players. *Journal of Gambling Studies, 8*, 245-261.
- Wilson, K., Fornasier, S., & White, K.M. (2010). Psychological predictors of young adults' use of social networking sites. *Cyberpsychology, Behavior, and Social Networking*, doi:10.1089/cpb.2009.0094.
- Wood, R. T. A. (2008). Problems with the concept of video game "addiction": Some case study examples. *International Journal of Mental Health and Addiction, 6*, 169-178.
- Wood, R. T. A., Griffiths, M. D., Chappell, D., & Davies, M. N. O. (2004). The structural characteristics of video games: A psychostructural analysis. *CyberPsychology & Behavior, 7*, 1-10.
- Wood, R.T.A., Griffiths, M.D. & Parke, A. (2007). Experiences of time loss among videogame players: An empirical study. *CyberPsychology & Behavior, 10*, 45-56.
- Wood R., Gupta, R., Derevensky, J. L., & Griffiths, M. D. (2004). Video game playing and gambling in adolescents: Common risk factors. *Journal of Child & Adolescent Substance Abuse, 14*, 77-100.
- Woog, K. (2004). A survey of mental health professionals clinical exposure to problematic computer use. Unpublished study. Retrieved online, 8/03/10 from: <http://www.wooglabs.com/>
- Woog, K. (2009). *Computer gaming addiction in adolescents and adults: Solutions for moderating and motivating for success*. Retrieved online, 8/03/10 from: <http://www.wooglabs.com/>
- World Health Organization (2000). *The ICD-10 classification of mental and behavioral disorders: clinical descriptions and diagnostic guidelines*. Geneva: World Health Organization.
- Yang, C.-K. (2001). Sociopsychiatric characteristics of adolescents who use computers to excess. *Acta Psychiatrica Scandinavica, 104*, 217-222.
- Yee, N. (unpublished). *Superstitions in online video game games*. Retrieved online from: <http://www.nick-yee.com/daedalus/archives/001554.php>
- Young, K. S. (1998). *Caught in the net*. New York: John Wiley & Sons.
- Young, K. S. (1999). *Internet addiction: symptoms, evaluation, and treatment*. In L. VandeCreek & T. L. Jackson (Eds.), *Innovations in Clinical Practice*. Sarasota, FL: Professional Resource Press.
- Young, K. S. (2007). Cognitive behavior therapy with Internet addicts: Treatment outcomes and implications. *CyberPsychology & Behavior, 10*, 671-679.

TRANSFER OF SPATIAL-KNOWLEDGE FROM VIRTUAL TO REAL ENVIRONMENT: EFFECT OF ACTIVE/PASSIVE LEARNING DEPENDING ON A TEST-RETEST PROCEDURE AND THE TYPE OF RETRIEVAL TESTS

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The aim of this study was to compare subjects' spatial performance on a pedestrian route depending on three factors: (1) the type of learning environment (real vs. virtual); (2) the exploration mode during the learning phase (active vs. passive); and (3) the type of spatial test administered at retrieval (i.e., wayfinding, sketch mapping, and picture ordering). Moreover, each subject was tested two times: 48hr and 7 days after the learning phase.

First of all, regarding the whole data, the results presented in this paper indicate good spatial-knowledge transfer from Virtual Reality to the real world, irrespective to the retrieval tests administered to the subjects. Moreover, the exploration mode does not seem here to significantly influence the spatial performance. In contrast, the subjects' performance was greatly increased on the 7-day compared to the 48hr recall phase, and particularly, on the wayfinding test (i.e., on the most ecological test).

In conclusion, the most influent factor on spatial-knowledge transfer from virtual to real environments seems not to be the active learning of the information, but the testing procedure. The results are discussed using the notions of training effect and transfer-appropriate processing. Although further investigations are needed, the results are already encouraging the development of virtual training or rehabilitation programs addressed to spatial cognitive processes.

Keywords: Spatial Cognition, Virtual Reality, Active/passive Learning, Test-retest Procedure

Spatial cognition refers to the cognitive processes associated with the development of a comprehensive understanding of a 3-D environment, and the utilization of this knowledge for various purposes (e.g., wayfinding). In the domain of spatial cognition, the use of virtual environments (VE) is becoming increasingly important in studies because it opens up many new experimental possibilities. A major issue is then to determine the extent to which spatial-knowledge can transfer from virtual to real environments (RE) (e.g., Péruch, Belingard & Thinus-Blanc, 2000).

In fact, several studies indicate that spatial-knowledge transfer from VE to RE may occur to a large degree (e.g., Foreman, Stirk, Pohl, Mandelkow, Lehung, Herzog & Leplow, 2000; Waller, Hunt & Knapp, 1998) or, at least, partially (e.g., Wilson, Foreman & Tlauka, 1997; Witmer, Bailey & Knerr, 1996). Péruch and Corazzini (2003) suggest that efficient knowledge transfer occurs particularly when the VE replicates relevant characteristics of the real world. However, even when using a good match between the virtual and real environments, many variables seem to influence spatial-knowledge transfer (e.g., Péruch & Wil-

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son, 2004; Wilson & Péruch, 2003). Therefore, it is crucial to identify the experimental factors that can promote this transfer.

One of these factors is the exploration mode (i.e., the mode of learning). The current literature with regard to VE is mainly concerned with two learning modes defined by Wilson, Foreman, Gillett and Stanton (1997). The first mode refers to the physical involvement of the participant during the learning phase. In this case, the participant can experience a dynamic three-dimensional simulation either physically passively (i.e., observing a pre-recorded scene in the VE) or physically actively (i.e., navigating within the VE using a joystick, mouse, keyboard, etc.). Furthermore, in the physically active condition, the participant can either have the entire freedom of his/her movements or be constrained to follow certain routes/rules. These two possibilities have then been called, respectively, psychologically active and psychologically passive by Wilson et al. (1997). The second mode defined by the authors thus refers to the psychological involvement of the participant during the learning phase.

Some studies have shown superior VE spatial learning from active rather than passive exploration (e.g., Carassa, Geminiani, Morganti & Varotto, 2002; Péruch, Vercher & Gauthier, 1995), although this is far from a universal outcome (e.g., Gaunet, Vidal, Kemeny & Berthoz, 2001; Wilson et al., 1997; for review see Péruch and Corazzini, 2003). Some studies have even reported a passive superiority (Wilson and Péruch, 2003, experiment 1) or mixed results, depending on the testing conditions. For example, Williams, Hutchinson, and Wickens (1996) (see also Aretz, 1991; Tong, Marlin & Frost, 1995) found that an active group was better than a passive group at following a route after exploration, and that a group using only a map showed intermediate performance compared to the two others. However, the active explorers were less efficient than the other groups in a second task that required them to reproduce the path. In contrast, in a study by Attree, Brooks, Rose, Andrews, Leadbetter & Clifford (1996) (see also Brooks, Attree, Rose, Andrews & Leadbetter, 1999), an active group visited interconnected rooms in a house, each containing several objects, and memory of spatial layout was better for active explorers, while yoked passive exploration enhanced memory for encountered objects. Actually, as underlined by Péruch and Wilson (2004), it is not clear at the present time that spatial-knowledge acquired through active exploration will necessarily be more accurate than that acquired through passive exploration.

The authors suggested that the outcome of passive-active comparisons may depend on procedural variables, such as evoked features of VE and the type of test administered. As evoked above, the type of retrieval tests may be actually one of the most important factors, as it is well-known in the domain of memory that the adequacy between the encoding and testing conditions greatly influences memory performance. This experimental fact refers to the transfer-appropriate principle (e.g., Lockhart, 2002; Morris, Bransford & Franks, 1977; Park & Rugg, 2008), indicating that the more the retrieval condition matches the learning phase, the better the performance. It is then not surprising that the adequacy between the encoding and testing situations may influence the active exploration effect, as well as the spatial-knowledge transfer in general. Consequently, it is important to understand in which situations active exploration will be relevant to improve the spatial-knowledge transfer from Virtual Reality (VR) to the real world. In other words, the active exploration effect has to be tested depending on various subject and task characteristics.

In this context, previous studies from our laboratory (Wallet, Sauzéon, Arvind Pala & N'Kaoua, 2009a; Wallet, Sauzéon, Rodrigues & N'Kaoua, 2009b) demonstrated that the benefit from active exploration may vary depending on, at least, three factors: (1) the task complexity; (2) the visual characteristics of the VE; and (3) the type of cognitive tests administered. Specifically, we demonstrated that active exploration seems particularly relevant to improve the subjects' performance on a wayfinding task even if the to-be-remembered route is complex (Wallet et al., 2009b), or if the VE is poorly detailed (i.e., no textures) (Wallet et al., 2009a).

In the present paper, the main objective was to go further with these results while testing the active exploration effect depending, this time, on a test-retest procedure (i.e., 48hr then 7 days after the learning phase). The test-retest procedure consists of, at least, two evaluations of the subjects' performance, separated by a retention interval (e.g., Bosco, Picucci, Caffò, Gyselinck & Lancioni, 2008; Gould, Holmes, Fantie, Luckenbaugh, Pine, Gould, Burgess, Manji & Zarate, 2007; Rutledge, Hancock & Walker, 1997; Tlauka, Donaldson & Wilson, 2008). Between each evaluation, other learning phases can or cannot be included. Moreover, the retention interval between the main learning phase and the test phases can range from several minutes to hours or even from several weeks to months. For example, Rutledge et al. (1997) studied adult

age differences in spatial memory, following retention intervals of various lengths (3, 15, or 30-min), in young and old subjects. The authors reported that the older adults were significantly less accurate than the younger participants following the 30-min retention interval only (i.e., no statistically significant effect of age at the 3-min and 15-min retention intervals).

In addition to the retention interval, the test-retest procedure is also particularly related to the notion of training effect (e.g., Jennings & Jacoby, 2003; Mozolic, Long, Morgan, Rowley-Payne & Laurienti, In Press; Rapp, Brenes & Marsh, 2002). The training effect can be defined as an improvement of performance after several trials or learning phases. For example, Mozolic et al. (In Press) investigated the effects of a cognitive training intervention aimed at helping healthy older adults to suppress irrelevant auditory and visual stimuli. Sixty-six participants received 8 weeks of either the modality-specific attention training program or an educational lecture control program. Participants who completed the intervention program had larger improvements in modality-specific selective attention following training than controls. The intervention group also showed larger improvements than the control group in non-trained domains such as processing speed and dual-task completion.

The test-retest procedure is actually an important experimental/clinical factor in terms of cognitive training or rehabilitation, as the objective is to maintain the performance or to offset the deficits durably over time (e.g., Mann, Günther, Stetter & Ackermann, 1999). In terms of ecological issues, it is then crucial to investigate spatial-knowledge transfer depending on the moment of the retrieval phase.

In this context, the study presented here aimed at comparing subjects' spatial performance on a pedestrian route depending on three factors: (1) the type of learning environment (real vs. virtual); (2) the exploration mode during the learning phase (active vs. passive); and (3) the type of spatial test administered at retrieval (i.e., wayfinding, sketch mapping, and picture ordering). In addition, each subject was tested two times: 48hr and 7 days after the learning phase.

MATERIAL AND METHODS

PARTICIPANTS

Participants were 60 students in Cognitive Science at the Victor Segalen University in Bordeaux, and were recruited

during psychology courses on a voluntary basis. No financial rewards were given. The test group was composed of 40 women and 20 men, aged between 18 and 30 years old ($M = 20.2 \pm 2.9$). All participants were native French speakers and right-handed. None of them were particularly familiar with the experimental route.

MATERIAL

Two environments (real vs. virtual) were used in the experiment (Figure 1). First, the RE was a part of the district surrounding the Pellegrin Hospital of Bordeaux. The VE, was a 3-D replica of the RE, modeled using the Virtools© software. Relevant landmarks (e.g., road signs, urban furniture, etc.) as well as an auditory context (i.e., urban sounds) were especially included into the VE to optimize the match between the two environments.



Figure 1. Illustrations of the real environment (left panels), and the corresponding modelling in the virtual environment (right panels), used in the experiment.

The apparatus used in the VR room was composed of: (1) a Dell© personal computer (3 GHz, 5Go RAM, with a nVidia© Quadro FX 4400 graphics card); (2) a F1+© video projector; (3) a Logitech© force 3-D pro joystick (used in the active exploration mode); and (4) a panoramic screen (2m x 1.88m) that allows good immersion of the subject during the task (Tyndiuk, Lespinet-Najib, Thomas, N'Kaoua, Schlick & Claverie, 2007).

DESIGN AND METHODS

A 2 (learning environments) x 2 (learning modes) x 2 (retrieval phases) x 3 (retrieval tests) mixed factorial design was utilized in the experiment. The 60 participants were divided into four groups of 15 random subjects (i.e.,

10 women + 5 men) corresponding to the four experimental conditions (i.e., active learning in RE, passive learning in RE, active learning in VE, and passive learning in VE).

Prior to the experiment, all participants were instructed that they would be presented with a pedestrian route, in the VE or the RE, and that they were to do their best to memorize it as they would be given memory tests later. Moreover, they were instructed that they would be tested two times, 48 hours and 7 days after the learning phase.

For each group, the learning phase consisted of memorizing a 1,457m pedestrian route (approximately a 20-minute walk) in the district surrounding of the Pellegrin Hospital in Bordeaux. This route was composed of 14 streets, 18 intersections, and 18 direction changes. Depending on the considered group, the learning phase was carried out either in the RE or the VE, and either actively or passively.

Active learning in the VE involved the use of a joystick that permitted the subjects to move “freely” inside the environment. In fact, the participants were instructed to follow the experimenter’s vocal and gestural instructions (e.g., “at the next crossroad, turn this way,” while showing the correct direction with the hand), indicating step-by-step the route to be memorized. In contrast, passive learning in the VE consisted for the subjects just to sit in front of the panoramic screen, and to visualize the recorded video of the to-be-remembered route. Here, the participants were then instructed to just look at the screen and try to memorize the presented route. In the VR room, all the participants were seated 2m away from the screen, and the speed of route display, either actively or passively, was fixed at 5 km/hr to match the real conditions.

In the RE, the distinction between the active and passive exploration modes was operationalized using two different instructions. Considering active learning, and similarly to the active virtual learning, the participants were instructed to follow the experimenter’s vocal and gestural instructions, guiding them all along the route to be memorized. In contrast, regarding passive learning in the RE, the experimenter just said to the subjects to follow him, without giving any information, at any time, on the to-be-memorized route. The subjects were then totally passive in the learning phase, as they had just to follow the experimenter without cognitive anticipation on the moves to make to take the correct paths.

Concerning the test phase, all subjects were evaluated on the learned route at two different times: 48hr and 7 days after the learning phase. Moreover, at each recall phase, the subjects were evaluated using three types of test: (1) wayfinding; (2) sketch mapping; and (3) picture ordering. For each of the two recall phases, the order of the tests was randomly determined to counterbalance their administration between subjects.

The wayfinding task consisted of replicating, in the RE, the memorized route without time limit. During the test, in case of error, the participant was stopped by the experimenter who then indicated the correct path to the subject. At the end of the test, the total number of errors was noted by the experimenter. The sketch-mapping task consisted of a free-hand reproduction of the learned route in the form of a sketch on a piece of paper. The required sketch was a simple outline draw (i.e., connected arrows) reflecting the number of crossroads and direction changes. On this test, the performance score corresponded to the number of correct direction changes among the 18 crossroads. Finally, the picture ordering task consisted of a chronological sorting – from start to end of the route – of 12 pictures taken along the route in the RE, and presented to the subjects in a random order on a table. Here, a good answer was considered each time a two-picture series was relevant, even if the chronological order was not strictly correct (e.g., picture 5 followed by picture 6 or picture 8 followed by picture 11 scores 1). Then, the total number of good answers was noted among the 12-picture series. In all these tests, the subjects’ performance was expressed in terms of percentage of error.

CONTROL TESTS

To control the spatial skills of the subjects, all the participants performed three cognitive evaluations: (1) an orientation test (part five of the GZ Aptitude Survey, Guilford & Zimmermann, 1981); (2) The mental rotation test of Vandenberg and Kuse (1978); and (3) the spatial memory-span test from the WMS III (Wechsler, 2001). There was no significant differences in performance on these tests on the four experimental groups, $F(2,112) = 1.654$, $p > 0.20$.

RESULTS

Subjects’ spatial performance is presented in Table 1. The results were analyzed with a 2 (learning environment: real vs. virtual) \times 2 (exploration mode: active vs. passive) \times 2 (recall phase: 48hr vs. 7 days) mixed ANOVA applied on the percentage of error for each of the three spatial tests (i.e., wayfinding, sketch mapping, and picture ordering).

Wayfinding: The ANOVA reveals a significant effect for two factors: Learning environment, $F(1,55) = 14.585$, $p < .001$; and recall phase, $F(1,55) = 74.371$, $p < .0001$. First, examination of the means indicates that the subjects who learned the route in the RE ($M = 2.1\%$) showed better route performance than the subjects who learned in the VE ($M = 7.8\%$). Also, greater performance was obtained on the 7-day recall phase ($M = 1.8\%$) compared to the 48hr recall phase ($M = 8.2\%$), irrespective to the other manipulated factors. In contrast, no significant effects are observed on the exploration mode factor, $F(1,55) = 1.351$, $p = .250$, indicating no differences on spatial performance using either active ($M = 4.1\%$) or passive ($M = 5.8\%$) learning of the route.

Concerning the interaction effects, the Recall phase*Learning environment interaction is significant, $F(1,55) = 11.498$, $p < 0.002$. This indicates a greater benefit from the test-retest procedure on the subjects who learned the route in the RE compared to the subjects who learned in the VE. Actually, regarding the proportional decrease of errors (which was computed by dividing the score obtained on the 7-day recall phase by the score obtained on the 48hr recall phase, and then by subtracting this number to one), the results indicate that a proportional decrease of about 96.3% is obtained on the subjects who learned in the RE, while a proportional decrease of about only 72.7% is observed on the subjects who learned in the VE. In addition, none of the other two-way or three-way interactions were significant.

Sketch mapping: The ANOVA reveals a significant effect on the recall phase factor, $F(1,55) = 26.787$, $p < .0001$, indicating greater performance on the 7-day recall phase ($M = 14.4\%$) compared to the 48hr recall phase ($M = 25.4\%$). In contrast, no significant effects are observed depending on the exploration mode, $F(1,55) = 2.089$, $p = .154$, or the learning environment, $F(1,55) = 0.464$, $p = .499$. These results indicate no differences on spatial performance using either active ($M = 16.9\%$) or passive ($M = 22.8\%$) learning of the route, and no differences between the subjects who learned in the RE ($M = 18.5\%$) or the VE ($M = 21.2\%$), respectively. Moreover, none of the two-way or three-way interactions were significant.

Picture ordering: Similarly to the other tests, the ANOVA reveals a significant effect on the recall phase factor, $F(1,55) = 21.285$, $p < .0001$, indicating greater performance on the 7-day recall phase ($M = 18.7\%$) compared to the 48hr recall phase ($M = 31.6\%$). In contrast, no significant effects are observed depending on the exploration mode, $F(1,55) = 2.275$, $p = .137$, or the learning environment, $F(1,55) = 0.472$, $p = .496$. Again, these results indicate no differences on spatial performance using either active ($M = 21\%$) or passive ($M = 29.2\%$) learning of the route, and no differences between the subjects who learned in the RE ($M = 23.3\%$) or the VE ($M = 26.9\%$), respectively. Also, similarly to the sketch-mapping test, none of the two-way or three-way interactions were significant.

Table 1

Subjects' spatial performance, expressed in percentage of error, depending on the encoding conditions, and the retrieval phases and tests. Standard deviations are indicated in parentheses. RE = Real Environment; VE = Virtual Environment; WF= Wayfinding; SM = Sketch Mapping; PO = Picture Ordering

Encoding conditions		Retrieval phases and tests					
		WF		SM		PO	
		48h	7 days	48h	7 days	48h	7 days
RE	Active	3.9 (1.1)	0.0 (0.0)	17.7 (3.7)	12.6 (2.7)	30.0 (6.9)	10.7 (4.1)
	Passive	4.2 (1.0)	0.3 (0.3)	26.1 (4.2)	17.3 (4.3)	29.3 (6.1)	22.9 (5.4)
VE	Active	11.1 (2.3)	1.4 (0.9)	25.7 (5.6)	11.4 (1.9)	29.3 (7.6)	14.1 (3.6)
	Passive	13.4 (3.1)	5.3 (1.9)	31.6 (7.1)	16.1 (4.7)	37.8 (6.0)	26.5 (7.1)

GENERAL DISCUSSION

The aim of this study was to compare subjects' spatial performance on a pedestrian route depending on three factors: (1) the type of learning environment (real vs. virtual); (2) the exploration mode during the learning phase (active vs. passive); and (3) the type of spatial test administered at retrieval (i.e., wayfinding, sketch mapping, and picture ordering). Moreover, each subject was tested two times: 48hr and 7 days after the learning phase. Here, the main objective was to test the active exploration effect depending on a test-retest procedure.

First of all, regarding the sketch mapping and picture ordering tasks, the results indicate no differences on spatial performance between the subjects who learned the route in the RE or the VE, irrespective to the other manipulated factors. In other words, learning the route either in the VE or the RE permitted to obtain similar spatial performance on these two retrieval tests. Furthermore, although the subjects who learned the route in the RE showed better performance on the wayfinding test than the subjects who learned in the VE, it can be noted that, on average, less than 10% of error was observed in the VE group during the task. This low average score then tends to indicate good memorization of the route even in the participants who learned in the VE. In accordance with previous papers (e.g., Foreman et al., 2000; Péruch et al., 2000; Waller et al., 1998; Wilson et al., 1997), the results presented here indicates good spatial-knowledge transfer from VR to the real world. In terms of applied issues, and in the vein of increasingly numerous studies (e.g., Lam, Man, Tam & Weiss, 2006; Rose, Brooks & Rizzo, 2005; Tsirlin, Dupierrix, Chokron, Coquillart & Ohlmann, 2009), the results thus encourage the development of virtual training or rehabilitation programs addressed to spatial cognitive processes.

Concerning the exploration mode factor, it cannot be conclude here that active learning of the route increased its memorization, and therefore, the performance on the spatial tests. This result is in accordance with several papers in the literature (e.g., Gaunet et al., 2001; Wilson et al., 1997), but in opposition with others (e.g., Carassa et al., 2002; Péruch et al., 1995), and notably, previous work from our laboratory (Wallet et al., 2009a, 2009b). One explanation for this result could be the influence of the retention interval on the information. In fact, in our previous studies (Wallet et al., 2009a, 2009b), and similarly to other papers (e.g., Carassa et al., 2002; Péruch & Wilson, 2004), the subjects were tested on their memorization immedi-

ately after the learning phase (i.e., no retention interval). In contrast, in the present work, the subjects were tested for the first time 48hr after the learning phase, and for the second time, 7 days after memorizing the route. Then, as the retention interval of the information was the main factor that varied between the present study and our previous work, we can assume that it may be responsible for the different results that are observed. As evoked in the introduction, this suggestion can be supported by some studies of the literature demonstrating, for example, that a 30-min retention interval induced a significant difference on spatial performance between young and old adults (Rutledge et al., 1997). Consequently, we propose here that the 48hr retention interval of the information may have decreased the benefit from the active exploration of the environment on the spatial performance. Péruch and Wilson (2004) underlined that a review of the evidence on active and passive learning in VE suggests that both conditions have shown superiority under some conditions of learning and testing, but there is no consistent outcome pattern. Our results then tend to confirm Péruch and Wilson's suggestion, while indicating in addition, that the retention interval of the information may be an influent factor on the active exploration effect. In relation to the retention interval, further investigations should then be done to complete these preliminary results, and to test a wider range of intervals.

In contrast to the exploration mode factor, the test-retest procedure induced a major significant effect on the subjects' performance. Precisely, in all the retrieval tests, greater performance was obtained on the 7-day compared to the 48hr recall phase. This result can be explained by a training effect (e.g., Jennings & Jacoby, 2003; Mozolic et al., In Press; Rapp, Brenes & Marsh, 2002). Generally, multiple trials or learning phases in a task permit to improve memory performance of the subjects. In the present study, the 48hr recall phase was actually both a test phase and a second learning phase, as all the participants replicated the route in the RE at that time. Then, it can be assumed that the memory trace of the route was reinforced during the 48hr recall phase, yielding later to increased performance on the 7-day recall phase. To confirm this suggestion, it is then necessary to evaluate the subjects' performance directly 7 days after the learning phase, without the 48hr recall phase (work in progress in our laboratory).

One interesting result is that, regarding the sketch mapping and picture ordering tasks (i.e., in two of the three tests administered to the subjects), no interactions were ob-

served between the learning environment and recall phase factors. This indicates that both the subjects who learned the route in the RE or the VE increased their performance on the 7-day recall phase. This result demonstrates that the benefit from reactivated route memory on the 48hr recall phase is similar after learning in either the RE or the VE on these tasks. Therefore, it tends to confirm relevant primary learning of the route in the VE, and in terms of ecological issues, a benefit from virtual learning even 7 days after the learning phase.

Similarly to the test-retest procedure, the type of retrieval test seems to be an influential factor on the subjects' performance. Specifically, regarding the whole results, the best spatial performance was observed on the wayfinding task ($M = 5\%$), then on the sketch mapping test ($M = 19.5\%$), and, lastly, on the picture ordering task ($M = 25.5\%$). This result is consistent with our previous work (Wallet et al., 2009a, 2009b) and can be explained by the transfer-appropriate principle (e.g., Lockhart, 2002; Morris, Bransford & Franks, 1977; Park & Rugg, 2008). In fact, the wayfinding task is the only retrieval test that involves the entire replication of the memorized route, and consequently, offers the best match between the encoding and retrieval conditions, yielding to improved memory performance. Here, it can be noted that the fact that transfer-appropriate processing improves memory performance may be viewed as a moderating point to the conclusion of good spatial-knowledge transfer in the present experiment. As both the VE and RE groups were tested in the RE at the 48hr recall phase, it then can be assumed that the better adequacy between the 48hr and 7-day recall phases, compared to the adequacy between the learning and 48hr recall phases, may have "artificially" increased the spatial-knowledge transfer, and so the performance at the 7-day testing phase in the VE group. To verify this point, further investigations are needed and the VE groups should be tested in the VE at the 48hr recall phase, and thereafter, in the RE at 7 days. The VE groups should also be directly tested at 7 days without the 48hr recall phase.

Finally, as presented in the result section, the Recall phase*Learning environment interaction is significant on

the wayfinding test, and indicates greater benefit from the test-retest procedure in the subjects who learned the route in the RE, compared to the subjects who learned in the VE. The fact that this interaction was only significant on the wayfinding test shows that the test-retest procedure permitted to improve the benefit from the transfer-appropriate processing on the subjects' performance. In other words, the transfer-appropriate processing seems to have been potentiated by the training effect related to the testing procedure. It then underlines the importance of these two factors in the spatial-knowledge transfer of the information. Moreover, it further confirms the fact that the VE groups should also be tested in the VE at the 48hr recall phase, or be directly tested at 7 days without the 48hr recall phase, to eliminate the transfer-appropriate "bias", and therefore, validate the conclusions about good spatial-knowledge transfer.

In conclusion, the active exploration of the route does not seem here especially relevant to increase the subjects' performance. However, the transfer-appropriate processing of the information – that is particularly involved in the wayfinding task – and the training effect, both permit to obtain good spatial performance during the testing procedure.

CONCLUSION

The results presented in this paper lead to three main conclusions. First of all, and despite the moderations evoked above, they confirm that good spatial-knowledge transfer can occur from VR to the real world, and, therefore, encourage the development of virtual training or rehabilitation programs addressed to spatial cognitive processes. Secondly, the results show that the active exploration effect seems to be sensitive to the retention delay of the information. Lastly, they tend to demonstrate that the most influential factor on spatial-knowledge transfer from VE to RE may not be the active learning of the information, but the transfer-appropriate processing and the training benefit that can be involved in the testing procedure. Our future investigations will focus on the notion of retention interval, and on its influence on the active exploration effect and on the spatial-knowledge transfer from VE to RE.

REFERENCES

- Aret, A. (1991). The design of electronic map displays. *Human Factors*, 33, 85-101.
- Attree, E.A., Brooks, B.M., Rose, F.D., Andrews, T.K., Leadbetter, A.G. & Clifford, B.R. (1996). Memory processes and virtual environments: I can't remember what was there, but I can remember how I got there. Implications for people with disabilities. In P.M. Sharkey (Ed.), *Proceedings of the 1st European conference on disability, virtual reality, and associated technologies* (pp. 117-122). Maidenhead, UK.
- Bosco, A., Picucci, L., Caffò, A.O., Gyselinck, V., Lancioni, G.E. (2008). Assessing human reorientation ability inside virtual environments: The effects of retention interval and landmark characteristics. *Cognitive processing*, 9, 299-309.
- Brooks, B.M., Attree, E.A., Rose, F.D., Clifford, B.R. & Leadbetter, A.G. (1999). The specificity of memory enhancement during interaction with a virtual environment. *Memory*, 7, 65-78.
- Carassa, A., Geminiani, G., Morganti, F. & Varotto, S. (2002). Active and passive spatial learning in a complex environment: the effect of efficient exploration. *Cognitive processing*, 4, 65-81.
- Foreman, N., Stirk, J., Pohl, J., Mandelkow, L., Lehung, M., Herzog, A. & Lepow, B. (2000). Spatial information transfer from virtual to real versions of the Kiel locomotor maze. *Behaviour Brain Research*, 112, 53-61.
- Gaunet, F., Vidal, M., Kemeny, A. & Berthoz, A. (2001). Active, passive and snapshot exploration in a virtual environment: Influence on scene memory, reorientation and path memory. *Cognitive Brain Research*, 11, 409-420.
- Gould, N.F., Holmes, M.K., Fantie, B.D., Luckenbaugh, D.A., Pine, D.S., Gould, T.D., Burgess, N., Manji, H.K. & Zarate, C.A. (2007). Performance on a virtual reality spatial memory navigation task in depressed patients. *American Journal of Psychiatry*, 164, 516-519.
- Guilford, J.P. & Zimmermann, W.S. (1981). *Guilford-Zimmerman Aptitude Survey: Manual of instructions and interpretations*. Minneapolis: Consulting psychologists press.
- Jennings, J.M. & Jacoby, L.L. (2003). Improving memory in older adults: Training recollection. *Neuropsychological Rehabilitation*, 13, 417-440.
- Lam, Y.S., Man, D.W.K., Tam, S.F. & Weiss, P.L. (2006). Virtual reality training for stroke rehabilitation. *NeuroRehabilitation*, 21, 245-253.
- Lockhart, R. (2002). Levels of processing, transfer appropriate processing, and the concept of robust encoding. *Memory*, 10, 397-403.
- Mann, K., Günther, A., Stetter, F. & Ackermann, K. (1999). Rapid recovery from cognitive deficits in abstinent alcoholics: A controlled test-retest study. *Alcohol and Alcoholism*, 34, 567-574.
- Morris, C., Bransford, J. & Franks, J. (1977). Levels of processing versus transfer appropriate processing. *Journal of Verbal Learning and Verbal Behavior*, 16, 519-533.
- Mozolic, J.L., Long, A.B., Morgan, A.R., Rawley-Payne, M. & Laurienti P.J. (In Press, corrected proof). A cognitive training intervention improves modality-specific attention in a randomized controlled trial of healthy older adults. *Neurobiology of Aging*. doi:10.1016/j.neurobiolaging.2009.04.013
- Park, H. & Rugg, M.D. (2008). The relationship between study and processing and the effects of cue congruency at retrieval: fMRI support for transfer appropriate processing. *Cerebral Cortex*, 18, 868-875.
- Péruch, P., Belingard, L., & Thinus-Blanc, C. (2000). Transfer of spatial knowledge from virtual to real environments. In C. Freska, W. Brauer, C. Habel and K.F. Wender (Eds), *Spatial cognition II* (pp. 253-264). New York: Springer, Berlin Heidelberg.
- Péruch, P. & Corazzini, L.L. (2003). Se déplacer et naviguer dans l'espace. In J. Fuchs, G. Moreau

- and J.P. Papin (Eds), *Traité de la réalité virtuelle* (pp. 189-208). Nantes : Les Presses de l'Ecole des Mines.
- Péruch, P., Vercher, J.L. & Gauthier, G.M. (1995). Acquisition of spatial knowledge through visual exploration of simulated environments. *Ecological Psychology*, 7, 1-20.
- Péruch, P. & Wilson, P.N. (2004). Active versus passive learning and testing in a complex outside built environment. *Cognitive Processing* 2004, 5, 218-227.
- Rapp, S.R., Brenes, G. & Marsh, A.P. (2002). Memory enhancement training for older adults with mild cognitive impairments: A preliminary study. *Aging & Mental Health*, 6, 5-11.
- Rose, F.D., Brooks, B.M. & Rizzo, A.A. (2005). Virtual reality in brain damage rehabilitation: Review. *CyberPsychology & Behavior*, 8, 241-262.
- Rutledge, P.C., Hancock, R.A. & Walker, L. (1997). Effects of retention interval length on young and elderly adults' memory for spatial information. *Experimental Aging Research*, 23, 163-177.
- Tlauka, M., Donaldson, P.K. & Wilson, D. (2008). Forgetting in spatial memories acquired in a virtual environment. *Applied Cognitive Psychology*, 22, 69-84.
- Tong, F.H., Marlin, S.G. & Frost, B.J. (1995). Visual-motor integration and spatial representation in a visual virtual environment. *Investigate Ophthalmology and Visual Science*, 36, 1679-1689.
- Tsirlin, I., Dupierrix, E., Chokron, S., Coquillart, S. & Ohlmann, T. (2009). Uses of virtual reality for diagnosis, rehabilitation and study of unilateral spatial neglect: Review and analysis. *CyberPsychology & Behavior*, 12, 175-181.
- Tyndiuk, F., Lespinet-Najib, V., Thomas, G., N'Kaoua, B., Schlick, C. & Claverie, B. (2007). Etude des caractéristiques de l'utilisateur, de la tâche et de l'interface en réalité virtuelle. *European Review of Applied Psychology*, 57(4), 225-236.
- Vandenberg, S.G. & Kuse, A.R. (1978). Mental rotations, a group test of three-dimensional spatial visualization. *Perceptual and Motor Skills*, 47, 599-604.
- Waller, D., Hunt, E. & Knapp, D. (1998). The transfer of spatial knowledge in virtual environment training. *Presence: Teleoperators and Virtual Environments*, 7, 129-143.
- Wallet, G., Sauzéon, H., Arvind Pala, P. & N'Kaoua, B. (2009a). *Benefit from active exploration on the Transfer of spatial knowledge: Impact of the visual richness of interface*. Annual CyberTherapy and CyberPsychology 2009 conference. DOI:10.3389/conf.neuro.14.2009.06.099
- Wallet, G., Sauzéon, H., Rodrigues, J. & N'Kaoua, B. (2009b). Use of virtual reality for spatial knowledge transfer: effects of passive/active exploration mode in simple and complex routes for three different recall tasks. *VRST '08*. New York, NY: ACM, pp. 175-178. DOI:http://doi.acm.org/10.1145/1450579.1450616.
- Weschler, D. (2001) *Echelle clinique de mémoire de Weschler MEM III (WMS-III)*. Paris: Les éditions du Centre de Psychologie Appliquée.
- Williams, H.P., Hutchinson, S. & Wickens, C.D. (1996) A comparison of methods for promoting geographic knowledge in simulated aircraft navigation. *Human Factors*, 38, 50-64.
- Wilson, P.N., Foreman, N., Gillett, R. & Stanton, D. (1997). Active versus passive processing of spatial information in a computer-simulated environment. *Ecological Psychology*, 9 (3), 207-222.
- Wilson, P.N., Foreman, N. & Tlauka, M. (1997). Transfer of spatial information from virtual to real environment. *Human Factors*, 39, 526-531.
- Wilson, P.N. & Péruch, P. (2003). The influence of interactivity and attention on spatial learning in a desk-top virtual environment. *Current Psychology of Cognition*, 21, 601-633.
- Witmer, B.G., Bailey, J.H. & Knerr, B.W. (1996). Virtual spaces and real world places: transfer of route knowledge. *Human-Computer Studies*, 45, 413-428.

A SERIOUS GAME FOR TOTAL KNEE ARTHROPLASTY PROCEDURE, EDUCATION AND TRAINING

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Traditionally, orthopaedic surgery training has primarily taken place in the operating room. Given the growing trend of decreasing resident work hours in North America and globally, due to political mandate, training time in the operating room has generally been decreased. This has led to less operative exposure, teaching, and feedback of orthopaedic surgery residents. We present a 3-D serious game that was designed using an “iterative test-and-design” method, for the purpose of training orthopaedic surgery residents the series of steps comprising the total knee arthroplasty (replacement) procedure, using a problem-based learning approach. Before implementing the serious game into teaching curricula, the first step, and the purpose of the current instigation, was to conduct a usability study to address user perceptions of the game’s ease of use, and the potential for learning and engagement. Real-time, 3-D graphical and sound rendering technologies are employed to provide sensory realism consistent with the real world. This will ensure that the knowledge gained within the serious game can be more easily recalled and applied when the trainee is placed in the real world scenario. Usability test results indicate that the serious game is easy to use, intuitive, and stimulating.

Keywords: Total Knee Arthroplasty, Serious Games,
Virtual Simulations, Learner-centered Teaching, Interactive Learning

INTRODUCTION

Total knee replacement, or total knee arthroplasty (TKA), is a surgical procedure whereby the painful arthritic knee joint surfaces are replaced with metal and polyethylene components that serve to function in the way that bone and cartilage previously had. This provides patients who have experienced painful, deformed, and unstable knees, with reproducible pain relief and improved functionality (Park, Yoon, Kim, Lee, & Han, 2007). Approximately 130,000 knee replacements are performed annually in the United States alone, and the procedure has been rated among the most successful surgical interventions across all surgical specialties, with respect to reliability of results and patient satisfaction

(Lavernia, Sierra, & Hernandez, 2000). In short, TKA involves replacing the articular joint surface of the femur, the tibia, and possibly the patella. Relatively speaking, the tibial and patellar component implantation requires fewer steps and fewer considerations. Correct implantation of the femoral component however is an extremely “position sensitive” surgical procedure and must take into account joint range of motion, limb alignment, degenerative and genetic anatomic abnormalities, and soft tissue releases amongst other factors (Laskin, 1991). The TKA procedure is comprised of a number of steps that are followed sequentially, and each step may involve the use of a variety of specialized surgical tools and equipment.

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The nuances, problem solving, and troubleshooting that surround orthopaedic surgery, and surgery in general, is acquired in the operating room as the trainee/resident is simultaneously focusing on his/her technical skill. However, such “hands-on” training of residents leads to increased resource consumption (e.g., monetary, faculty time, and time in the operating room). A study by Lavernia et al. (2000) examined the cost of TKA surgery at teaching hospitals vs. non-teaching hospitals. They found patients who underwent surgery at a teaching hospital had higher associated charges (\$30,311.00 ±\$3,325.00 as opposed to \$23,116.00 ±\$3,341.00 in a non-teaching hospital; in US funds), in addition to longer times in the operating room (190 ±19 minutes as opposed to 145 ±29 minutes in a non-teaching hospital). They attribute the increases in resource consumption to the “hands-on” approach required to train residents. However, there is a growing trend of decreasing resident work hours in North America and globally due to political mandate (Zuckerman, Kubiak, Immerman, & DiCesare, 2005). This has led to decreased training time in the operating room and hence less operative exposure, teaching, and feedback (Weatherby, Rudd, Ervin, & Staff, 2007). Operative time must be maximized in order to maintain a high level of surgical training. Although the amount of repetition necessary to obtain the surgical competence required of residents is still unclear, medical literature suggests that technical expertise is acquired through years of practice (Ericsson, Krampe, & Tesch-Romer, 1993) and indicates a positive correlation between volume and patient outcome (Halm, Lee, & Chassin, 2002). Regardless of the amount of repetition necessary to obtain the surgical competence that is required of residents, it is evident that given the increasing time constraints, trainees are under great pressure to acquire complex surgical cognitive and technical skills. Therefore, efforts must be made to optimize operative room exposure. Furthermore, there is little available time either for the attending surgeon or the trainee, given other clinical and academic responsibilities.

Other available alternative methods for surgical training include the use of animals, cadavers, or plastic models; each option with its share of problems (Heng et al., 2004). More specifically, animal anatomy can vary greatly from humans, cadavers cannot be used multiple times, and plastic models don't necessarily provide realistic visual and haptic feedback (Heng et al., 2004). Simulations offer a viable alternative to practice in an actual operating room, offering residents the opportunity to train until they reach a specific competency level. Simulations range from de-

contextualized bench models and Virtual Reality (VR)-based environments, to high fidelity recreations of actual operating rooms (Kneebone, 2009). Although VR-based technologies have been incorporated in the teaching/training curricula of a large number of professions across various lines of work (including surgery) for several decades, the rising popularity of video games has seen a recent push towards the application of video game-based technologies to teaching and learning. Serious games, that is video games whose main purpose is not entertainment but rather teaching and learning, along with the growing popularity of video games, particularly with today's generation of students/learners, leverage the advances made in the video game realm to overcome some of the problems and limitations associated with traditional teaching methods, including surgical training techniques. Although virtual simulations and serious games are similar and can employ identical technologies (hardware and software), being a video game, serious games should strive to be fun and include some of the primary aspects of games including challenge, risk, reward, and loss.

Here we present the design and development of an interactive serious game for the purpose of training orthopaedic surgery residents the series of steps comprising the TKA procedure, using a problem-based learning approach. Before implementing the serious game into teaching curricula, the first step, and the purpose of the current instigation, was to conduct a usability study to address user perceptions of the game's ease of use, and the potential for learning and engagement. We employed an “iterative test-and-design” method whereby the serious game was refined during the design and implementation phase, based on the results of the usability study that was conducted with game development experts and orthopaedic surgery residents. In addition to assisting in the development phase, usability test results indicate that the serious game is easy to use, intuitive, and stimulating. From an educational perspective, we hypothesize that by learning the total knee arthroplasty procedure in a fun and interactive “first-person-shooter gaming environment,” that the trainees will have a better understanding of the cognitive process and ability to focus solely on the technical aspects of learning, and will therefore be able to focus on the technical aspect of the procedure in higher fidelity physical models or in the operating room (this will be tested in the future).

PAPER ORGANIZATION

The remainder of the paper is organized as follows. A brief

review of serious games and virtual simulations along with their use in orthopaedic (knee) surgery is provided in Section 2. Details regarding the serious game proposed here are provided in Section 3. Usability test results are presented in Section 4, while a discussion, concluding remarks, and plans for future research are provided in Section 5.

BACKGROUND

Traditional teaching-and-learning environments often do not address the learning needs of the current generation of millennial students (the generation raised in the sensory-flooded environment of digital technology and mass media e.g., the “Internet generation” (Prensky, 2005)) who prefer teamwork, experiential activities, structure, and the use of technology. Furthermore, traditional classroom teaching environments present a teacher-centered approach to learning whereby the teacher controls what is being learned and when. This is in contrast to the fact that such approaches have been proven to be ineffective for today’s generation of students who prefer a learner-centered teaching approach whereby they (the students) control the learning through interactivity allowing them to learn via active, critical learning (Stapleton, 2004). The fact that the millennial generation has always been digitally connected has led to a mindset unlike any that medical faculty have ever seen. Understanding this mindset is an important aspect of educational planning and course development. Specifically, according to Villeneuve and MacDonald (2006), this generation does not remember a time without e-mail, Internet, cell phones, laptop computers, or video game consoles. In fact, according to a report released by the Kaiser Family Foundation, 83% of 8 to 18 year-olds have a video game console at home, 56% have two or more consoles, 55% own a handheld video game player, and on average, spend about one hour playing video games every day (Rideout, Roberts, & Foehr, 2005). Their unique way of being and knowing has largely influenced the learning needs of this generation of students. It is not surprising that this generation views technology as a necessity both in life and learning, and highly regards “doing rather than knowing,” making interactive, experiential learning a necessity for their educational success (Mangold, 2007).

Although no particularly clear definition of the term is currently available, serious games usually refer to games that are used for training, advertising, simulation, or education, and are designed to run on personal computers or video game consoles (Susi, Johannesson, & Backlund, 2007).

Serious games have also been referred to as “games that do not have entertainment, enjoyment, or fun as their primary purpose” (Michael & Chen, 2006). A serious game can more formally be defined as an interactive computer application, with or without a significant hardware component, that (i) has a challenging goal, (ii) is fun to play and/or engaging, (iii) incorporates some concept of scoring, and (iv) imparts to the user a skill, knowledge, or attitude that can be applied to the real world (Bergeron, 2006). Serious games “leverage the power of computer games to captivate and engage players for a specific purpose such as to develop new knowledge or skills” (Corti, 2006). In addition to promoting learning via interaction, there are various other benefits to serious games. More specifically, they allow users to experience situations that are difficult (even impossible) to achieve in reality due to a number of factors including cost, time, and safety concerns (Squire & Jenkins, 2003). Serious games support the development of various skills including analytical and spatial, strategic, recollection, and psychomotor skills as well as visual selective attention (Mitchell & Savill-Smith, 2004). Further benefits of serious games include improved self-monitoring, problem recognition and solving, improved short- and long-term memory, and increased social skills (Mitchell & Savill-Smith, 2004). The term serious games is rather new, dating back to 1992, but despite its relatively recent adoption to the field of game development, serious games and virtual simulations in general have been used by the United States military, medical schools, and in academia before the term was introduced (Bergeron, 2006). A complete review of serious games/virtual simulations used by the military, in medical schools, and in academia, is beyond the scope of this paper. Here we describe several virtual simulations developed specifically for orthopaedic (knee) surgery.

Park et al. (2007) present a virtual simulation system for total knee replacement. Their system is based on mechanical computer-aided design (CAD) software and implemented using basic CAD functionality such as shape modeling, assembly, automation, etc., allowing surgeons to determine important surgical parameters prior to the operation itself. Ting et al. (2003) describe a VR system for unicompartmental knee replacement surgery training using a typical PC-based system and low-cost, six-degrees of freedom (motion), and three-degrees of freedom (force/resistive) manual manipulator. They model both the soft and skeletal tissue of the knee (based on computerized tomography scans) as well as an assortment of surgical tools. Using the manual manipulator, trainees are able to

interact with the model, performing the surgical steps. In addition to virtual simulations/serious games for total knee arthroplasty, a number of virtual simulations have been developed for arthroscopic knee surgery. Mabrey et al. (2000) developed a VR system for arthroscopic knee surgery. Their system consists of a typical PC, video display, and two force-feedback haptic devices. Forces that would normally be applied by the surgeon to the lower limb during the arthroscopy procedure are directed to a surrogate leg. Proprietary software provides a mathematical representation of the real world while mimicking the mechanical, visual, and behavioral aspects of the knee. Cannon et al. (2006) describe the development of an arthroscopic VR knee simulator to train orthopaedic residents arthroscopic surgery techniques before they begin to practice with “live patients” in the operating room. Their simulation employs realistic human knee models derived from the US National Library of Medicine’s Visible Human Dataset. Arthroscopic virtual simulations have also been developed by Zhang et al. (2003), and Heng et al. (2004).

Previous work involving virtual simulations for total knee arthroplasty, including the systems described above, have ignored the “gaming” element (e.g., risk, reward, loss, and fun). In contrast, we present a serious game where the goal is for the user/trainee to successfully complete the TKA procedure in a fun and interactive “first-person-shooter” gaming environment. Furthermore, since our long term research goal is to examine how levels of realism affect transfer of knowledge, we have chosen to focus on realism and more specifically, rendering of very accurate models and the complex lighting requirements of the operating room.

THE SERIOUS GAME

The TKA serious game is intended to serve as a memory aid to students learning the procedure and to be used in conjunction to other “traditional” learning materials including books, and videos. The goal is for the user/trainee to successfully complete the TKA procedure, focusing on the ordering in which steps are performed and on the tools required to perform each step, as opposed to the technical aspects of the procedure, while maximizing their score (points are either added or taken away based on the trainee’s (player’s) actions). There is also a mechanism in place to allow “games within the game,” whereby at various points in the game, the user can be presented with a “sub-game” where they are required to perform a small task related to the step they are performing. Currently, sub-games are restricted to one or two multiple choice questions randomly selected from a predefined list of

questions. Answering these multiple questions correctly allows the user to accumulate further points.

OVERVIEW

Users begin the serious game in the operating room taking on the role of the orthopaedic surgeon, viewing the scene in a first-person perspective. The world is viewed through the viewpoint of the user’s avatar and as such, the avatar’s body is not viewed (except for their hand). Several other non-player characters (NPCs) also appear in the scene including the patient (lying on a bed), assistants, and nurses. Currently, the NPCs are not animated and are not user controllable. Future versions will allow them to be controlled remotely by other users or controlled using artificial intelligence techniques. The user/trainee has the ability to move and rotate the “camera” using the mouse in a first-person style, thus allowing them to move within the scene. A cursor appears on the screen and the trainee can use this to point at specific objects and locations in the scene. A sample screenshot is provided in Figure 1.



Figure 1. Sample screenshot of the environment as seen by the user’s avatar in a first-person perspective – only the user’s avatar hand is visible.

Objects that can be selected will appear to glow when the cursor is placed over them. “Selectable objects” include the NPCs (assistants and nurses) in addition to the surgical tools. When a highlighted object is clicked on, a menu appears providing a list of selectable options for this particular object. For example, clicking on a nurse or an assistant allows the user to interact with them (e.g., ask them to hand over a particular tool or perform a specific task; see Figure 2(a)). The surgical tools are also selected using the cursor and once a particular tool is selected, the tool appears in the hands of the user’s avatar. Such as, after requesting the drill, the drill appears in the hand of the user’s avatar (see Figure 2(b)). Once the tool has been chosen, if the patient’s

knee is selected using the cursor, a menu appears providing the user a list of options corresponding to that step. For instance, if the user chooses the scalpel and then clicks the patient's knee, a menu appears prompting the user to choose how big the incisions should be.

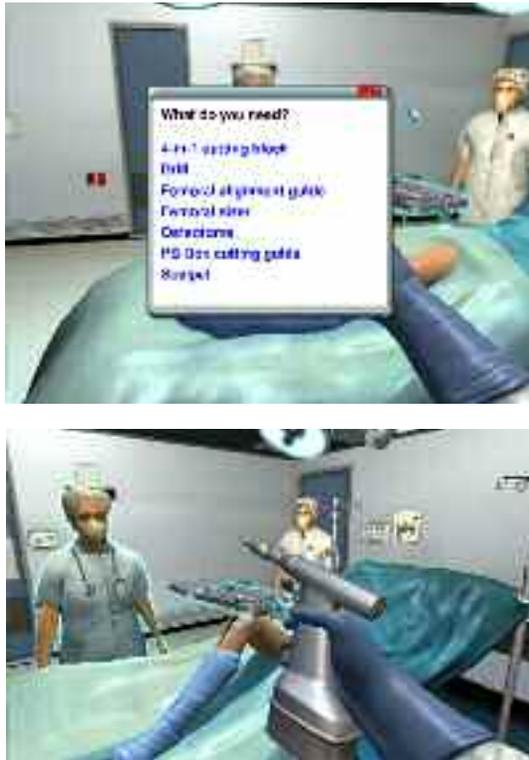


Figure 2. Sample screenshots: (a, top) Choosing the selectable surgical assistant/nurse results in the menu providing the user with a list of potential tools they can choose; (b, bottom) After choosing the surgical drill, the drill is in the hand of the user's avatar. The user can then proceed to perform the appropriate next step.

Once the correct step is chosen, they will be asked a multiple choice question to test their knowledge of that step. Answering correctly results in a number of “points” earned which are added to an accumulating score. If the user answers the multiple choice question incorrectly, they are corrected by an “animated angry assistant” in the form of dialogue speech (that, as described below, is voice acted and is intended to provide a “fun” factor) along with text and/or illustrations (in a pop-up window) to ensure they understand why their answer was incorrect (see Figure 3). If they answer the question correctly, they are presented a

short video segment illustrating a surgeon performing that particular step on a “real” patient with the surgeon narrating the details of the step). If the user chooses an incorrect tool(s) for the corresponding step or performs a step out of order, he/she is also corrected once again by an “animated angry assistant” and are presented a text description often accompanied by a diagram of the procedure (see Figure 3). When the procedure is complete, the player is shown a score card listing the number of questions answered incorrectly, the number of tools selected out of order, and the overall score (as a percentage of correct responses (see Figure 4 for a sample score card)).

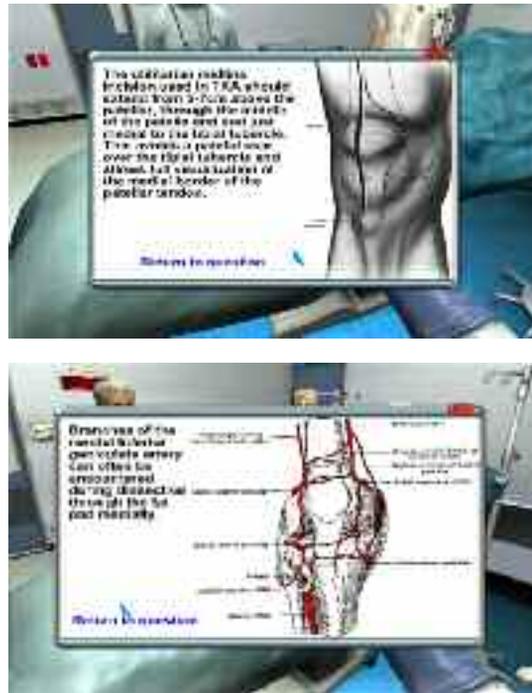


Figure 3. Sample screenshots: If the user chooses an incorrect tool(s) for the corresponding step or performs a step out of order, they are corrected once again by an “animated angry assistant” and are presented a short video segment illustrating a surgeon performing that particular step on a “real” patient with the surgeon narrating the details of the step, or with detailed information (text and images) regarding the procedure.

TECHNICAL DETAILS

GRAPHICS

The 3-D rendering engine was built “in-house” using the C++ programming language and the OpenGL 3-D graphics API.



Figure 4

Sample score card provided to the user after completion of the procedure.

Rendering in real-time was accomplished using the graphics processing unit (GPU); “shaders” (GPU-based software) were written using the OpenGL shading language (GLSL) (Rost, 2006). Sound effects were rendered using the FMOD music and sound effects system. The operating room was faithfully modeled after an actual operating room at Mount Sinai Hospital in Toronto, Canada. Low polygon count models were developed using the Maya 3-D modeling and visual effects software, and 3-Ds Max modeling and rendering software. The Z-Brush “digital sculpting” tool was used to develop a high polygon count version of the models originally developed with Maya. Mental Ray was used for “baking” and simulating the light, UV layout was used to apply UV mapping to all the models, and Xnormal was used for “baking” all the model normal maps. Finally, the serious game is unique in that it utilizes video game effects such as “outer glow” (the outer glow is used to indicate a “selectable object”), “reflection mapping,” and “bloom filtering,” to generate realistic metal surfaces (for the tools, lights, etc.). Such effects are accomplished using the graphics hardware to ensure real-time frame rates.

The menus and pop-up windows are designed to look and behave similar to typical webpages to ensure the interface is intuitive and familiar to the majority of users. The “clickable” text appearing in a menu and pop-up window is blue just like typical links found on a webpage while non-clickable text appears black. Clickable text also changes to a lighter blue when the mouse is over it, again imitating typical webpages. Users can click on the red “X” in the top right corner of the menu/pop-up window to close the menu similar to a web browser.

GAME SOUND

Background sound included a recording made during an actual total knee replacement surgical procedure in an operating room. Although the background sound does not include any dialogue, it does capture the typical ambient sounds present during the TKA procedure including the prominent sound of the anaesthetic machine. Background (mono) sound recordings were made using a Zoom H4n portable field recorder with a 24-bit quantization level and a 44.1 kHz sample rate.

Dialogue (speech) from the nurses and surgical assistants is included within the game. Dialogue/speech is used for output only to provide the user with feedback, and an indication of how well or poorly the user is doing. Dialogue is also used to increase the game’s “fun factor.” For example, if the surgeon asks for the incorrect tool at a particular step in the procedure, the nurse/surgical assistant may respond with the following phrases: “Are you sure that’s what you want,” or “Oh, that’s not what we usually use next.” If the user progresses through a number of steps of the procedure correctly, the nurse/surgical assistant may respond with: “Doctor, you really are on the ball today.” In addition, speech that is commonly heard throughout the knee replacement procedure is also output at various stages of the game. Several sample speech phrases are provided in Table 1.

Table 1

Sample dialogue spoken by the nurse/surgical assistant to the surgeon/user

Section	Sample Line
Inquiries (calm)	“Doctor, we are prepared to begin.”
Inquiries (hurried)	“We’re on the clock, doctor.”
Correct responses	“Check.”
Incorrect responses	“This looks like a job for a different surgical instrument.”
Joke (incorrect)	“Doctor, that’s the wrong leg.”

Two voice actors were used for the dialogue/speech and the recordings were made in an Eckel audiometric room to limit external noise/interference. Dialogue was recorded using Digidesign's Pro Tools LE v 7.1 (with a 24-bit quantization level, and a 44.1 kHz sample rate) and an Apex 415 studio condenser microphone (omni-directional polar pattern).

PRELIMINARY USABILITY STUDY RESULTS

As previously described, the serious game was developed using an "iterative test-and-design" methodology whereby the final implementation accounted for the feedback from orthopaedic surgery residents, and game development students obtained via a usability study (institutional ethics approval was obtained for this study). Usability studies were carried out in a focus group setting in which the participants were provided a brief (five minute) overview of the serious game (purpose, how to use it, etc.), followed by a 30 minute exploratory period that involved using the serious game and freely exploring its interface/options. Finally, participants were asked to complete a brief questionnaire which comprised a subset of questions (32) from the Questionnaire for User Interaction Satisfaction (QUIS) (Shneiderman, 1998). QUIS is a tool developed by a multidisciplinary team of researchers to assess users' subjective satisfaction with specific aspects of the human-computer interface and is highly reliable across many types of interfaces (Shneiderman, 1998). The questions measure the users' overall satisfaction with some aspect of the interface, and the factors that make up that facet on a 9-point scale. In addition to the QUIS-based questions, the questionnaire contained

several "open-ended" questions where participants were asked for any comments/suggestions regarding the serious game and more specifically, its graphical user interface. The participants consisted of seven unpaid senior students from the Game Development program at the University of Ontario Institute of Technology, and four unpaid orthopaedic surgery residents from the Department of Surgery, University of Toronto. Two separate sessions were held – one session for the game development students and the other for the orthopaedic surgery residents. In total, each focus group session lasted approximately one hour. A small sample size was employed in order to perform an "initial assessment" test to detect and correct the majority of usability issues (if any) early in the design phase prior to the final serious game implementation (i.e., to allow for an "iterative test-and-design" manner) (Turner, Lewis, & Nielson, 2006; Virzi, 1992).

The following features were highlighted by the participants as necessary in order to enhance realism, navigation, immersion, and educational benefit and have been taken into account in the current implementation stage:

1. Provide various alternatives for moving objects (e.g., both mouse, and "W, A, S, D" keys).
2. Rendering effects are very important.
3. Incorporate videos of some of the procedure tasks as a source of information.
4. Incorporate audio/sound cues while performing the tasks.

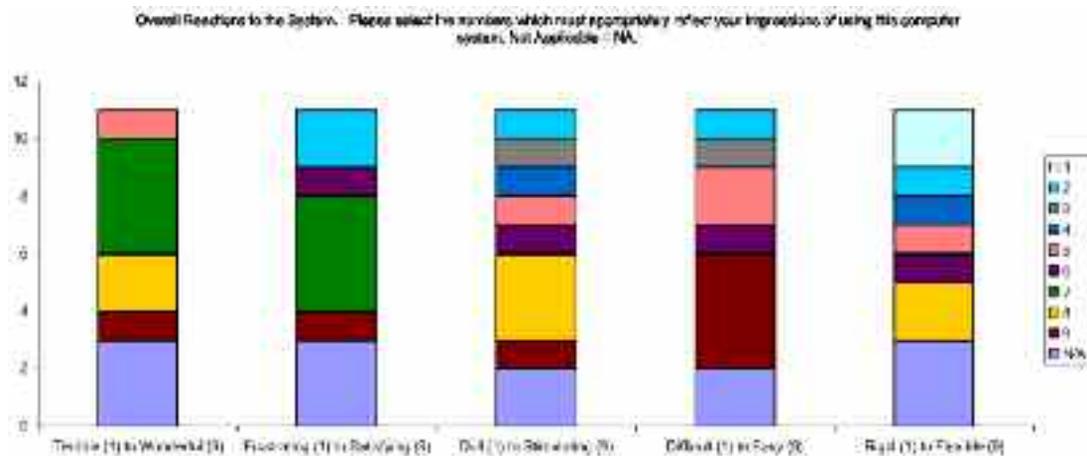


Figure 5. Results: Overall reactions to the system.

5. Allow users to select the level of difficulty for a given task.

6. Provide training strategies on the features and use of the game such as an instructional webpage or educational workshops.

7. Lack of time is a potential threat to using such types of games.

The 32 QUIS-based questions were classified into four categories:

1. Overall reactions to the system.

2. Graphics and sound.

3. Learning.

4. System capabilities.

A summary of the results appear in the bar graphs of Figures 5-8 where, for each question in each category, the number of responses from each of the 10 choices (1-9 in addition to N/A or non-applicable) is shown (color coded). The results from Category 1 are shown in Figure 5. The majority of participants believed that the serious game was good, were satisfied with it, and believed that it was adequately stimulating and easy to use.

Category 2 results are shown in Figure 6. The majority of participants indicated that the serious game had good graphics, found the highlighting feature (used to indicate a “clickable” object) to be useful, and found that the amount of information provided was adequate and logically arranged on the screen.

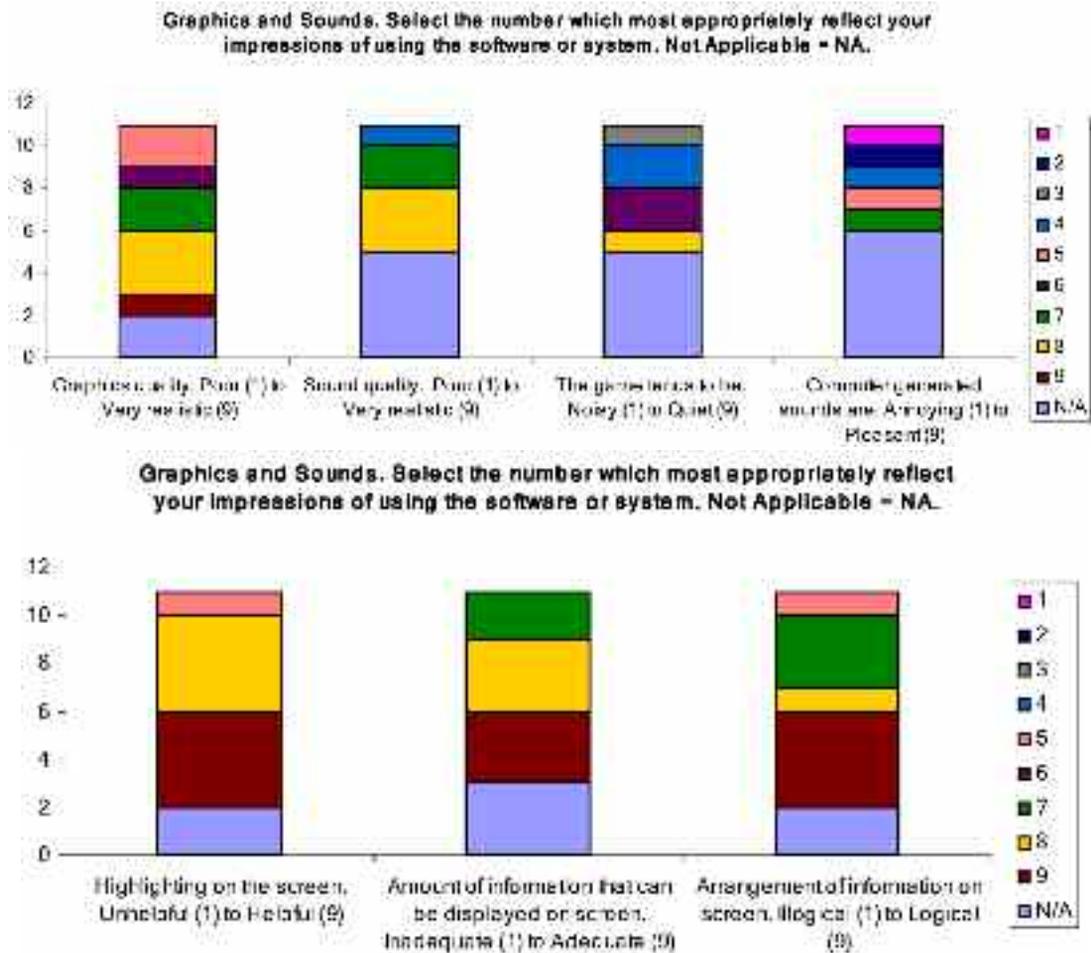


Figure 6(a, top, b, bottom). Results: Graphics and sound.

Category 3 results are shown in Figure 7. The majority of participants indicated that the serious game was adequate with respect to allowing them to learn how to operate it, to learn advanced features, to explore and discover new features, and to remember previously used commands. Moreover, participants believed that the serious game was properly designed to provide a logical sequence to complete tasks and that it provides feedback on the completion of particular steps.

The results from Category 4 are shown in Figure 8. The majority of participants indicated that the system was fast enough with respect to response time for most operations and the display of information. They also indicated that the serious game was adequately reliable, failures rarely occurred, that it provided them the opportunity to correct mistakes, that it provided the ability to undo operations, and that it adjusted to the user's prior experience level.

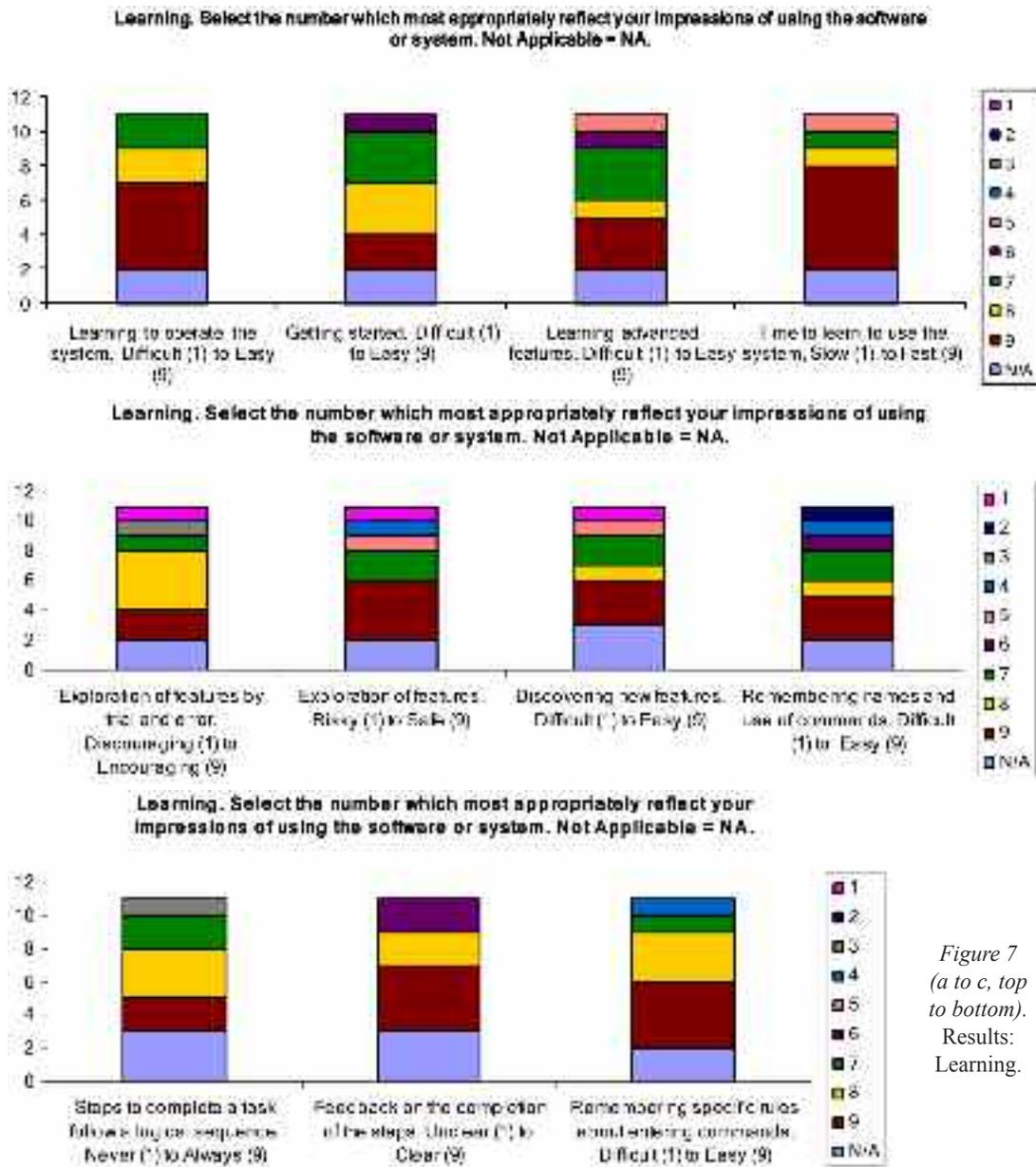


Figure 7 (a to c, top to bottom). Results: Learning.

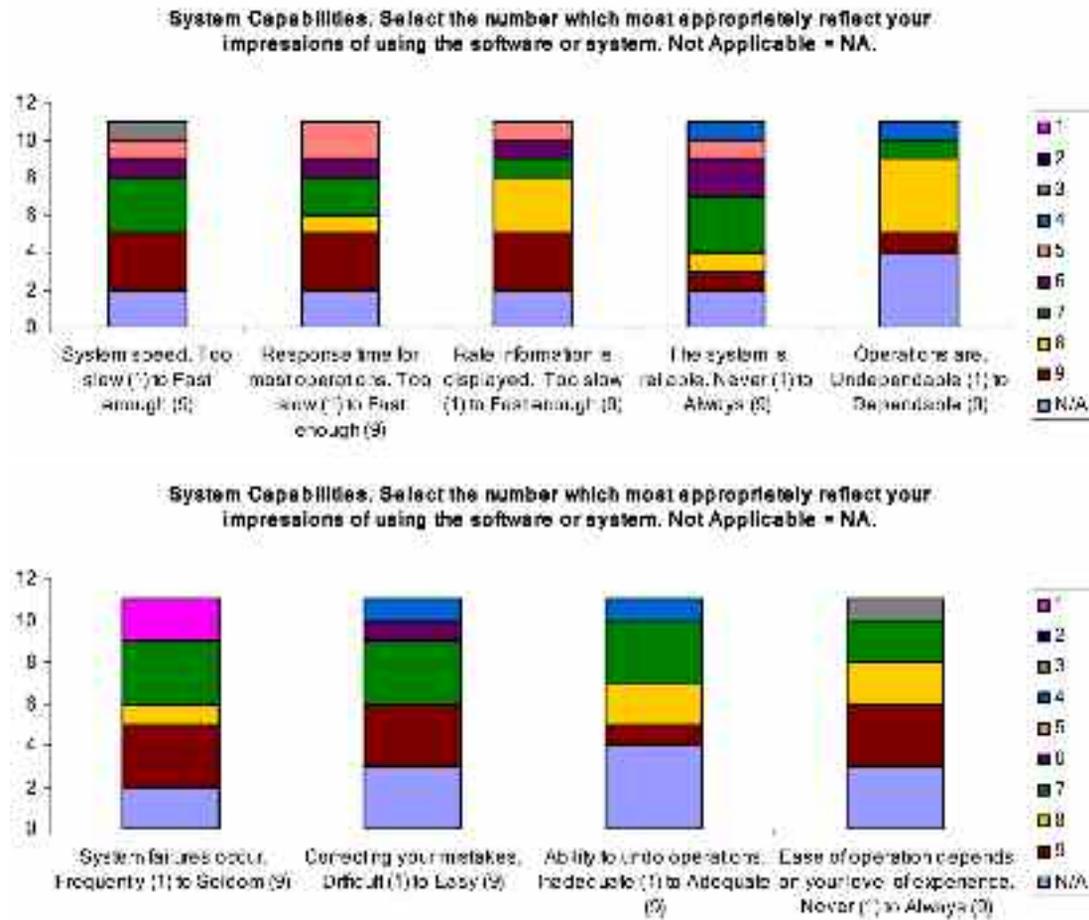


Figure 8(a, top, b, bottom). Results: System capabilities.

DISCUSSION AND SUMMARY

Total knee arthroplasty (TKA) is a commonly performed surgical procedure whereby knee joint surfaces are replaced with metal and polyethylene components that serve to function in the way that bone and cartilage previously had. Surgical training has predominantly taken place in operating rooms placing a drain on the limited available operating room resources. Simulations, both physical and virtual, have been effectively used to complement residents’ training and education. Serious games, or the use of video game-based technologies for applications whose primary purpose is other than entertainment, have become very popular. In addition to promoting learning via interaction, serious games allow users to experience situations that are difficult (even impossible) to achieve in reality and they support the

development of various skills including analytical and spatial, strategic, recollection, and psychomotor skills as well as visual selective attention. Here we described a serious game that leverages the power of computer games to captivate and engage orthopaedic surgery residents, while training and educating them about total knee arthroplasty procedures in a fun and engaging manner.

An initial usability study confirms that the serious game is easy to use, intuitive, and stimulating. The purpose of the usability test was two-fold: (i) to perform an “initial assessment test” of the serious game; and (ii) to obtain and incorporate any comments regarding the serious game and more specifically, the user interface into the final implementation. Despite the small number of participants (11),

previous influential studies that have investigated sample size with respect to usability studies have revealed that the majority of usability problems are detected with the first three to five participants. Also, more importantly, when including additional participants within the same study it is unlikely any new information will be revealed (Lewis, 1994; Nielson & Landauer, 1993; Turner et al., 2006; Virzi, 1992). Virzi (1993) claims that running usability tests using small samples in an iterative test-and-design fashion will identify most usability problems and lead to both time and money savings. This claim is based on the outcome of a series of earlier experiments conducted by Virzi (1992): (i) observing four or five participants allows practitioners to discover 80% of a product's usability problems; (ii) observing additional participants reveals fewer and fewer new usability problems; and (iii) the most severe usability problems are detected by the first few participants. It should be noted that although the usability results are positive and encouraging, the results only pertain to the interface and not to the effectiveness of the serious game. The effectiveness of the serious game as an educational aid will be examined in future work.

Although residents are able to read about the TKA procedure in various available textbooks and manuals, we have decided to take a situated learning approach in which the learning environment is modeled on the context whereby the knowledge is expected to be applied (Brown, Collins, & Duguid, 1989; Dalgarno & Lee, 2010; Lave & Wenger, 1991; Ruzic, 1999). In other words, given that the trainees will be applying their acquired knowledge and skills in an operating room, the serious game places the trainee in this same context, taking on the role of the surgeon. Furthermore, 3-D technologies (graphical and sound rendering) are employed to provide sensory realism consistent with the real world, ensuring that the knowledge gained within the serious game can be more easily recalled and applied when the trainee is placed in the real world scenario (Dalgarno & Lee, 2010).

KNOWLEDGE TRANSLATION

The recent translation trend of research-derived knowledge into actual practice, implies that some thought should be given by researchers regarding the knowledge (i.e., research product) that should be put into practice and to which audience, keeping in mind how the knowledge could be used (Tetroe, 2007). This process is called knowledge translation (KT) and the strategies designed by researchers to provide a match between the expected research findings and the targeted knowledge-user(s) are

referred to as KT plans (Ross, Goering, Jacobson, & Butterill, 2007). In following this trend, we have decided to provide a KT structure to the development and testing of the serious game described in this paper. Although the impact of the KT approach can only be assessed once the TKA serious game has been formally "field-tested," we believe that a strategy to increase the KT effectiveness is to engage the potential end-users (e.g., the orthopaedic surgery residents) early in the design and implementation of the game.

In terms of the overall KT plan that we are concurrently formulating, the main issues to be addressed will be, (i) persuading end-users that a serious game is an effective learning tool, and (ii) assisting them in integrating the serious game within their training activities. Consequently, as part of our future work, we will also conduct a usability study with a larger pool of end-users in order to both gauge their perceptions on the final version of the game and to refine the knowledge translation strategies that should be implemented during the educational encounter. Amongst them, we are considering the possibility of implementing face-to-face interactive workshops, as well as creating an online community of practice, which have been identified in the literature as some of the most effective KT methods (Grol & Grimshaw, 2003). The feasibility of the KT plan will be tested in future work by conducting educational studies on the effectiveness of using a serious game as a complement to traditional teaching materials to train orthopaedic surgery residents in total knee arthroplasty.

FUTURE WORK

In addition to testing the effectiveness of the serious game as an educational aid by incorporating it into the orthopaedic surgery training curriculum as previously described, from the technological perspective, future work will also investigate the factors that will lead to a maximum transfer of knowledge and retention for users of games for learning and training with respect to game parameters. This will include examining (i) do "better," more realistic graphical and sound cues lead to greater transfer of knowledge, and (ii) how do multi-cues (graphical and auditory cues in particular) interact and affect the transfer of knowledge? Given very realistic, high quality models, lower quality models can easily be derived. This provides the opportunity to develop various versions of the serious game (with respect to visual/graphics-based quality) and examine how levels of realism affect transfer of knowledge. Finally, future work will also include incorporating

artificial intelligence (AI) techniques and predefined motions into the non-playing characters (NPCs) providing them with more realistic behaviors.

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REFERENCES

- Bergeron, B. (2006). *Developing serious games*. Hingham, MA, USA: Thomson Delmar Learning.
- Brown, J. S., Collins, A., and Duguid, S. (1989). Situated cognition and the culture of learning. *Educational Researcher*, 18 (1), 32-42.
- Cannon, W. D., Eckhoff, D. G., Garrett, W. E., Hunter, R. E., and Sweeny, H. J. (2006). Report of a group developing a virtual reality simulator for arthroscopic surgery of the knee joint. *Clinical Orthopaedics and Related Research*, 442 (1), 21-9.
- Corti, K. (2006). *Game-based learning; a serious business application*. PIXELearning. Coventry, UK.
- Dalgarno, B., and Lee, M. J. W. (2010). What are the learning affordances of 3-D virtual environments? *British Journal of Educational Technology*, 41 (1), 10-32.
- Ericsson, K. A., Krampe, R., and Tesch-Romer, C. (1993). The role of deliberate practice in the acquisition of expert performance. *Psychological Review*, 100 (3), 363-406.
- Grol, R., and Grimshaw, J. (2003). From best evidence to best practice: Effective implementation of change in patients' care. *Lancet*, 362 (9391), 1225-30.
- Halm, E. A., Lee, C., and Chassin, M. R. (2002). Is volume related to outcome in healthcare? A systematic review and methodological critique of the literature. *Annals of Internal Medicine*, 137 (6), 511-520.
- Heng, P. A., Cheng, C. Y., Wong, T. T., Xu, Y., Chui, Y. P., and Tso, S. K. (2004). A virtual reality training system for knee arthroscopic surgery. *IEEE Transactions on Information Technology in Biomedicine*, 8 (2), 217-227.
- Kneebone, R. L. (2009). Practice, rehearsal, and performance: An approach for simulation-based surgical and procedure training. *Journal of the American Medical Association*, 302(12), 1336-8.
- Laskin, R. S. (1991). *Total knee replacement*. London, UK: Springer-Varlag.
- Lave, J., and Wenger, E. (1991). *Situated learning: Legitimate peripheral participation*. New York, NY, USA: Cambridge University Press.
- Lavernia, C. J., Sierra, R. J., and Hernandez, R. A. (2000). The cost of teaching total knee arthroplasty surgery to orthopaedic surgery residents. *Clinical Orthopaedics and Related Research*, 380, 99-107.
- Lewis, J. R. (1994). Sample sizes for usability studies: Additional considerations. *Human Factors*, 36 (2), 368-378.
15. Mabrey, J. D., Cannon, W. D., Gillogly, S. D., Kasser, J. R., Sweeny, H. J., Zarins, B., et al. (2000). Development of a virtual reality arthroscopic knee simulator. *Studies in Health and Technology Informatics*, 20, 192-4.
- Mangold, K. (2007). Educating a new generation: Teaching baby boomer faculty about millennial students. *Nurse Educator*, 32 (1), 21-3.
- Michael, D., and Chen, S. (2006). *Serious games: Games that educate, train and inform*. Boston, MA, USA: Thomson Course Technology.

- Mitchell, A., and Savill-Smith. (2004). *The use of computer and video games for learning: A review of the literature*. www.LSDA.org.uk. London, UK.
- Nielson, J., and Landaurers, T. K. (1993, April 24–29). A mathematical model of the finding of usability problems. In *Proceedings of the ACM INTERCHI 93 Conference*. Amsterdam, The Netherlands.
- Park, S. H., Yoon, Y. S., Kim, L. H., Lee, S. H., and Han, M. (2007, July 4-7). Virtual knee joint replacement surgery system. In *Proceedings of the International Conference on Geometric Modeling and Imaging* (p. 79-84). Zurich, Switzerland.
- Prensky, M. (2005). Computer games and learning: Digital game-based learning. In J. Raessens and J. Goldstein (Eds.), *Handbook of computer game studies* (p. 97-122). Cambridge, MA, USA: MIT Press.
- Rideout, V., Roberts, D. F., and Foehr, U. G. (2005). *Generation M: Media in the lives of 8-18 year-olds*. Kaiser Family Foundation. Menlo Park, CA USA.
- Ross, S., Goering, P., Jacobson, N., and Butterill, D. (2007). *Towards more effective peer review of knowledge translation (KT) plans in research grant proposals*. (Tech. Rep.). Ottawa, Ontario, Canada: Canadian Health Services Research Foundation (CHSRF).
- Rost, R. (2006). *OpenGL Shading Language* (Second ed.). Boston, MA, USA: Addison-Wesley Professional.
- Ruzic, F. (1999). The future of learning in virtual reality environments. In M. Selinger and J. Pearson (Eds.), *Telematics in education: trends and issues*. Amsterdam: Pergamon Press.
- Shneiderman, B. (1998). *Designing the user interface* (Third ed.). Reading, MA, USA: Addison-Wesley Longman, Inc.
- Squire, K., and Jenkins, H. (2003). Harnessing the power of games in education. *Insight*, 3 (1), 5-33.
- Stapleton, A. J. (2004). Serious games: Serious opportunities. In *Proceedings of the 2004 Australian Game Developers' Conference* (p. 1-6). Melbourne, Australia.
- Susi, T., Johannesson, M., and Backlund, P. (2007, February). *Serious games -an overview* (Tech. Rep. No. HS-IKI-TR-07-001). School of Humanities and Informatics, University of Skovde, Sweden.
- Tetroe, J. (2007). *Knowledge translation at the Canadian Institutes of Health Research: A Primer* (Tech. Rep. No. No. 18). Austin, TX, USA: National Center for the Dissemination of Disability Research.
- Ting, Y., Lin, S. D., Chen, C. H., Lee, S. S., and Chang, Y. F. (2003). Development of a virtual reality surgical platform for unicompartamental knee replacement. In *Proceedings of the IEEE International Conference on Systems, Man and Cybernetics* (p. 2932-7). Washington, DC, USA.
- Turner, C. W., Lewis, J. R., and Nielson, J. (2006). Determining usability test sample size. *International Encyclopedia of Ergonomics and Human Factors*, 2006, Second Edition, Volume 3. Edited by Waldemar Karwowski, Boca Raton, FL: CRC Press.
- W. Karwowski (Ed.), *International Encyclopedia of Ergonomics and Human Factors* (Second ed., Vol. 3). Boca Raton, FL, USA: CRC Press.
- Villeneuve, M., and MacDonald, J. (2006). *Toward 2020: Visions for nursing*. Canadian Nurses Association, ISBN 1-55119-818-5. Ottawa, Ontario, Canada.
- Virzi, R. A. (1992). Refining the test phase of usability evaluation: How many subjects is enough? *Human Factors*, 34 (4), 457-468.
- Weatherby, B. A., Rudd, J. N., Ervin, T. B., and Staff, P. R. (2007). The effect of resident work hour regulations on orthopaedic surgical education. *Journal of Surgical Orthopaedic Advances*, 16 (1), 19-22.

- Zhang, G., Zhao, S., Y., and Xu. (2003). A virtual reality based arthroscopic surgery simulator. In *Proceedings of the 2003 IEEE International Conference on Robotics, Intelligent Systems and Signal Processing* (p. 272-7). Changsha, China.
- Zuckerman, J., Kubiak, E., Immerman, I., and DiCesare, P. (2005). The early effects of code 405 work rules on the attitudes of orthopaedic residents and attending surgeons. *Journal of Bone and Joint Surgery*, 87 (A(4)), 903-8.

COMPARING EXPERT AND NOVICE SPATIAL REPRESENTATION ON THE BASIS OF VR SIMULATION, MRI IMAGES, AND PHYSICAL OBJECTS

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Progress in medical imaging and refined methods of surgery planning, such as Virtual Reality (VR), call for an investigation of the acquisition of three-dimensional (3-D) anatomical knowledge as a crucial goal of medical education. This study compared the efficacy to reconstruct a 3-D arrangement of objects that was either presented as a real model, as magnetic resonance images (MRI), or as a VR model.

From April 2005 to June 2006 two groups, experienced neurosurgeons and medical students in their fourth year of medical education, studied a three-dimensional arrangement of water-filled plastic objects either as a real model, using a VR workstation, or by examining the MRI images. They were then asked to reconstruct the model as accurately as possible. The reconstructed models were then compared to the respective original models.

The most accurate reconstructions were achieved when the participants had memorized the real model. VR visualization produced larger errors, and reconstruction accuracy based on MRI scans was worst. Neurosurgeons did not perform better than students.

Our results show that, compared to standard MRI scans, the accuracy of mental representation does benefit from the stereoscopic rendering of the model, which has been built from sequential MRI scans. However, best results were achieved when learning from the original model. Thus, VR is beneficial and at the same time there is room for further improvement when trying to optimize the visual basis for anatomy training and surgery planning, both for expert as well as for novice surgeons.

Keywords: Adult Learning, Interactive Learning Environments, Simulation, Teaching/learning Strategies, Virtual Reality

INTRODUCTION

Spatial understanding (a person's aptitude for understanding 3-D structures and positions of objects) in anatomy is required for many clinical tasks especially in surgery. (Levinson, Weaver, Garside, McGinn, & Norman, 2007) Although this ability has been under research since Shep-

ard's and Metzler's work in 1971, it is still poorly understood in the applied domain. (Shepard & Metzler, 1971).

In neurosurgery, spatial understanding is needed by the surgeon to plan the intervention. A neurosurgical operation is usually planned by the surgeon who obtains a represen-

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tation of the patho-anatomical situation on the basis of computed tomography (CT) and/or magnetic resonance images (MRI) of the patient. The surgeon thus has to create a 3-D mental image, the so-called mental representation, entirely based on two-dimensional (2-D) information.

Since CT and MRI scans are sequential computer-generated images, it is possible to transform them into 3-D VR models, thus visualizing the patho-anatomical situation stereoscopically in a detailed way. (Kockro, et al., 1999; Kockro, et al., 2000) The influence of 3-D VR computer visualizations has been examined in recent studies especially in teaching medical students and residents.

Our first experiences of VR-aided surgery planning have been encouraging. (Stadie, et al., 2008) The results are comparable to a study of Hariri and co-workers. Students who learned anatomy using a VR simulator indicated that they were more likely to use the VR simulator as a learning tool than a textbook group was willing to use the textbook (Hariri, Rawn, Srivastava, Youngblood, & Ladd, 2004).

However, some important aspects of the effects of VR-aided learning have not yet been addressed. To this date, the studies that have been conducted to clarify the influence of VR-aided teaching focused on students. The benefit of VR for experienced neurosurgeons, who are used to building complex 3-D representations from two-dimensional images, has not yet been elucidated. One would expect experienced surgeons to perform better than inexperienced students, but do both groups benefit equally from 3-D visualization?

The effects of VR-enhanced learning have been compared to textbook learning but not to image-based learning, although in a clinical situation the surgeon often has to understand the anatomical situation based on CT or MRI scans. (A. Garg, Norman, Spero, & Maheshwari, 1999; A. X. Garg, Norman, & Sperotable, 2001; A. X. Garg, Norman, Eva, Spero, & Sharan, 2002; Hariri, et al., 2004; Levinson, et al., 2007). Another goal of the current study was to examine a realistic anatomical situation that featured a complex 3-D configuration not thus far considered by existing studies (A. Garg, et al., 1999; Levinson, et al., 2007). Additionally, we did not want to evaluate anatomical knowledge in a "point and identify" manner, (Hariri, et al., 2004) but rather directly test spatial knowledge.

An important but not yet fully understood aspect in the

use of electronic enhanced learning relates to the degree of learner control over study materials (Levinson, et al., 2007). While in a first study, Garg and colleagues found that multiple views had no overall instructional advantage over a simple presentation of key views. They found in a more recent study that self-directed examination of an object from multiple different perspectives improves spatial learning (A. Garg, et al., 1999; A. X. Garg, et al., 2001). This was also observed by Jang and coworkers. They found that active manipulation of a complex 3-D structure with an intuitive interface aids in developing an accurate internal representation of the structure (Jang, Black, & Jyung, 2007).

We sought to compare the exactness of the mental representation based on the object being actively rotated in VR as opposed to the representation based on planar MRI scans of the object. We present a prospective, randomized, and multi-centric study. In this study we examined how actively rotating a complex 3-D model in VR by using an intuitive joystick enhanced the development of a precise mental representation. The results were compared to those gained by learning the setup of that model from serial MRI scans and by looking at the real model. Additionally, we compared the benefits of VR-enhanced learning for students and experienced neurosurgeons.

MATERIALS AND METHODS

PARTICIPANTS

We examined 33 surgeons (9 female, 24 male) and 32 medical students (26 female, six male). A mandatory requirement for taking part in the study was normal stereo vision as tested with the Randot SO-002 stereo test of Stereo Optical, Inc., Chicago, USA.

Surgeons (Group 1) needed to have at least two years of professional experience. They were either working in the University Clinic of Mainz, Germany, or in the Hospital Clinic de Barcelona, Spain. Their mean age was 37 years (standard deviation = 8.52 years; range = 26-56 years). Medical students (Group 2) had to be at least in their 7th semester and were all enrolled at the Johannes Gutenberg-University, Mainz, Germany. Their mean age was 24.7 years (standard deviation = 2.11; range = 22-32 years). The tests were always performed with one single participant. Students received an allowance of 10,€. Spatial ability was assessed before and after the examination by administering a subscale of a standard intelligence test (subtest "Würfelaufgaben" of the I-S-T 2000 R) (Amthauer, Brocke, Liepmann, & Beauducel, 2001).

MATERIALS

To compare 3-D and 2-D visualization of spatial arrangements, we constructed a 3-D object using Lego building blocks and three plastic objects resembling fruit (pear, strawberry, orange). The objects were filled with water to make them visible on the MRI-scan. The objects' longitudinal axis was marked using a wooden toothpick that protruded on either end. The midpoint of the longitudinal axis defined also the center-point of the object. The three objects were placed at defined orientations and positions above a ground plane using the Lego blocks (see Fig. 1a). The first setup was named model 1. A second setup in which the spatial arrangement of the three objects had been changed was named model 2.

We acquired MRI scans for both models (Siemens Sonata 1.5 T, 240 slices, T1w, slice thickness 1,5 mm, no gap). 3-D visualization was achieved by building a VR model out of the MRI dataset using a Dextroscope of Volume Interactions, Singapore and the Radiodexter Software 1.0 (Fig. 1b). For a detailed description of the VR workstation refer to the article of Kockro and coworkers (Kockro, et al., 2000). 2-D visualization was achieved by printouts of the MRI data. The printouts consisted of two sheets containing 20 evenly sampled MRI slices for each model (Fig. 1c).

DESIGN OF THE EXPERIMENT

EXPERIMENTAL SUBGROUPS

In the subgroup "Real" one of the original Lego models



Figure 1. a. Exemplar view of one experimental setup, which was viewed directly or via imaging, and which had to be reconstructed later. Note that the LEGO bricks and the LEGO ground-plate are visible. b. Image showing the initial VR screen of model 1. Note that the Lego bricks are not visible in the VR model. c. MRI images of model 1. Note that the Lego bricks are barely visible in the MRI scan.

was presented to the participants. Participants were allowed to look at the model from all angles but not to move it actively in order to prevent the water filled objects from toppling off the Lego bricks. The subgroup "VR" received a visualization of the objects using the Dextroscope. The VR objects were moved actively by the participants and could thus be viewed from all sides.

The subgroup "MRI" consisted of the presentation of two sheets showing the MRI data (total of 40 slices). In both subgroups "VR" and "MRI", only the water-filled plastic objects were visible because the Lego blocks were practically not detectable by MRI. Technically, the creation of a colored VR model also displaying the Lego bricks would have been possible. We decided against it since a colored MRI cannot be created and the VR model should match the MRI slices. Thus the dynamic aspect of VR was the only difference between the conditions. We counterbalanced the order in which the two different models (model 1 or 2) were presented. To compare 3-D and 2-D visualization, participants were asked to reconstruct the disassembled model as accurately as possible after having learned the spatial relationships either by examining the real model, the VR model, or the MRI scans. Participants were allowed three minutes to memorize the spatial arrangement and five minutes for reconstructing the model using the same materials that had been used to construct the original models.

RANDOMIZATION

Surgeons and students were each assigned to one of the three subgroups (Real, VR, MRI). Students were assigned randomly. To attain an equal distribution of expertise, surgeons were assigned to a subgroup in a pseudo-randomized fashion. Professional experience was used to classify the experience in analyzing tomographic examinations. 10 years of professional experience corresponded with the 50% percentile.

The first surgeons were assigned to a subgroup by drawing straws. The next surgeon with a comparable professional experience was then assigned – again by drawing a straw – to one of the two remaining subgroups. The third surgeon with a comparable professional experience was then assigned to the last subgroup. Then the procedure was repeated. This ensured comparable degrees of expertise in each subgroup.

Each participant reconstructed both models (Model 1 and Model 2). The order of which model was reconstructed

first was counterbalanced such that an equal number of participants started with a given model in each subgroup.

PROCEDURE

At first, demographic features were obtained and the ability to view stereoscopically was tested. All participants then had to complete the spatial intelligence subtest “Würfelaufgaben” of the I-S-T 2000R (Amthauer, et al., 2001). Afterwards, all participants completed a five-minute VR workstation training session, even if not needed later on. According to the assigned subgroup, they were then shown either the original (“Real”) or the visualized model (“MRI”, “VR”). After three minutes of memorizing the model, they were allowed five minutes to reconstruct the objects of the physical model in position and orientation. Then the second model was viewed and reconstructed. In the end, a questionnaire was filled out by all participants assessing their subjective experience concerning tomographic imaging and subjective accuracy of their reconstructions. The test duration was 45 minutes.

DATA ACQUISITION

The model was measured within a Cartesian coordinate system. The x-axis defined left-right, the y-axis up-down, and the z-axis the forward-backward direction. To define an object’s position in this Cartesian coordinate system, the center of each object was determined from the x-, y-, and z-values of the toothpicks’ endpoints, measured in cm. In the next step the vertical elevation angle (alpha) and the horizontal azimuth angle (beta) of the longitudinal axis were measured to determine the object’s orientation. The differences between the model and the reconstruction were measured in two ways. Firstly, and most importantly, we determined the Euclidean distance between the center-point of model and reconstruction. This was done by taking the square root of the summed x-, y-, and z-distances. Secondly, the differences between azimuth and elevation angles were analyzed separately. For all difference measures between model and reconstruction absolute, unsigned errors were used. All mathematical and statistical calculations were made using the SPSS software (Version 15.0 of SPSS Inc., Chicago, Illinois, USA). Prior to testing our hypothesis, all interval-scaled variables were checked for normal distribution.

RESULTS

LOCALIZATION ERRORS MEASURED AS EUCLIDEAN DISTANCES OF THE CENTER-POINTS

First, we checked for systematic differences between the first and the second reconstruction attempt that our ob-

servers made. Such a difference was not found, thus, we computed the average error scores across both reconstructions. The aggregate error score was then used as dependent measure in an Analysis of Variance (ANOVA) with the independent factors of Group (Students vs. Expert Surgeons) and Condition (Real object, VR, and sequential MRI-images).

Figure 2 shows the average Euclidean reconstruction errors by Group and by Condition. Clearly, reconstruction on the basis of the real object was most accurate, followed by the 3-D-visualization (VR). All participants produced the largest Euclidean distance errors when (re)constructing the objects on the basis of the MRI images. The ANOVA confirms this impression, the factor condition produced a significant main effect [$F(2,52) = 19.24$, $p = .046$, $\eta^2 = .95$]. Post-hoc comparisons with Bonferroni-corrected t-tests between the three conditions likewise revealed that reconstruction with the Real model was significantly better than the VR group, and the latter was significantly better than the MRI group (all p-values < .01). The slight difference between the student group and the expert group in the MRI condition failed to reach significance [$F(1,52) = 1.23$, $p = .371$, $\eta^2 = .35$]. None of the interactions were significant.

When looking at individual performances as well as group performance for each model that had to be reconstructed, the general impression gleaned from the Euclidean distance errors was confirmed. Figure 3 shows the distribution data separately for each group of experts and students. Note the large variability in performance. Also note that all models show the same pattern.

ORIENTATION ERRORS

Alpha angles (elevation) in degrees differed significantly according to an ANOVA on the average errors from both model reconstructions (see Figure 4). Expert surgeons were significantly better than medical students [$F(1,58) = 10.25$, $p = .002$, $\eta^2 = .15$]. As visible in Figure 4, the superiority of experts was mainly manifest in reconstructing the vertical orientation of the object from MRI images. The same ANOVA revealed a main effect of condition, errors in the MRI condition were overall significantly larger than in the other conditions [$F(2,58) = 9.49$, $p < .001$, $\eta^2 = .25$]. The interaction between condition and expertise was not significant.

Azimuth angle errors (beta) are shown in Figure 5. Experts and students did not differ significantly from one another

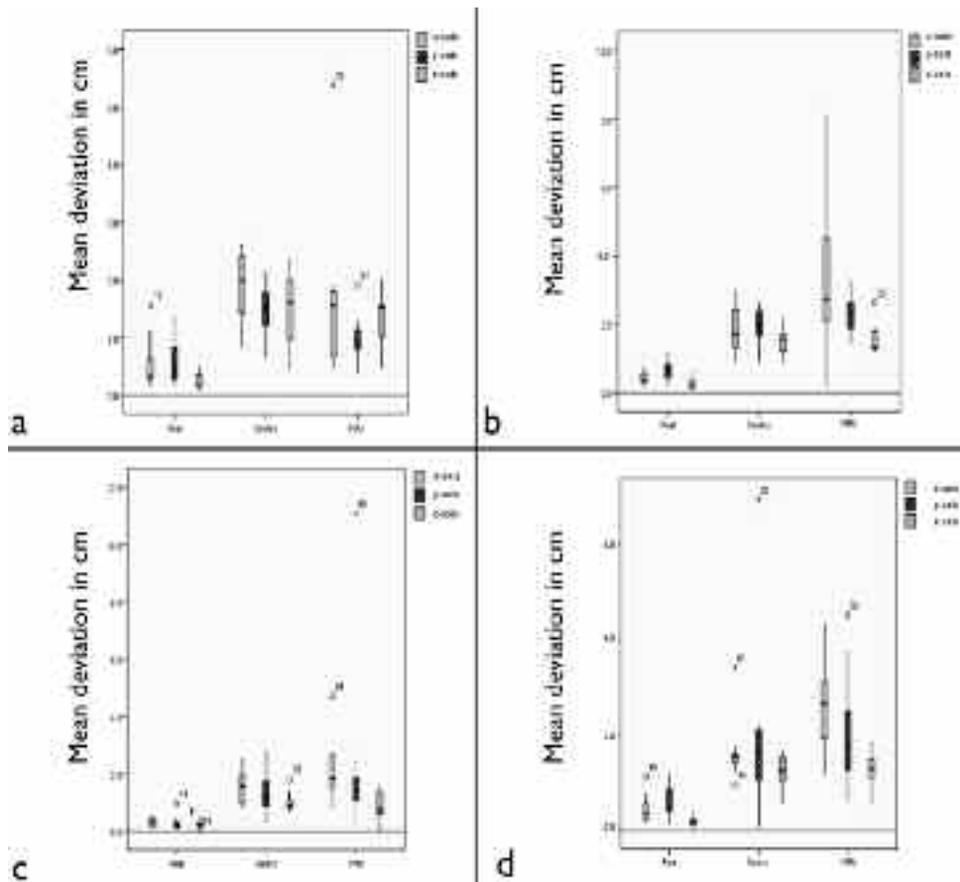


Figure 2. Average distance errors by experimental Group (Real objects, 3-D visualization per VR, and MRI). Errors were defined as the Euclidean distance between the midpoint of the actual object and its reconstructed position. Open circles represent average errors for the expert surgeons (averaged across both reconstructions of model 1 and model 2). Filled squares represent the student participants.

in a separate ANOVA on azimuth errors averaged across both model reconstructions. The horizontal orientation error was smallest for the Real objects, second smallest for the VR condition, and largest for the MRI condition [$F(2,58) = 7.42$, $p = .001$, $\eta^2 = .20$]. Interactions were not significant.

Surprisingly, spatial intelligence did not correlate with the quality of reconstructions (p -value > 0.1). That is, participants with relatively high scores on spatial intelligence did not outperform those with lower scores. Presumably, both our groups, medical students and surgeons alike were already preselected on this criterion of superior spatial ability. Neither did the level of expertise interact with the task. The number of years of surgery experience did not correlate positively with performance. Reconstructions from MRI or VR images were inferior to reconstructions from the real scene for all participants. Thus, the experience of constructing internal 3-D representations of organ

and tissue locations did not help to extract the volume information from MRI scans.

SUBJECTIVE IMPRESSIONS

The questionnaire revealed that participants regarded the virtual reality display of the models and their handling with the Dextroscope as user friendly and comfortable, as expressed in the good grade ($M = 1.59$ for experts, $M = 1.97$ for novices) on a five-point scale (1 = very user friendly, 5 = very hard to use). Experts found the VR trainer slightly better than did the novices, by a significant but very small margin [$F(2,58) = 5.70$, $p = .02$, $\eta^2 = .089$]. The rating of user-friendliness did not change as a function of experimental condition.

Both experts and novices who were in the Real object condition reported higher subjective accuracy of reconstructions scores than did participants in the VR and MRI groups [$F(2,58) = 5.20$, $p = .008$, $\eta^2 = .15$].

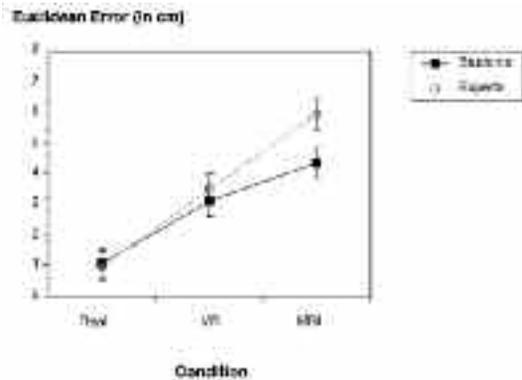


Figure 3. Box plot diagrams of the results of the reconstructions separated by localization errors per axis. The center of the box represents the median value. The box comprises 50 % of the values (2nd and 3rd quartile) in that group, Numbers outside the box indicate outliers. One box each for the x-, y-, and z-dimension are plotted. a. Reconstruction of model 1 (expert surgeons). b. Reconstruction of model 1 (students). c. Reconstruction of model 2 (surgeons). d. Reconstruction of model 2 (students).

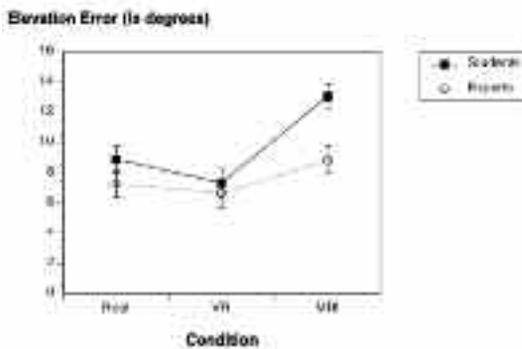


Figure 4. Average elevation errors (alpha) reflecting the accuracy of the vertical orientation of the objects. Errors were averaged across all three fruit objects and both models independently for each group of participants. Error bars indicate standard errors of the mean.

DISCUSSION

VR should provide a decisive advantage in medicine because of its ability to supply direct 3-D experience. However, upon closer inspection the benefits for medicine are not quite so obvious. We do not fully understand if this

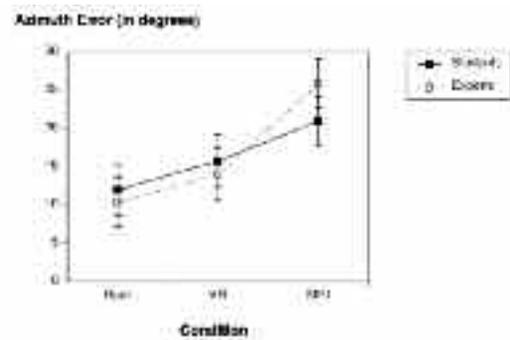


Figure 5. Average azimuth errors (beta) reflecting the accuracy of the horizontal orientation of the objects. Errors were averaged across all three fruit objects and both models independently for each group of participants. Error bars indicate standard errors of the mean.

new technology may help the surgeon, or if reliance on 2-D images is sufficient (Gorman, Meier, & Krummel, 1999; Kockro, et al., 2000). To investigate the matter we asked six groups of observers to first view three objects and to remember their positions and orientations with respect to a ground surface. Then, observers had to reconstruct the arrangement from memory. The groups differed in their expertise (surgeons vs. medical students) and the viewing condition in the learning phase. One group at each expertise level could learn from Real objects, a 3-D-rendering of the objects (VR), or a sequence of MRI-pictures.

Not surprisingly, the groups who could learn from the real objects produced the best reconstructions. When regarding the average distance of the reconstructed object center from the actual object center, this distance error was 1 cm. This is quite remarkable as no reference points other than the Lego ground plane were provided. The distance error increased to about 3 cm when the mental representation was based on the 3-D-visualization of the MRI-data. Finally, when the MRI-pictures served as the information source about the objects, distance errors were largest, around 5 cm. Students did just as well as experts in all conditions, with the only exception of vertical object orientation. Experts were better to reproduce this elevation angle.

We have to bear in mind that the real model contained more information than MRI scans or the VR model. Since the support of the objects (Lego bricks) was practically in-

visible in the MRI and the VR condition, one might assume that the support provided important information about the height of the object. This information had to be inferred for the MRI and the VR model (Fig. 2a). By simply counting the Lego bricks, quantitative spatial information could have been gained. This might be an advantage for the real model leading to the observed more accurate reconstruction. However, our participants have not reported such strategies. To rule out this effect entirely, further investigations are needed which use different models further closing the gap between true 3-D and realistic VR. Additionally, the real model displayed the Lego ground plate and color information, which were absent in the MRI and VR models. Possibly, by using the full capabilities of a VR workstation, the results for the VR group will come closer to those of the real model group.

Multiple views have been found to aid in learning 3-D anatomic details. We could confirm these findings (A. X. Garg, et al., 2001; Kockro, et al., 1999), but note that there are cases that failed to find a general superiority of multiple views in learning anatomy (A. Garg, et al., 1999; A. X. Garg, et al., 2002; Hariri, et al., 2004). In our study VR-visualization showed a significant benefit.

Despite some evidence that individuals learn more when given control over their instruction, most of the existing literature suggests that increased learner control courses are not effective for people with little previous experience, or with low meta-cognitive capabilities (Levinson, et al., 2007). In our study, the test persons had a high degree of learner control. They were allowed to manipulate the VR model such that they were absolutely free to look at it in any way they wanted to. The superiority of VR to MRI in our experiment may be due to this active control, as some earlier studies would suggest (A. X. Garg, et al., 2001; Kockro, et al., 1999). However, in the MRI-condition observers also could control the images by rotating them, holding them up, etc. Thus, it seems likely that it is the particular case of controlling a 3-D object that makes the decisive difference. It has been hypothesized that learners spend about 80% of the total time looking at so-called key or near key views when they are allowed to control the views. Key views are those views that are typically displayed in anatomical textbooks, e.g. anterior-posterior or lateral views. Having to deal with multiple orientations may depress learning by exerting undue cognitive load on the learner and decrease the learner's ability to lay down new memories. Levinson and co-

workers suggest that learners may have to convert the more unfamiliar, oblique orientations into more familiar key representations. This process would effectively increase the cognitive load of the task (Levinson, et al., 2007). Other authors confirm these findings (A. Garg, et al., 1999; A. X. Garg, et al., 2002; Hariri, et al., 2004). This would also explain why our experts were superior to the novices on the parameter of vertical object orientation only.

We had expected that neurosurgeons that are used to dealing with MRI or CT scans on a daily basis would produce better results reconstructing a 3-D model. Why were medical students just as good as the experts? They all lacked surgical practice. One explanation is that the task of our experiment was too far removed from representational demands in real-world surgery scenarios. Alternatively, our students might have been able to read the MRI images fairly well, such that they could glean rich information from the MRIs. We favor this second alternative. Reading MRI images was part of their training. Also, the task to memorize position and orientation was by no means trivial, and on theoretical grounds should engage the same mental faculties as memorizing, for instance, a tumor viewed on a CT image. Finally, there is some evidence that new knowledge acquisition may be a very different cognitive process than re-learning or re-activating prior knowledge. More advanced learners may benefit from different types of presentations than learners new to a topic (Clark & Mayer, 2003; Lee & Lee, 1991; Mayer, 2001), and our material surely was new to all participants, including the surgeons.

Our finding that the interaction with the VR-visualization was regarded to be more intuitive and comfortable correlates with earlier studies that confirmed that VR provides a more user-friendly interaction (Gorman, et al., 1999; Reinhardt, Trippel, Westermann, & Gratzl, 1999; Stadie, et al., 2008).

CONCLUSIONS

In summary, using a sophisticated stereoscopic VR workstation to visualize 3-D position and orientation of objects appears to be beneficial in neurosurgery. At the same time, the even better performance with a real model suggests there is room for further improvement. Visualization aids should benefit students and also help the already experienced surgeon in planning and simulating complex interventions.

REFERENCES

- Amthauer, R., Brocke, B., Liepmann, D., & Beauducel, A. (2001). *I-S-T 200R Intelligenz Struktur Test 2000 R* (1 ed.): Hogrefe Verlag GmbH & Co.KG.
- Clark, R. C., & Mayer, R. E. (2003). *e-Learning and the Science of Instruction*. San Francisco: Pfeiffer.
- Garg, A., Norman, G. R., Spero, L., & Maheshwari, P. (1999). *Do virtual computer models hinder anatomy learning?* *Acad Med*, 74(10 Suppl), S87-89.
- Garg, A. X., Norman, G., & Sperotable, L. (2001). *How medical students learn spatial anatomy*. *Lancet*, 357(9253), 363-364.
- Garg, A. X., Norman, G. R., Eva, K. W., Spero, L., & Sharan, S. (2002). *Is there any real virtue of virtual reality?: the minor role of multiple orientations in learning anatomy from computers*. *Acad Med*, 77(10 Suppl), S97-99.
- Gorman, P. J., Meier, A. H., & Krummel, T. M. (1999). *Simulation and virtual reality in surgical education: real or unreal?* *Arch Surg*, 134(11), 1203-1208.
- Hariri, S., Rawn, C., Srivastava, S., Youngblood, P., & Ladd, A. (2004). *Evaluation of a surgical simulator for learning clinical anatomy*. *Med Educ*, 38(8), 896-902.
- Jang, S., Black, J. B., & Jyung, R. W. (2007). How direct interaction in a virtual reality program aids in developing an internal representation of a complex 3-d structure. *Proceedings of world conference on educational multimedia, hypermedia and telecommunications*, 4214-4218.
- Kockro, R. A., Serra, L., Tsai, Y. T., Chan, C., Sitoh, Y. Y., Chua, G. G., et al. (1999). Planning of skull base surgery in the virtual workbench: clinical experiences. *Stud Health Technol Inform*, 62, 187-188.
- Kockro, R. A., Serra, L., Tseng-Tsai, Y., Chan, C., Yih-Yian, S., Gim-Guan, C., et al. (2000). Planning and simulation of neurosurgery in a virtual reality environment. *Neurosurgery*, 46(1), 118-135; discussion 135-117.
- Lee, S. S., & Lee, Y. H. K. (1991). Effects of learner-control versus program-control strategies on computer-aided learning of chemistry problems: for acquisition or review? *J Educ Psychol*, 83, 491-498.
- Levinson, A. J., Weaver, B., Garside, S., McGinn, H., & Norman, G. R. (2007). Virtual reality and brain anatomy: a randomised trial of e-learning instructional designs. *Med Educ*, 41(5), 495-501.
- Mayer, R. E. (2001). *Multimedia Learning*. Cambridge: Cambridge University Press.
- Reinhardt, H., Trippel, M., Westermann, B., & Gratzl, O. (1999). Computer aided surgery with special focus on neuronavigation. *Comput Med Imaging Graph*, 23(5), 237-244.
- Shepard, R. N., & Metzler, J. (1971). Mental rotation of 3-D objects. *Science*, 171(972), 701-703.
- Stadie, A. T., Kockro, R. A., Reisch, R., Tropine, A., Boor, S., Stoeter, P., et al. (2008). Virtual reality system for planning minimally invasive neurosurgery. *J Neurosurg*, 108(2), 382-394.

OPEN SURGERY WHILE WEARING NIGHT VISION GOGGLES

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Night vision technology is nothing new. In fact, the military rely significantly on this technology during nighttime operations. A surgeon is like a medical soldier in the battlefield. His/her only mission is that of keeping people alive. Due to many technological advances, patients cannot only train on relaxation while visiting their doctors but also get distracted by playing videogames while waiting for them. Furthermore, this virtual reality experience can be enhanced if the patient wears goggles or Head Mounted Displays under dimmed or absence of lights. The purpose of this study was to test if a surgeon could operate when extending into such a dark condition situation, but in the surgical suite. Therefore, a surgeon performed seven open surgeries on rabbits. All surgeries were performed on the thorax and abdomen regions. Specifically, the surgeon was able to perform these surgeries by wearing on his head a micro camera with infrared light and a night vision goggles. The first assistant used this same system while the scrub nurse and the anesthesiologist did not. There were no complications either during or after these procedures. It is possible to make open surgeries wearing a night vision system. Further approaches should be tested with human volunteers.

Keywords: Night Vision Goggles, Open Surgery, Cyber-medicine

INTRODUCTION

The typical medical tools used to help make diagnoses are white and black color images in double dimension (2-D; e.g., X-rays images, scanner, and magnetic resonance images). Pictures with motions such as ultrasound, cholangiography, cardiac catheterization, and amniocentesis are other examples of how black and white colors permit physicians to help patients with high precision to make invasive medical treatments. Fortunately, during the last decade, technology has helped improve these traditional images with better visualization with three-dimensional (3-D) reconstruction from 2-D medical images. That is, physicians may now interact with 3-D models and feedback devices that help them learn more about the physical and the biological reactions of virtual tissues and organs. In fact, this technological advancement has been crucial in helping prevent medical risks with real organs. Medical simulations help navigate inside reconstructed virtual

anatomy to give patients a better diagnosis and plan medical procedures more accurately in the future.

NIGHT VISION TECHNOLOGY AND TREATMENT

Night vision goggles (NVG) are widely used by soldiers to conduct night tactical operations. Some soldiers wearing NVGs have trained with mannequins during intravenous line insertions (Brummer, 2006; MacIntyre, 2007) or even volunteer patients during endotracheal (Schwartz, 2001). Similarly, Mosso and others (Gorini, 2009; Stetz, 2010), have been testing a few applications of these technologies on humans (e.g., psychotherapy and recovery surgeries) to test the efficacy of virtual immersion to reduce anxiety and pain in the surgical suite. Surgeons are like soldiers trying to work only with white light colors. Therefore, surgeons wearing NVGs may avoid unnecessary dissections that may cause high surgical risk of fatal bleeding (see concept in Figure 1). The purpose of this paper is to share pre-

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liminary findings of surgeons conducting surgeries on animals while wearing NVGs.



Figure 1. Final concept for cyber-surgery with total immersion with night vision on humans.

METHODS

The following procedures were performed by the Department of Surgery, School of Medicine, Universidad Panamericana in Mexico City from April to May 15, 2009. Three rabbits (between four and five kilograms), under general anesthesia with orotracheal intubation and selective intubation for thoracotomies, were the subjects of the five different surgeries.

The three bodies were covered with sterile clothing and a large medial incision was performed in two of the rabbits to perform a laparotomy with total exploration of the abdominal cavity, preperitoneal kidney removal, spleen extraction and appendectomy. Both the thorax and abdomen areas were cleaned with Betadine previous to the trichotomy. A short incision was first made in the right chest area and then in the left one in order to explore the thorax cavities. Exploration of the abdomen and thorax were performed using traditional techniques with sutures and surgical tools for open surgery. The same surgeon and assistant made all procedures. All the rabbits underwent total anesthesia and were immediately euthanized at the end of the procedures.

The NV system use consisted of the following items—one wireless micro camera with night vision infrared CLR (model 1036 Lloyd 2.4 Gigahertz) was used by the surgeon, and Eyeclip night vision infrared stealth goggles (450 X 320 58 kilobyte) were used for the assistant (see Figure 2). A micro camera was connected to the head mounted display (HMD; Vuzix iWear 920, 332 X 250 15 kilobyte). The anesthesiologist only used a small lamp. A mechatronics engineer

set up the equipment for each person in the operating room before and after every surgery. A holder was designed for the engineer to be able to grasp the micro camera on the diadem to hold the HMD (see Figure 3).



Figure 2. Night vision equipment used by the surgical team in the Department of surgery, School of Medicine, Universidad Panamericana, Mexico City, 2009.



Figure 3. Microcamera with infrared light for night vision held in a diadema.

RESULTS

A total of seven open surgical procedures were performed on rabbits in the intraoperative/surgical suite with no complications. Tables 1-3 show the breakdown of the visual recognition of all organs and sutures while wearing the NV system. Abdominal organs with their respective vessels were identified during surgical procedures with night vision, which were then tied and cut (see Figure 4). Appendix, spleen and kidneys were removed with no significant bleeding (see Figure 5). During thoracotomy, lungs were viewed clearly unlike heart, and pleura were identified with more difficulty.

CONCLUSIONS, LIMITATIONS, AND RECOMMENDATIONS

NV can provide surgeons with the possibility to per-



Figure 4 (top to bottom). Laparotomy: a) Skin incision, b) Muscular aponeurosis, c) Peritoneum, d) Small bowel and colon.



Figure 5. Appendicular artery dissection under night vision.

form surgeries under total darkness, in animals. The equipment used in this study helped recognize and dissect abdominal, retroperitoneal and thoracic organs as well as small vessels. Surgeons did experience some limitations while grasping needles and sutures such as the catgut chromic and the nylon or polypropylene.

The following material and organs were not easily recognized—the catgut chromic 000, nylon 00, needle, bladder, gallbladder, diaphragm, pleura and arteries. Also, the micro camera vision direction was different compared to the surgeon's vision direction. That is, there were 15 degrees of difference between the camera and the surgeon's vision field. Therefore, the surgeon had to adjust his head position as needed during the endoscopic surgery. A technical disadvantage was the disconnection of cables from the micro camera resulting from pasting these on the back of the surgeon's clothes. All members in the surgical team should have night vision goggles to be in the same surgical field for future work. Also, the micro cameras must have high definition and resolution.

A potential use of this technology could be reproduced with humans playing videogames and doctors' NV systems during ambulatory procedures. That is, cybermedicine can provide patients with a total immersion that could be related to less perceived pain and anxiety, while in total darkness. Future work must involve improving visual resolution to develop or add augmented reality to recognize better organs or structures with artificial colors in 3-D environments. This study demonstrates that surgeons with surgical experience and with well-developed anatomical recognition can perform dissections with night vision.

Table 1
NVG-enabled visual recognition of abdominal and retroperitoneal organs

Visual Recognition			
	Excellent	Very Good	Good
Appendix	X		
Stomach	X		
Spleen	X		
Kidney	X		
Colon		X	
Bowel		X	
Bladder		X	
Liver	X		
Gallbladder			X
Peritoneum		X	
Artery			X
Vein	X		
Ureter		X	

Table 2
NVG-enabled Visual recognition of thoracic organs

Visual Recognition			
	Excellent	Very Good	Good
Heart	X		
Lung	X		
Diaphragm		X	
Pleura			X
Vein	X		
Aorta		X	

Table 3
NVG-enabled Visual recognition of surgical sutures

Visual Recognition			
	Excellent	Very Good	Good
Silk	X		
Catgut chromic			X
Vicryl		X	
Nylon			X

REFERENCES

- Brummer S., Dickinson E.T., Shofer F.S., McCans J.P., Mechem C.C. Effect of night vision goggles on performance of advanced life support skills by emergency personnel. *Mil Med.* 2006 Apr;171(4):280-2.
- Gorini, A., Mosso, J.L., Emotional response to virtual reality exposure across different cultures: The role of attribution process. *Journal Cyberpsychology and Behavior* 2009; 12 (6), 1-7.
- MacIntyre A., Markarian M.K., Carrison D., Coates J., Kuhls D., Fildes J.J. Three-step emergency cricothyroidotomy. *Mil Med.* 2007 Dec;172 (12):1228-30.
- Mosso, J.L., Wiederhold, M., Wiederhold, B., Rizzo, S., et al. *Cybertherapy and open surgery*. Cybertherapy 12th conference, 2006, pp 82.
- Mosso, J.L., Rizzo, S., Wiederhold, B., et al In: (Jim Westwood et als. Editors, proceedings, 2007). *Cybertherapy. New applications for discomfort reductions, Surgical Care Unit of Heart, Neonatology Care Unit, Transplant Kidney Care Unit, Delivery Room-Cesarean Surgery and ambulatory surgery, 27 case reports*. Medicine Meets Virtual Reality 2007 proceedings, Long Beach California, USA. pp. 337-339.
- Mosso, J.L., Wiederhold, B., Rizzo, S., et al. *Laparoscopic cholecistectomies, and inguinal hernia repairs assisted by Virtual reality*. Preliminary results. MMVR 16 th. Long Beach, CA, USA, January 29 to February 1, 2008.
- Mosso, J.L., Riva, G. et als. *Mobile phones to reduce anxiety in ambulatory surgeries*. Cybertherapy conference 2008. San Diego CA, USA, 24-26 June 2008.
- Mosso, J.L., Gorini, A., De la Cerda, G. et al. In: *Virtual Reality on mobile phones to reduce anxiety in outpatient surgery*. Medicine Meets Virtual Reality 17. (James Westwood, Susan W. Westwood, Randy S. Haluck et al. Editors), IOS Press, 2009, pp 195-200.
- Schwartz, R.B., Gillis, W.L., Miles, R.J. Orotrachial intubation in darkness using night vision goggles. *Mil Med.* 2001 Nov;166(11):984-6.
- Stetz, M. C., Makela, A., Folen, R. A., & Wiederhold, B. K. (2010). Cyberstudies: Lessons from the Trenches. *Cyberpsychology, Behavior, and Social Networking*, 13: 79-82.

MANAGEMENT OF CHRONIC PAIN FOR OLDER PERSONS: A MULTISENSORY STIMULATION APPROACH

Mimi M.Y. Tse¹ and Suki S.K. Ho¹

Since the prevalence of chronic pain among the elderly is high and reduces their quality of life, effective non-pharmacological pain management should be promoted. The purpose of this quasi-experimental pretest and posttest control design was to enhance pain management via an 8-week multisensory stimulation art and craft appreciation program (MSSAC). Residents from two nursing homes were randomized into an experimental group with MSSAC and a control group with regular care but without MSSAC. Relevant data were collected from both groups before and after the MSSAC. The MSSAC consisted of an 8-week program, with one session per week consisting of an art and craft activity and practicing multisensory stimulation therapy.

There were 59 and 82 older people in the experimental and control group respectively. No significant differences were found in their demographic characteristics, pain parameters, number of non-pharmacological strategies for pain relief, effectiveness scores on the non-pharmacological therapies, and psychological wellbeing at the baseline. Upon completion of the MSSAC, there was a significant decrease in pain scores and in the use of non-drug methods to control pain. Also, a significant improvement was observed in all psychological parameters in the experimental group, but not for the control group. The MSSAC proved to be effective in reducing pain, enhancing psychological wellbeing, and increasing the use of non-pharmacological therapies for the elderly.

Keywords: Pain Management, Multisensory Stimulation, Non-drug Strategies, Psychological Wellbeing, Nursing Home Residents

INTRODUCTION

With the increase in average life expectancy, the impact of disease, and the greater prevalence of disabilities, older adults are in increasing need of some form of alternative accommodation and/or residential care facilities (Sandberg et al. 2001). It has been estimated that there is more than a 40% chance that individuals aged 65 and older will spend time in a nursing home (Sandberg et al., 2001).

Most age-related diseases and illnesses bring chronic pain and disability. Pain is common in our aging population, and particularly so among older adults living in nursing homes (Bishop et al., 2007). Fifty percent of community-dwelling adults aged 60 or over have been

found to experience pain, and this number increases to 45-80% in the nursing home population (Ferrell et al., 1990; American Geriatric Society, Panel on Chronic Pain in Older Persons, 1998; Chung & Wong, 2007). Although pain is common among nursing home residents (Fox et al., 1999), older people living in nursing homes are at risk of not having their pain assessed and not receiving adequate treatment even if pain is documented (Achterberg et al., 2009). One of the greatest challenges facing nursing today is the provision of proper pain management for patients suffering from both acute and chronic pain (Sicilliano & Burrage, 2005). However, lack of knowledge about pain and its treatment remains an important barrier to effective pain management (Jones et al., 2004).

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Chronic pain can cause psychological, physical, social and financial problems (Fordyce, 1995). Chronic pain and psychological distress are found to occur together in a frequent manner and most patients with chronic pain experience emotional distress to varying degrees including depression, hopelessness, despair and dependency, loss of sleep, and loss of mobility (Farezadi et al., 2008). Unrelieved pain also has negative effects on psychological aspects including anxiety, fear, anger, and hopelessness (Bullock and Henze, 2000).

Analgesics do not always relieve pain or emotional restlessness, irritability, muscle tension, concentration and sleep disturbance (Schaffer & Yucha, 2004). Indeed, non-pharmacological methods of pain management can diminish the emotional components of pain (McCaffery & Pasero, 1999). As such, non-drug therapies including relaxation, deep breathing exercises, listening to music and meditation have demonstrated efficacy in treating chronic pain (NIH Technology Assessment Panel, 1996), headache (Silberstein, 2000), and postoperative pain (Good et al., 1999), yet healthcare providers have always underused non-drug therapies.

Relaxation and music have been recommended as adjuncts to medication. Both act on pain by decreasing anxiety, lowering muscle tension and distracting attention (Good, 1995). Relaxation directs the mind to concentrate on relaxing the muscles, reduces heart rate and blood pressure, and improves mood (Kerr, 2000). It also has the beneficial effect of combining deep breathing and imagery with a musical background. Music is composed of auditory tones and rhythms that do not direct the mind but distract it, and relax the body as well. Music can focus attention, facilitate breathing, and stimulate the relaxation response (Miller & Perry, 1990). Studies have shown that relaxation and music have beneficial effects on disease, pain, and emotional control (Mandle et al., 1990; Schofield, 2002).

Schofield & Bryn (1998) defined the use of the sensory environment for the management of chronic pain as "Snoezelen," a term that is reportedly a contraction of two Dutch words meaning "to sniff" and "to doze." Thus, it is a place for interaction within an engaging environment, which can facilitate rest and help to overcome fatigue (Schofield, 1996). The original concept was developed using simple effects, such as colored paper and light bulbs with tin foil, music and textures such as a heated waterbed, a ball pool and a vibrating massage bed designed to stimulate all of the primary senses – vision, hearing, touch,

taste and smell – simultaneously. These approaches can create a peaceful and tranquil experience for the elderly, encouraging them to feel safe (Kewin, 1991). There was widespread interest in the use of "Snoezelen" to enable relaxation, psychological promotion and pain reduction (Schofield & Hutchinson, 2002). Indeed, the use of multisensory therapies as a non-pharmacological pain management approach was proven to be effective and less expensive (Keefe et al., 1992).

While relaxation and multisensory therapies (Snoezelen) have been found to be effective in reducing pain, fatigue and anxiety symptoms, improving quality of life, and enhancing patients' ability to cope with distress (Peace & Manasse, 2002; Cassileth & Vickers, 2004 & Cassileth & Deng, 2004), art and craft therapy is one of the complementary therapies used to relieve these symptoms. Art therapy is a clinical intervention based on the belief that the creative process allows expression of an individual's deepest emotions (Malchiodi, 1999) and improves quality of life, emotional wellbeing, and physical symptoms such as pain (Favara-Scacco et al., 2001 & Nainis et al., 2006).

The objectives of the present study were to explore the effectiveness of multisensory stimulation with art and craft therapies for relieving pain and enhancing psychological wellbeing for older people in pain.

METHODS

DESIGN & SAMPLE

This research was a quasi-experimental pretest and posttest control group study design. After gaining approval from the Ethics Committee of the university, two private nursing homes were approached and invited to participate in the study. They were randomized into an experimental group with the MSSAC and a control group with regular care but without the MSSAC. Their residents were recruited by convenience sampling.

Written consent was obtained from all participants. Inclusion criteria entailed being 60 or older, able to communicate in Cantonese, and oriented as to time and place. By contrast, those who were bed bound and those with a history of mental disorder were excluded from the study.

PROCEDURE

Information regarding demographic, medical and pain-related data, self-perceived effectiveness scores, and psychological wellbeing parameters were collected from both groups' elderly before and after the MSSAC.

INTERVENTION: MULTISENSORY STIMULATION WITH ART AND CRAFT APPRECIATION PROGRAM (MSSAC)

The multisensory stimulation with art and craft appreciation program (MSSAC) was an 8-week program consisting of around 1 hr 30 min per week for eight weeks. Each week included various art and craft activities (45 min) with the older persons, and also practicing multisensory stimulation therapy (45 min). Details are shown in Table 1.

The content of the multisensory program included teaching relaxation techniques and pain control through the five primary senses: touch, smell, taste, hearing and vision. Essential lotions were given to the older people to apply to their faces and hands, and they were instructed to gently massage the acupressure points in their hands, backs, and legs under the guidance of the researcher. They were also instructed to close their eyes and take deep breaths while paying attention to the relaxing music, and to smell the essential oil that was distributed by a diffuser. Tea was provided to appeal to the taste buds, and they worked in groups to put together attractive puzzles.

The art and craft activities aimed at enhancing social connection, fine motor activities, and multisensory stimulation for the elderly. Activities included making photo albums, paper flowers, cups, decorations, paper fans and key chains by the use of scissors, folding papers, and sticking art materials onto artwork. The elderly people designed the products by themselves in a creative manner, and discussed them with one another in the process of the art and craft classes. Upon completion of the art and craft classes, they could bring their finished products back to

their bedside and show them to their family members and friends during their visits.

MEASUREMENTS

DEMOGRAPHIC DATA

The demographic sheet collected information including subjects' gender, age, marital status, education level, frequency of visits from relatives, past occupation, length of time living in nursing home, medical history, the reason for pain, pain triggers and any analgesic drugs intake.

PAIN SCALE

An 11-point numerical rating scale (NRS) was used in the study to assess the presence and intensity of pain among participants. The scale was presented vertically, with 0 referring to no pain and 10 referring to the worst pain imaginable. The Spearman's correlation coefficients for validity were 0.74 (Lara-Munoz et al., 2004).

PSYCHOLOGICAL WELLBEING ASSESSMENT

The Chinese version of the subjective happiness scale (Sonja & Heidi, 1999) consisted of four items with a rating provided on a 7-point Likert scale to determine the elderly person's happiness level. The Cronbach's alpha was 0.79 to 0.94. The test-retest reliability ranged from 0.55 to 0.90. The total scores ranged from 4-28, with higher scores indicating higher subjective happiness.

The revised UCLA Loneliness Scale, version 3 is a standard scale for measurement of loneliness (Russell, 1996). The scale consisted of 20 items to measure the feelings of loneliness and social isolation of the participants. The

Table 1
Multisensory Stimulation with art and craft appreciation therapy (MSSAC)

Week	Art & craft therapy (60mins)	Activities	Week	5 sensations therapy (45mins)	Activities
1	- making a photo album	-Encourage the elderly to make their products by using scissors, folding papers, sticking art materials onto artwork to promote their fine motor activities.	1-2	-introduce 5 sensation therapy, using the sense of touch, smell, taste, hearing & vision	- Encourage to use heat, cold and acupressure therapy.
2	- making a paper fan				
3	- making paper flowers	-Encourage the elderly to use their creativity to design a product to facilitate their mental stimulation.	3-4	-introduce breathing & relaxation exercise	- Elderly were taught to apply fragrant essential lotion to their face & hands. Simultaneously, instructed them to close their eyes and take deep breaths while playing relaxing music.
4	- making a key chain				
5	- making floral flower decorations				
6	- making festival decorations	-Encourage the elderly to have discussions with their fellow residents to enhance social connection.	3-6	-introduce non-drug therapy, e.g. watching TV, listening to music, hot & cold therapy, acupressure, exercise, deep breathing, aroma therapy, change of body posture and talking with friends	- To get them used to the feel of their bodies, to enjoy the fragrant atmosphere, and to sense the uniqueness and lovely skin textures.
7	- making a cup				
8	- having tea together		7-8	-experience sharing & reflection	- Refreshing them by providing some tea to drink and smell, and pleasuring them with some attractive pictures.

range of possible scores was 20-80, with higher scores signifying greater loneliness. A Chinese version of the Revised UCLA Loneliness Scale was validated and used, and the Cronbach's alpha of the Chinese UCLA Loneliness Scale was 0.90 (Chou et al., 2005).

The Life Satisfaction Index-A (Neugarten et al., 1961) form scale consisted of 18 questions related to five different components: zest, resolution and fortitude, congruence between desired and achieved goals, positive self-concept and mood tone. Items score 1 point for agree and 0 for disagree. A Chinese version of the Life Satisfaction Index-A form was used, with the Cronbach's alpha 0.7 for reliability and split half value 0.62 for internal consistency (Chi & Boey, 1992).

The Geriatric Depression Scale was used to measure depression (Yesavage et al., 1983). The scale consisted of 15 yes/no questions, with higher scores indicating more depression. Cronbach's alpha of internal consistency was 0.89, and the test-retest reliability was 0.85. A Chinese version of the Geriatric Depression Scale was used (Chan, 1996; Mui, 1996).

DATA ANALYSIS

Several statistical methods were used in data analysis. Descriptive statistical analysis of the quantitative data was conducted using the Statistical Package for the Social Sciences version 16.0. The Chi-square tests were used to determine any differences between the experimental group and the control group. Also, the paired sample t-test and the independent sample t test were used to examine differences within and between groups over two occasions in pain scores and psychological wellbeing parameters. A p-value <0.05 was considered statistically significant.

RESULTS

DEMOGRAPHIC CHARACTERISTICS

There were 141 older people who participated in the study, 59 in the experimental group and 82 in the control group. Table 2 shows their demographic characteristics. No significant differences were found in marital status, previous occupation, frequency of visits from relatives, length of time in nursing home, medical history, baseline pain scores, use of pain killers and non-drug therapy ($p>0.05$) for participants in the experimental and control group.

The mean age was 85.5 ± 5.39 for the experimental group and 82.6 ± 6.29 for the control group. The majority of the residents in both groups had been in nursing homes for 10

years. They received regular visits from their relatives. Most in the experimental group had visitors every week (33.9%), while those in the control group received visits less than once a month (31.7%). In general, their major underlying medical problems included stroke, hypertension, diabetes mellitus, cerebral vascular accidents, heart disease, eye disease and previous fracture. The pain scores were 4.83 ± 2.65 for the experimental residents and 4.28 ± 2.35 for the control residents who reported suffering from chronic pain. In the experimental group, 50.8% of participants and 43.9% in the control group used oral medications to relief pain. As for using non-drug therapy, 76.3% of the experimental group and 56.1% of the control group would choose to use non-drug therapy as pain relief.

PAIN SCORES IN ELDERLY PATIENTS

Table 3 shows the pain scores of the experimental and control groups at the baseline and post-MSSAC. At the baseline (week 1), the pain scores were 4.83 ± 2.65 and 4.28 ± 2.35 among the experimental and control group, and there was no significant difference ($p>0.05$). Upon completion of the MSSAC (week 8), there was a significant reduction of pain scores to 2.76 ± 2.07 in the experimental group ($p<0.05$), while the control group showed decreased pain scores but not significantly so ($p>0.05$). Also, the most common pain locations among both groups of elderly were the knee (67.3%), back (37.3%) and shoulder (34.6%), as shown in Figure 1.

THE USE OF NON-DRUG METHODS AS PAIN RELIEF

As shown in Table 3, upon completion of the MSSAC, there was a significant increase in the use of non-drug methods in pain relief for the experimental group, from 1.11 to 5.46 times ($p<0.05$), while the control group showed only a slight increase in the use of non-drug methods in pain relief and was not significant ($p>0.05$). Also, the experimental group used more non-drug methods to relieve pain as compared to the control group ($p<0.05$).

In terms of perceived effectiveness in using non-drug methods, participants in the experimental group showed a significant increase in scores, from 1.72 to 3 ($p<0.05$) post-MSSAC, while there was no change in the control group ($p>0.05$). Furthermore, participants in the experimental group perceived the use of non-drug methods to be more effective in pain relief than the control group ($p<0.05$).

Also in Table 4 is evidence of a significant positive correlation of non-drug methods used and perceived effectiveness of non-drug methods ($p<0.05$). This demonstrates

Table 2
Demographics data (experimental group vs control group)

	Experimental group N=59		Control group N=82		<i>p-value</i> □1
	Number	Percentage	Number	Percentage	
Gender					0.00*
Male	4	6.8	28	34.1	
Female	55	93.2	54	65.9	
Age					0.04*
	(85.5±SD5.39)		(82.6±SD6.19)		
Under 60	0	0	0	0	
60-70	0	0	3	3.7	
71-80	6	10.2	19	23.2	
Over 80	53	89.8	60	73.1	
Marital status					0.32
Single	8	13.6	11	13.4	
Married	6	10.2	15	18.3	
Divorced	0	0	2	2.4	
Widowed	45	76.2	54	65.9	
Education level					0.03*
No formal education	47	79.7	46	56.1	
Primary school	11	18.6	28	34.1	
Secondary school	1	1.7	7	8.5	
University or above	0	0	1	1.2	
Previous occupation					0.17
Primary industry	6	10.2	13	15.9	
Secondary industry	13	22.0	26	31.7	
Tertiary industry	14	23.7	21	25.6	
Housewife	26	44.1	22	26.8	
Frequency of visits from relatives					0.34
Daily	0	0	3	3.7	
Alternate days	0	0	2	2.4	
Every week	20	33.9	21	25.6	
Every month	17	28.8	20	24.4	
Less than once a month	18	30.5	26	31.7	
No visitors	4	6.8	10	12.2	
Length of time in nursing home (years)					0.31
≤1-3 years	14	23.7	26	31.7	
≥4-6 years	10	16.9	15	18.3	
≥7-9 years	16	27.1	12	14.6	
≥10 years	19	32.2	29	35.4	
Past & present medical history (can choose more than one)					
Stroke	11	18.6	18	22	0.78
Hypertension	35	59.3	58	70.7	0.21
DM	11	18.6	18	22	0.78
Heart disease	21	35.6	20	24.4	0.21
Cataract	33	55.9	27	32.9	0.24
Previous fracture	14	23.7	18	22	0.96
Urinary tract infection	5	8.5	2	2.4	0.22
Arthritis	14	23.7	11	13.4	0.17
Respiratory disease	7	11.9	14	17.1	0.53
Use of pain killers					0.52
Yes	30	50.8	36	43.9	
No	29	49.2	46	56.1	
Use of non-drug therapy					0.06
Yes	45	76.3	46	56.1	
No	14	23.7	36	43.9	
Pain scores (Mean±SD)	4.83±2.65		4.28±2.35		<i>P-value</i>□2 0.18

□1 Chi-Squared test was used, □2 Independent sample t- test was used

Table 3

Pain parameters, non-drug methods used and perceived effectiveness of non-drug methods among older persons in experimental group and control group: Baseline (week 1) vs Post MSSAC (week 8)

Elderly with pain	Experimental Group (N=52)		p-value β_1	Control Group (N=56)		p-value β_2	p-value β_3	p-value β_4
	Baseline (Week 1) Mean \pm SD	Post intervention (Week 8) Mean \pm SD		Baseline (Week 1) Mean \pm SD	Post intervention (Week 8) Mean \pm SD			
Pain scores	4.83 \pm 2.65	2.76 \pm 2.07	0.00*	4.21 \pm 2.35	3.31 \pm 1.76	0.09	0.18	0.15
Non-drug methods used	1.11 \pm 0.78	5.46 \pm 2.14	0.00*	0.91 \pm 1.12	1.31 \pm 1.59	0.12	0.45	0.00*
Perceived effectiveness of non- drugs method (4 point scores)	1.72 \pm 1.64	3.0 \pm 0.67	0.00*	1.43 \pm 1.61	1.58 \pm 1.51	0.59	0.47	0.00*

β_1 Comparison of baseline & post intervention for experimental group (paired sample t test)

β_2 Comparison of baseline & post intervention for control group (paired sample t test)

β_3 Comparison of baseline among experimental & control group (independent sample t test)

β_4 Comparison of post intervention among experimental & control group (independent sample t test)

* A p-value of < 0.05 was considered statistically significant

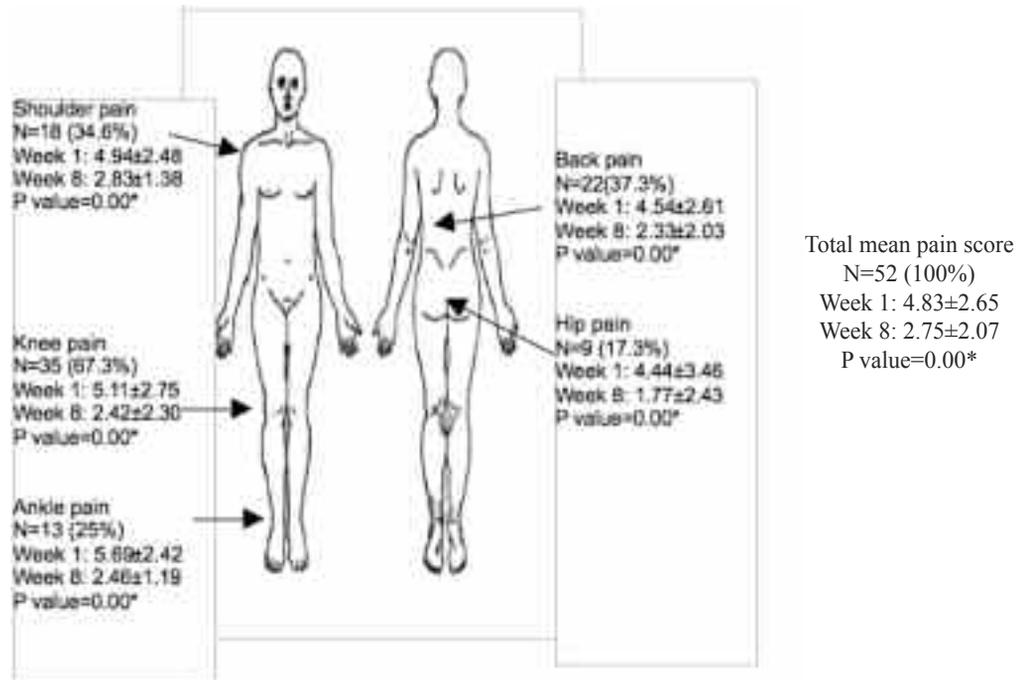


Figure 1. Pain intensity and pain site in experimental group (N= 52): Baseline (week 1) vs Post-MSSAC (week 8).

that the more effective they perceived the use of non-drug methods to be, the more non-drug methods the participants would use to control and relieve pain.

PSYCHOLOGICAL PARAMETERS OF ELDERLY PATIENTS
 No significant differences were found in the happiness, life satisfaction, loneliness and geriatric depression scores between the experimental and control elderly

($p > 0.05$) at the baseline (as shown in Table 5). Upon completion of the MSSAC, there was significant improvement ($p < 0.05$) in all psychological parameters in the experimental group, yet this was not so in the control group, except for improvement in loneliness ($p < 0.05$). Also, participants in the experimental group were significantly better in all psychological parameters than their counterparts in the control group.

Table 4
Correlation between total non- drugs therapy methods and perceived effectiveness scores by older persons- Pre and post intervention

Pearson correlations	Experimental group (N=52)			
	Baseline (week 1)		Post intervention(week 8)	
	r	p-value	r	p-value
Non-drug methods used	-0.03	0.85	0.45	0.02*
Perceived effectiveness of non- drug methods				

Pearson correlation test was used
 * $p < 0.05$ was considered statistically significant

Table 5
Psychological parameters in Experimental Group and Control Group: Baseline (week 1) vs post MSSAC (week 8)

	Experimental Group (N=59)		p-value $\beta 1$	Control Group (N=82)		p-value $\beta 2$	p-value $\beta 3$	p-value $\beta 4$
	Baseline (Week 1) Mean \pm SD	Post intervention (Week 8) Mean \pm SD		Baseline (Week 1) Mean \pm SD	Post intervention (Week 8) Mean \pm SD			
Happiness scores	16.55 \pm 6.10	20.60 \pm 5.53	0.00*	17.82 \pm 6.88	18.00 \pm 5.65	0.41	0.125	0.02*
Loneliness scores	36.88 \pm 12.46	35.81 \pm 10.53	0.00*	44.01 \pm 11.59	43.55 \pm 9.89	0.26	0.01*	0.00*
Life satisfaction scores	9.03 \pm 3.46	10.37 \pm 3.95	0.03*	8.31 \pm 3.72	8.83 \pm 3.81	0.06	0.20	0.00*
Depression scores	6.36 \pm 3.75	5.28 \pm 3.19	0.04*	7.15 \pm 73.72	6.50 \pm 3.99	0.06	0.07	0.00*

$\beta 1$ Comparison of baseline & post intervention for experimental group (paired sample t test)
 $\beta 2$ Comparison of baseline & post intervention for control group (paired sample t test)
 $\beta 3$ Comparison of baseline among experimental & control group (independent sample t test)
 $\beta 4$ Comparison of post intervention among experimental & control group (independent sample t test)
 * A p-value of < 0.05 was considered statistically significant

DISCUSSION

The present study demonstrates the effectiveness of the MSSAC in reducing pain and enhancing psychological parameters in older persons. The results are consistent with previous studies using multisensory stimulation therapy for chronic pain among the elderly (Schaffer & Yucha, 2004). It was Pat Schofield who pioneered the use of multisensory environment concepts for individuals with chronic non-malignant pain and with positive outcomes. In the present study, a multisensory stimulation environment was created in the nursing home environment, in which the primary senses (hearing, vision, smell, taste and touch) were gently stimulated. Soft music was played, with fragrant lotion given to each older person to apply to both hands. They were then asked to close their eyes and practice deep breathing while listening to the music. They were guided in feeling their bodies and smelling the fragrant lotion as well as gently massaging the acupressure points along their faces, hands, backs and legs. Also, they were asked to smell the essential oil that was distributed by a diffuser. Tea was provided at the end of the session to appeal to the taste buds, and they worked in groups to put together attractive puzzles. All participants showed positive responses to the multisensory stimulation environment, and reported lower pain, loneliness and depression, while improving their happiness and life satisfaction. People may experience sensory deprivation in environments that may be perceived as boring, monotonous, and uninteresting. Indeed, life in a nursing home can be very uninteresting, with limited physical and social activity, leading to further decline in function ((Lassey & Lassey, 2001). Good psychological and mental health means normal mental status without disease or disorder, enabling the older individual to think and manage him/herself while interacting comfortably with others (Lassey & Lassey, 2001). In the absence of disorder, our general mental ability continues throughout life, despite the fact that advancing age does lead to deterioration of sensory and cognition function to some extent. Mental health is thus one of the keys to optimal aging (Porello et al., 1995, Lassey & Lassey, 2001). Our overall mental capacity is partially structured by genetic factors. The brain has the capacity to compensate for minor loss of neurons. Older people can maintain their mental health and overall mental ability by effective socialization, education, and other forms of planned activities and training (Cotman, 1990).

It is a concern when more than 50% of older people living in nursing homes suffer from some form of minor or major mental disorder (Vaczek, 1994). The findings of the pres-

ent study at the baseline (week 1) illustrate a situation of poor psychological parameters, including low happiness scores, high levels of loneliness, and low life satisfaction among older people living in nursing homes in both the experimental and control group. Indeed, they may be more prone to mental issues when no further action is taken in a timely fashion. The multisensory stimulation and art and craft program is therefore an appropriate activity to enhance psychological parameters and overall mental ability for older people living in nursing homes.

Pain is a complex experience that is made up of physical, psychological, social and spiritual components as the total pain experience, coined by Dame Cicely Saunders (Clark, 1999). Pain management and social support networks are important initiatives for older adults living in nursing homes. Upon completion of the MSSAC, it was encouraging to find that pain scores had decreased significantly, while psychological parameters including happiness, life satisfaction, loneliness and depression had been improved to a significant degree. The quality of life for older persons living in nursing homes was thus improved.

One of the limitations of the present study would be the Hawthorne effect, whereby the special attention of receiving multisensory stimulation has beneficial effects on the participants. Indeed, changes in the experimental group may be due to the "good subjects" effect that occurs when researchers seemed to commit a great deal of their time and effort to helping participants. Nevertheless, the dramatic positive benefit of multisensory stimulation from this single simple intervention was impressive and should be integrated into daily care and management of pain and chronic illness for older persons.

In conclusion, multisensory stimulation with art and craft appreciation proved to be effective in enhancing the use of non-pharmacological therapies and reducing pain saturation, as well as improving the psychological wellbeing parameters for nursing home residents. It is important to implement the new paradigm of pain management in a holistic way as the total pain concept in the nursing home environment.

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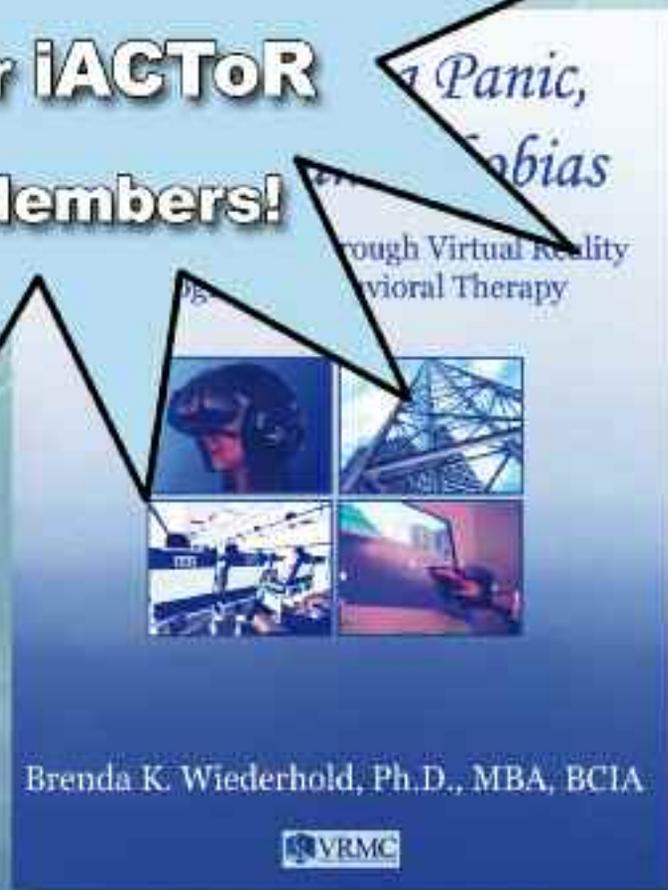
REFERENCES

- Bullock, B. & Henze, R. (2000). *Focus on pathophysiology*. Philadelphia: Lippincott Williams & Wilkins.
- Cassileth, B. R. & Deng, G. (2004). Complementary and alternative therapies for cancer. *Symptom Management and Supportive Care*, 9(1), 80-89.
- Cassileth, B. R. & Vickers, A. J. (2004). Massage therapy for symptom control: outcome study at a major cancer center. *Journal of Pain and Symptom Management*, 28(3), 244-249.
- Chan, A. C. M. (1996). Clinical validation of the geriatric depression scale (GDS). *Journal of Aging and Health*, 8(2), 238-253.
- Chi, I. & Boey, K. W. (1992). Validation of measuring instruments of mental health status of the elderly in Hong Kong. Department of Social Work & Social Administration, University of Hong Kong.
- Clark, D. (1999). 'Total pain', disciplinary power and the body in the work of Cicely Saunders, 1958-1967. *Social Science & Medicine*, 49, 727-736.
- Cotman, C. W. (1990) The Brain: New Plasticity / New Possibility, in Robert N. Butler, M.R. Oberlink & M. Schechter, *The Promise of Productive Aging: from Biology to Social Policy*. New York: Springer, 70-84.
- Farezadi, Z., Normah, C. D., Zubaidah, J. & Maria, C. (2008). Chronic pain and psychological well-being. *Symposium Sains Kesihatan Kebangsaan Ke 7 Hotel Legend, Kuala Lumpur; 18-19*, 202-204.
- Favara-Scacco, C., Smirne, G., Schiliro, G. & Di Cataldo, A. (2001). Art therapy as support for children with leukemia during painful procedures. *Medical and Pediatric Oncology*, 36, 474-480.
- Fordyce, W. (1995). *Back Pain in the Workplace*. IASP Press, Seattle.
- Fox, P. L., Perminder, R. & Jaded, A. R. (1999). Prevalence and treatment of pain in older adults in nursing homes and other long term care institutions: a systematic review. *Canadian Medical Association*, 160 (3), 329-333.
- Good, M. (1995). A comparison of the effects of jaw relaxation and music on postoperative pain. *Nursing Research*. 44, 52-57.
- Good, M., Stanton-Hicks, M., Grass, J. A., Anderson, G. C., Choi, C., Schoolmeesters, L. J. & Salman, A. (1999). Relief of postoperative pain with jaw relaxation, music and their combination. *Pain*, 81 (1-2), 163-172.
- Jones et al. (2004). Improving nursing home staff knowledge and attitudes about pain. *The Gerontologist*, 44(4), 469-478.
- Keefe, F. J., Salley, A. N., Lefebvre, J. C. (1992). Coping with pain: conceptual concerns and future directions. Guest editorial. *Pain*, 5 (2), 131-134.
- Kemper, P. & Murtaugh, C. (1991). Lifetime use of nursing home care. *New England Journal of Medicine*, 324, 595-600.
- Kerr, K. (2000). Relaxation techniques: a critical review. *Critical Reviews in Physical and Rehabilitation Medicine*, 12(1), 51-89.
- Kewin, J. (1991). *Snoezelen User Guide*. North Derbyshire Health Authority, Rompa- Winslow Publications, Chesterfield.
- Killick, J. & Allan, K. (1999). The arts in dementia care: tapping a rich resource. *Journal of Dementia Care*, 7, 35-38.
- Kwekkeboom, K., Moore, K. H. & Ward, S. (1998). Imaging ability and effective use of guided imagery. *Research in Nursing and Health*, 21, 189-198.
- Lassey, W. R. & Lassey, M. L. (2001). *Quality of life for older people. An international perspective*. New Jersey: Prentice-Hall Inc.
- Lara-Munoz, C., De Leon, S. P., Feinstein, A. R., Puente, A. & Wells, C. K. (2004). Comparison of three rating scales for measuring subjective phenomena in clinical research. I. Use of experimentally controlled auditory stimuli. *Archives of Medical Research*, 35, 43-48.

- Lau, O. W. Y., Leung, L. N. Y. & Wong, L. O. L. (2002). Cognitive behavioural techniques for changing the coping skills of patients with chronic pain. *Hong Kong Journal of Occupational Therapy*, 12, 13-20.
- Luk, J. K. H., Chiu, P. K. C. & Chu, L. W. (2008). Factors affecting institutionalization in older Hong Kong Chinese patients after recovery from acute medical illnesses. *Archives of Gerontology and Geriatrics*, 49, 110-114.
- Malchiodi, C. (1999). *Medical Art Therapy with Adults*. Jessica Kingsley Publishers Limited, London.
- Mandle, C. L. et al. (1990). Relaxation response in femoral angiography. *Radiology*, 174(3), 737-739.
- McCaffery, M. & Pasero, C. (1999). *Pain: Clinical Manual*. 2nd ed. St. Louis: Mosby.
- Miller, K. M. & Perry, P. A. (1990). Relaxation technique and postoperative pain in patients undergoing cardiac surgery. *Heart Lung*, 19, 136-146.
- Mobily, P. R., Herr, K. A. & Kelley, L. S. (1993). Cognitive-behavioural techniques to reduce pain: a validation study. *International Journal of Nursing Study*, 30(6), 537-548.
- Mui, A. C. (1996). Geriatric depression scale as a community screening instrument for elderly Chinese immigrants. *International Psychogeriatrics*, 8(3), 445-458.
- Nainis, N., Paice, J. A., Patner, J., Wirth, J. H., Lai, J. & Shott, S. (2006). Relieving symptoms in cancer: innovative use of art therapy. *Journal of Pain and Symptom Management*, 31(2), 162-169.
- Ng, K. F., Tsui, S. L. & Chan, W. S. (2002). Prevalence of common chronic pain in Hong Kong adults. *The Clinical Journal of Pain*, 18, 275-281.
- NIH Technology Assessment Panel on Integration of Behavioral and Relaxation Approaches into the Treatment of Chronic Pain and Insomnia. (1996). Integration of behavioral and relaxation approaches into the treatment of chronic pain and insomnia. *The Journal of the American Medical Association*, 276(4), 313-318.
- Peace, G. & Manasse, A. (2002). The Cavendish Centre for Integrated Cancer Care: assessment of patients' needs and responses. *Complementary Therapies in Medicine*, 10(1), 33-41.
- Porello, P. T., Madsen, L., Futterman, A., Moak, G. S. (1995) Description of a Geriatric Medical / Psychiatric Unit in a Small Community General Hospital. *Journal of Mental Health Administration* 22 (1), 3eight 48.
- Russell, D. W. (1996). UCLA Loneliness Scale (version 3): Reliability validity and factor structure. *Journal of Personality Assessment*, 66(1), 20-40.
- Schaffer, S. D. & Yucha, C. B. (2004). The relaxation response can play a role in managing chronic and acute pain. *American Journal of Nursing*, 104(8), 75-82.
- Schofield, P. A. (1996). Snoezelen: its potential for people with chronic pain. *Complementary Therapies in Nursing & Midwifery*, 2, 9-12.
- Schofield, P. A. (2002). Evaluating Snoezelen for relaxation within chronic pain management. *British Journal of Nursing*, 11 (12), 812-820.
- Schofield, P. A. & Bryn, D. (1998). Sensory deprivation and chronic pain: a review of the literature. *Disability and Rehabilitation*, 20(10), 357-366.
- Schofield, P. A. & Hutchinson, R. (2002). *Snoezelen: the evidence from practice*. Free Association Books, London.
- Siciliano, P. & Burrage, R. (2005). Chronic pain in the elderly: a continuing education program for certified nursing assistants. *Geriatric Nursing*, 26 (4), 252-258.
- Silberstein, S. D. (2000). Practice parameter: evidence-based guidelines for migraine headache (an evidence-based review): report of the Quality Standards Subcommittee of the American Academy of Neurology. *Neurology*, 55 (6), 754-762.

- Sonja, L. & Heidi, S. L. (1999). A measure of subjective happiness: preliminary reliability and construct validation. *Social Indicators Research*, 46, 137-155. The Hong Kong Council of Social Services (2009). Elderly service in Hong Kong. Available at http://www.hkcss.org.hk/download/folder/el/el_eng.htm. Accessed July 12, 2009.
- Vaczek, D. (1994) How can facilities improve mental health services? *Contemporary Long Term Care* 17(8),28.
- Yesavage, J. A., Brink, T. L., Rose, T. L., Lum, O., Huang, V., Adey, M., Leirer, V. O. (1983). Development and validation of a geriatric depression screening scale: A preliminary report. *Journal of Psychiatric Research*, 17 (1), 37-49.

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CYBERPROJECTS

IN THIS FEATURE, we will try to describe the characteristics of current cyberpsychology and rehabilitation research. In particular, CyberProjects aims at describing the leading research groups and projects, actually running around the world, with a special focus on European research.

ROBOTS LEARNING FROM EXPERIENCE

Software that enables robots to move objects about a room, building up and increasing their knowledge about their environment, is an important step forward in artificial intelligence.

Some objects can be moved, while others cannot. Balls can be placed on top of boxes, but boxes cannot be stably stacked on top of balls. A typical one-year-old child can discover this kind of information about its environment very quickly. But it is a massive challenge for a robot – a machine – to learn concepts such as “movability” and “stability,” according to Björn Kahl, a researcher at the Bonn-Rhein-Sieg University and a member of the Xpero robotics research project team.

The aim of the “Xpero – Learning by Experimentation” project was to develop a cognitive system for a robot that would enable it to explore the world around it and learn through physical experimentation.

LOGICALLY TESTING HYPOTHESES

The first step was to create an algorithm that enabled the robot to discover its environment from data it received from its sensors. The Xpero researchers installed some very basic predefined “knowledge” into the robot. That knowledge is based on logic. The robot believes that things are either true or false – there are no “maybes.” The robot uses the data from its sensors as it moves about to test that knowledge. When the robot finds that an expectation is false it starts to experiment to find out why it is false and to correct its hypotheses.

Picking out the important factors in the massive and continuous flow of data from the robot’s sensors created one challenge for the EU-funded Xpero project

team. Finding a way for a logic-based system to deal with the concept of time was a second challenge.

Initially, the robot has no useful vision of the probable future, but with each observation it learns better hypotheses that it can use to predict the effects of its actions. If an experiment showed that one of its hypotheses was false, then there were literally an infinite number of possibilities of what the correct solution might be. The team had to find ways to short-circuit the process to stop the robot spending an infinite amount of time testing each possibility.

Part of the Xpero team’s solution was to ignore some of the flow of data coming in every millisecond and instead to get the robot to compare snapshots of the situation after a few seconds. When an expectation proved false they also cut down the possible number of solutions by getting the robot to build a new hypothesis that kept the logic connectors from its old hypothesis, simply changing the variables. That drastically reduced the number of possible solutions.

BUILDING A STORE OF KNOWLEDGE

An important development from Xpero is the robot’s ability to build its knowledge base. “It makes no distinction between previous knowledge and learnt knowledge,” explains Kahl. “That it can re-use knowledge is very important. Without that there would be no incremental learning.”

In award-winning demonstrations, robots with the Xpero cognitive system on board have moved about, pushed and placed objects, learning all the time about their environment. In an exciting recent development the robot has started to use objects as tools. It has used one object to move or manipulate another object that it cannot reach directly.

While exploring robots makes great theatre, the most exciting developments to come out of Xpero are what the team learnt about the process of learning itself, says Kahl. “We gained a lot of insight into what the challenges in learning are and how machine-learning really

works. Just getting the robot to figure out that something is not right required major insights from a research point of view.”

They are planning a new project that will run one or two robots for a much longer time – perhaps months – to see how they advance.

The Xpero project lays the first cornerstones for a technology that has the potential to become a key technology for the next generation of so-called service robots, which clean our houses and mow our lawns – replacing the rather dumb, pre-programmed devices on the market today. A robotics manufacturer is already planning to use parts of the Xpero platform in the edutainment market.

“But while Xpero advances machine learning, it is still far short of the capabilities of a baby,” says Kahl. “Of

course, the robot can now learn the concept of movability. But it does not understand in the human sense what movability means.”

The Xpero project received funding from the FET-Open strand of the EU’s Sixth Framework Programme for research.

For more info: <http://www.xpero.org/>.

Compiled by Giuseppe Riva, Ph.D., and Simona Raspelli, Ph.D.
Istituto Auxologico Italiano
Data provided by ICT Results
(<http://cordis.europa.eu/ictresults>)

CYBERFOCUS

New technologies are developing at a rapid pace. To help you stay abreast of the latest trends in advanced technologies and healthcare, this feature showcases upcoming, 2009- 2010 events, which will provide you with the opportunity to connect with leading experts worldwide and remain on the cutting edge of the most recent developments.

The CyberFocus column welcomes your contributions. To supply relevant information for this feature, please send an e-mail to: office@vrphobia.eu.

CyberPsychology & CyberTherapy 16

June 20-22, 2011

Gatineau, Canada

www.interactivemediainstitute.com

The Journal of CyberTherapy & Rehabilitation is the official journal of the CyberTherapy Conference. The 16th Annual International CyberTherapy Conference (CT16) brings together researchers, clinicians, policy makers and funding agencies to share and discuss advancements in the growing discipline of CyberTherapy & Rehabilitation, which includes training, education, prevention, rehabilitation, and therapy. The focus of next year's conference is two-fold—first, “Technologies as Enabling Tools” will explore the use of advanced technologies in diagnosis, assessment and prevention of mental and physical disorders. In addition, attention will be drawn to the role of interactive media in training, education, rehabilitation and therapeutic interventions. Secondly, CT16 will investigate the “Impact of New Technologies” and how they are influencing behavior and society through cyberadvertising, cyberfashion and cyberstalking, among others. Technologies featured at the conference include VR simulations, video games, telehealth, the Internet, robotics, brain-computer interfaces, and non-invasive physiological monitoring devices. Conference attendees have the opportunity to play a role in designing the future of mental healthcare. CT16 features interactive exhibits at the Cyberarium allowing participants to experience the technologies firsthand as well as the opportunity to display their exhibits in a forum-type setting.

2010 Conferences

10th International Conference on Intelligent Virtual Agents (IVA 2010)

September 20 -22

Philadelphia, Pennsylvania, USA

<http://iva2010.org/>

ICT 2010

September 27-29

Brussels

http://ec.europa.eu/information_society/events/ict/2010/index_en.htm

40th European Association for Behavioural and Cognitive Therapies Annual Conference

October 7 - 10

Milan, Italy

<http://www.eabct2010-milan.it/>

JCR

eChallenges

October 27-29

Warsaw

<http://www.echallenges.org/e2010/>

ACM Multimedia

October 29

Florence

<http://www.acmmm10.org/>

Global Telehealth

November 10-12

Perth, Western Australia

<http://www.hisa.org.au/node/756>

HIMSS Middle East

November 8-10

<http://www.himssme.org/>

Association for Behavioral and Cognitive Therapies (ABCT 2010)

November 18 - 21

San Francisco, California, USA

<http://www.abct.org/dMembers/?m=mMembers&fa=Convention>

WHCC Middle East

December 5-7

Abu Dhabi

<http://www.worldcongress.com/>



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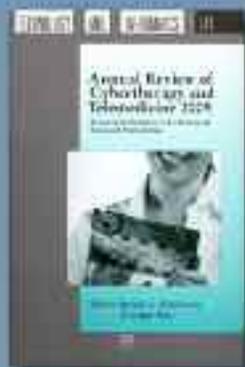
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Advanced Technologies in the Behavioral, Social and Neurosciences

Editors: B.K. Wiederhold and G. Riva

\$ 167.00

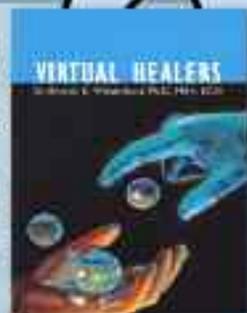
Cybertherapy – the provision of healthcare services using advanced technologies – can help improve the lives of many of us, both patients and health professionals, while tackling the challenges to healthcare systems.

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Virtual Healers

Brenda K. Wiederhold, Ph.D., MBA, BCIA

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Virtual Reality in the Mental Health arena is barely over a decade old. Because VR is still such a young and focused field, the members of its community have come together as a tight-knit family. In Virtual Healers, Dr. Brenda K. Wiederhold, herself a pioneer of VR, sits down in casual one-on-one interviews with more than a dozen of the top researchers of this select group.



Virtual Healing

Brenda K. Wiederhold, Ph.D., MBA, BCIA

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Along with aliens and time travel, virtual reality (VR) is often thought of as a science fiction dream. Though it was developed nearly five decades ago, the use of VR in the private sector, particularly in the field of patient care, has become a possibility only in the past decade. As programmers are creating more detailed and interactive environments, the rapid advancement of technology combined with decreasing costs has turned VR into a promising alternative to traditional therapies.

Virtual Reality Resources

By Brenda K. Wiederhold, PhD, MBA, BCIA

\$19.95



We, at the Interactive Media Institute, realized early on that it was relatively difficult for professionals wanting to break into the Virtual Reality (VR) field to locate relevant information. While the material was out there, there was no clear organizational structure or database to link it. To solve this problem, we have put together Virtual Reality Resources, a relevant compilation for researchers and clinicians alike.



CyberTherapy Conference Archives 1996-2005

A Collection of all abstracts from the past 10 years of CyberTherapy

By Brenda K. Wiederhold, PhD, MBA, BCIA

\$ 29.95

A decade ago, CyberTherapy, then still in its infancy, only existed as a specialized Virtual Reality and Behavioral Healthcare Symposium at the Medicine Meets Virtual Reality (MMVR) Conference. It is now clear that in 1996, we had only begun to realize what promise might lie ahead for both VR technology and the CyberTherapy Conference.

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BOOK REVIEW

Interface Fantasy: A Lacanian Cyborg Ontology
André Nusselder, The MIT Press, Cambridge, Massachusetts, 2009, 176 pages, \$18.95

Belonging to the Short Circuits book series (edited by Slavoj Žižek), André Nusselder's own work, *Interface Fantasy: A Lacanian Cyborg Ontology*, is a thought-provoking, philosophical discussion that engages the complexities of Lacanian psychoanalysis within cyberspace, and the interactions between humans and digital technologies. Cyberspace, according to Nusselder, is a "psychological space," through which the notion of the "cyborg" is manifested. This "cyborg" is a concept that suggests the embodiment of human and computer, epitomizing the inseparability, intimacy, and entanglement between humans and digital technologies. Precursors of Nusselder's conception of the cyborg were evident as long ago as 1966, when the Massachusetts Institute of Technology (MIT) created a computer, ELIZA, that became noted as the first computer psychotherapy program in history (114). ELIZA's groundbreaking feature was its ability to "converse" with any user who typed in a query. As conversations with ELIZA continued, psychoanalytic philosopher Jacques Lacan acknowledged the development of a "transference relation" between ELIZA and the human conversant. In other words, an affective (unconscious) attachment was created as human conversants found "something of themselves" in ELIZA, and so "unconsciously transferred" (perhaps via projection) their desires (e.g. acceptance, companionship, love) to ELIZA (114).

Though ELIZA's technological features are substandard compared to today's advanced artificial intelligence, the psychoanalytic implications of entangled human-computer relationships transcend time and space, remaining as potent in the past as in modern day.

Nusselder examines the powerful nature and workings of the "unconscious" by linking the growing development, intrigue, and questions surrounding the intimate human-computer dyad through key Lacanian psychoanalytic conceptualizations of human reality: fantasy (or imagi-

nary); the symbolic (codes, signs, language); and the notion of "the real" in this context of cyberspace. A thought-provoking, philosophical discussion of these links is offered throughout the first half of the book. According to Nusselder, with the computer screen acting as the staging area, the "symbolic" both orders and situates the human subject on the psychological stage, where "fantasy" (or the imaginary) serves as an "interface" that mediates between human reality and the Lacanian "real." The author asserts that "the real" is both one's personal human trauma (as per one's unique, personal life context), and also one's ultimate trauma evident in the fundamentality of human mortality, or the inevitability of death, dying, and decay. This notion of "real" expresses itself as "anxiety," which according to Nusselder, is the emotion that most closely simulates the personal and mortal traumas that connect with the human finitude associated with "the real." Fantasy, then, serves to shape the world and our mortality into more favorable circumstances, frames, and images (e.g. freedom from pain, immortality). The "real" lies behind the interface of fantasy. From these key Lacanian concepts, Nusselder communicates the psychoanalytic connections between the unconscious and the development of cyborgs.

The second half of the book continues the author's philosophical explanation on the development of cyborgs, offering some illustrations of psychopathologies that exemplify the negative consequences of human and digital technology entangled within cyberspace. Confusion between reality and fantasy, or "hyperreality," according to Nusselder, explains the possible etiology of psychopathologies such as Internet delusions (e.g. paranoia of big brother surveillance), Internet addictions, cybersex obsessions, and "techno-fetishes" (e.g. obsessions with all sorts of technological toys, online gaming worlds, websites, online streaming sites, etc.), that offer a desirable representation of one's fantasy, or illusory reality.

Nusselder's most effective illustration of the Freud-Lacanian etiology behind such online pathologies describes one's online gaming "avatar" that exists in a given virtual world. For instance, Nusselder gives an example of a

“very macho” avatar – a fantasmatic image that an insecure, neurotic person might select or create in a given MMORPG (massively multiplayer online role-playing game) (102). Through the avatar, this neurotic person symbolically represents himself/herself through particular ways of speaking, acting, moving, and perhaps “fighting” within a non-immersive Virtual Reality setting. Nusselder suggests that this type of online, symbolic image of self or particular reality epitomizes what the user wants others to see (or wants oneself to identify with) in a cyberspace fantasy.

So, our “self-portrait” moves us. And it also legitimizes actions: “human as astronaut” for the exploration of outer space; “human as multiple personality” for the exploration of cyberspace. Because I see myself as...(beautiful, desirable, explorative, multiple, etc.), I define my sense of self and my actions. It is the virtual image that sustains desire. And I get anxious when I lose this image, or depressed when it is a negative one (“I am nothing, nobody wants me...”). This exploration of space can nevertheless transform into a domination of space. Lacan diagnoses science and technology as guided by such imaginary desires. This imaginary conquest of space can also seize upon people in the digital era. Virtual space then replaces real space: someone’s life in cyberspace is no longer an exploration but a compensation. (98)

Thus, in the case of this avatar, it reveals the neurotic person’s unconscious desires while simultaneously cushioning him/her from facing the personal traumas found in “the real” that perhaps have led to the user’s neurosis. Essentially, Nusselder argues, “technologies make us believe that we are not nobodies” (127). This attractive belief then allows the computer and its screen of fantasy to capably seduce the user into a “hyperreality,” or confusion of what is “real” versus “illusion.”

Without a doubt, many assertions in *Interface Fantasy* are heavily inspired by renowned Slovenian philosopher Slavoj Žižek’s interpretations of Lacanian psychoanalysis. Nusselder is respectfully explicit about this, recognizing Žižek’s established work in Lacanian studies. Nonetheless, Nusselder makes an admirable attempt to make his contributions distinct by adding his unique “signature” to this area of Internet studies. To do this, the author inten-

tionally develops his theoretical foundation based on the original source – psychoanalyst Jacques Lacan’s views – as opposed to a reliance on Žižekian perspectives (which “interpret” Lacan’s concepts). Overall, Nusselder is successful in managing to distinguish himself from his contemporary, Žižek, building upon his own unique formulations of Lacanian fantasy, the symbolic, and the real. In fact, Nusselder’s position on human and digital technologies is noticeably more balanced, offering a less bleak perspective on present human states compared to what a Žižekian-based analysis might offer. That is, while Nusselder does not hesitate to discuss the dangers and seductive capacities of digital technologies, he is also quick to assert how the screen “allows us to play, to indulge or enjoy our fantasies,” assuming that a certain distance and “awareness guards us from taking the construction for real” (142).

Psychological researchers, or research practitioners who are interested in the field of human relationships and digital technologies, and are seeking a pragmatic book with a practical treatment of objectives or suggestions may feel initially disappointed that the objectives of Nusselder’s book lean more heavily towards a philosophical discussion of theoretical possibilities. In fact, this bias towards an involving conversation (especially in the first half of the book) of concepts and references citing renowned figures such as Slavoj Žižek (and also philosophical “giants” like Gilles Deleuze, Michel Foucault, Immanuel Kant, René Descartes) may initially require some additional effort from readers less familiar with such academic discourses typically evident within academic fields like media and communication, and/or cultural studies. However, the reader with a strong general psychology (and certainly psychoanalytic and clinical/counselling therapy) background might find his/her education and training especially advantageous in understanding and evaluating the Freud-Lacanian psychoanalytic frames and conceptions of unconscious drives, desires, attachments, and deterministic explanations of psychopathological development in cyberspace.

Though it is unfair to expect Nusselder to extend beyond his book’s purpose and psychoanalytic foundation to offer a more varied psychological debate within human-computer interactions, Nusselder’s willingness to describe a fair number of real world examples of psychopathological situations leads one to query whether Nusselder could have included more, especially in the first half of the book, to clarify his heavier theoretical discussion. Per-

haps additional work could have been done to involve more empirical research studies in support of his present examples, offering a valuable comparison between a Lacanian perspective and the theoretical frame of the supporting research.

Regardless of these suggestions, *Interface Fantasy* indeed offers some intriguing theoretical insights for the psychology research scientist and/or clinical practitioner to consider. The author effectively presents some challenging ideas and theories that are worth debating within one's own formulations, theoretical assumptions, and present understandings of the human-computer dynamic. Thus,

for those who enjoy philosophical discourses and are curious to see how a Freudo-Lacanian psychoanalysis might explain the psychological complexities between humans and digital technologies, André Nusselder's book is well worth reading.

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Prepared by Alessandra Gorini, Ph.D.

Learning Ecology Issues of the Mediterranean Sea in a Virtual Aquatic World - Pilot Study (Wrzesien, pg. 11)

If you answer 10 out of 12 questions correctly, you will be awarded one CE credit.

1. *Climate changes have a substantial impact on sealife game, as represented by the SVR?*

- a) yes, but not substantial
- b) no impact
- c) no relation to the game rules
- d) moderate as in reality

2. *Can effectiveness of learning by SVR be proved?*

- a) not yet
- b) not with the present program
- c) there is no tool to do it
- d) it would require questions and answers after the game

3. *Can motivation be improved by SVR through action?*

- a) the study does not allow to assess
- b) more tests results are needed
- c) yes if through a continuous exercise
- d) interaction options too much limited

4. *Does self confidence develops in relation to other players?*

- a) only in few cases
- b) in all cases
- c) it depends on character solidity
- d) it may generate frustration

5. *Self assessment advisable before starting interaction game?*

- a) definitely yes
- b) irrelevant
- c) impact not evaluated
- d) negative

6. *Theory or playing , which one should prevail?*

- a) very much related to the person
- b) good theory grants interest more (than playing)
- c) balancing is essential
- d) some people ignore theory

7. *Is virtual tutor key?*

- a) still to be proved
- b) it increases confidence of participants
- c) it is fundamental
- d) it activates competitiveness

8. *Should the game be made multiplayer?*

- a) for future consideration
- b) it may generate confusion
- c) it would increase potentials
- d) much too complicated

9. *Is the playing part essential for learning?*

- a) apparently yes
- b) apparently no
- c) it contributes to increasing interest
- d) absolute necessity

10. *Improve/expand checks on learning curve*

- a) Yes, checks shall be systematic
- b) Results on learning are important, if made clear and known
- c) Checks may help improving the game
- d) Checks may help modifying the game

11. *Sealife elements to be enriched?*

- a) Yes, advisable
- b) No, learning would become too difficult
- c) Yes, if thought for older pupils
- d) Risk of complications

12. *Similar applications for other ambients?*

- a) Effectiveness to be ascertained before further developments
- b) Yes, it would increase interested population
- c) Irrelevant
- d) Wider market

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- Shock Prevention & Treatment



Cricothyrotomy Skills Trainer



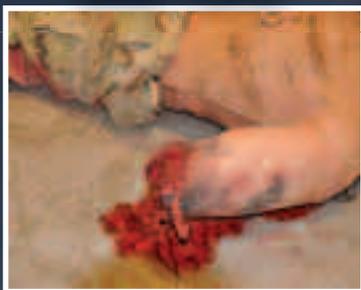
Needle Decompression Skills Trainer



Bleeding Wound Skills Trainer



Severe Amputation Skills Trainer



Simulated Burn Wound Package



Odor Simulation Wound Kit



*Visually Realistic - Comfortable - Easy to Use
Durable - Reusable - Tactilely Realistic*

CYBERPSYCHOLOGY & CYBERTHERAPY CONFERENCE



JUNE 19TH TO 22ND 2011

EVIDENCE-BASED CLINICAL APPLICATIONS OF INFORMATION TECHNOLOGY

UNIVERSITÉ DU QUÉBEC EN OUTAOUAIS (UQO), CANADA

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