# CyberTherapy & Rehabilitation

Issue 2 / 2010

The Official Voice of iACToR

FEATURES:

Augmenting Mental Models

▸ p 19

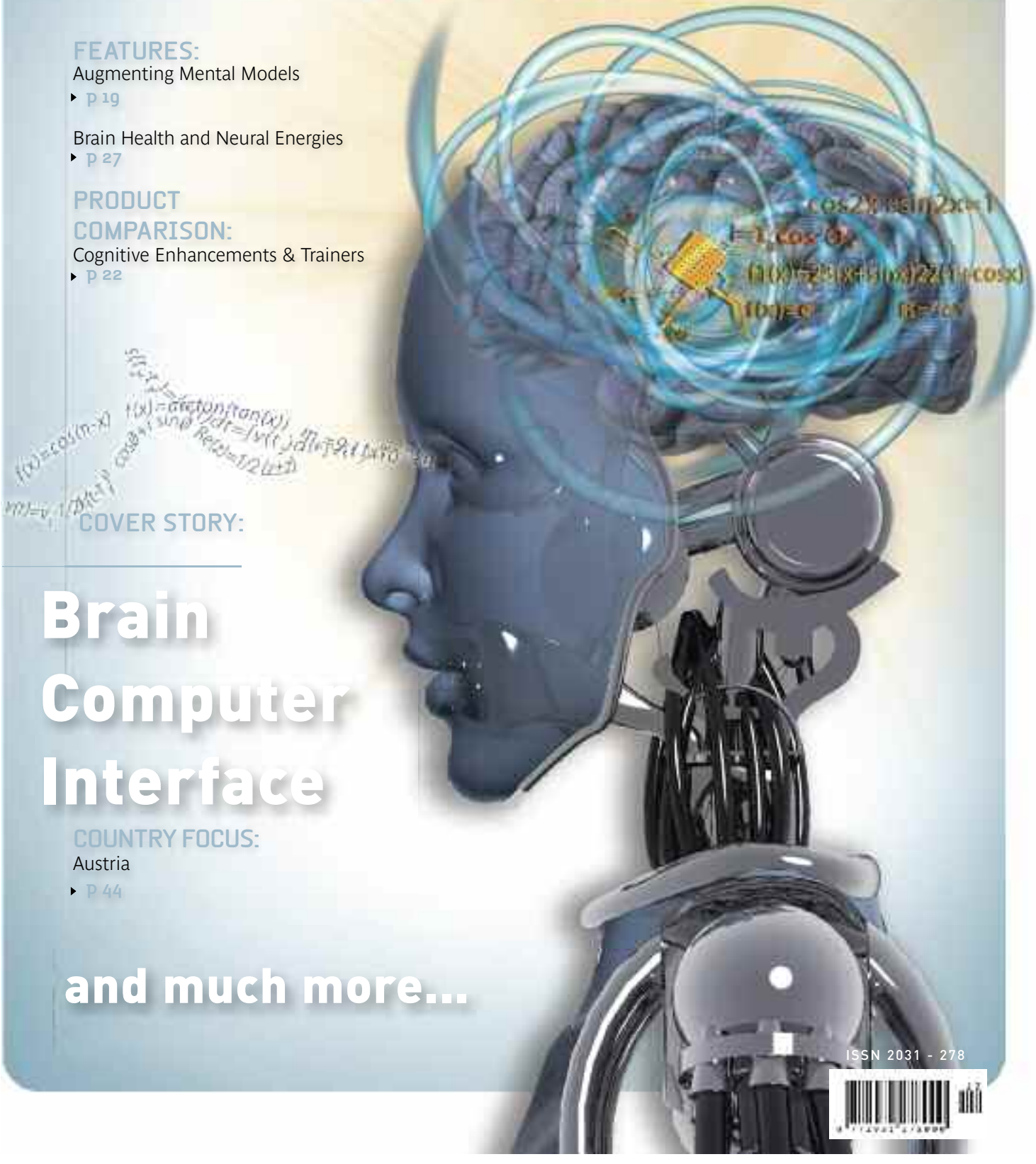
Brain Health and Neural Energies

▸ p 27

PRODUCT COMPARISON:

Cognitive Enhancements & Trainers

▸ p 22



COVER STORY:

## Brain Computer Interface

COUNTRY FOCUS:

Austria

▸ p 44

and much more...

ISSN 2031 - 278

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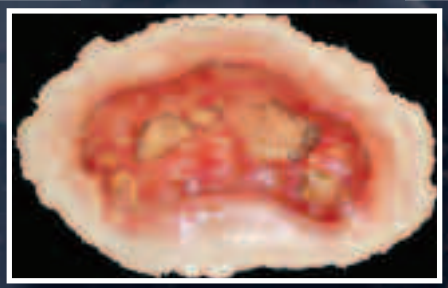

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# President's Note

**Professor Dr. Brenda K. Wiederhold**

*At C&R, we believe in letting efficacy drive the market for neuroceuticals ... To accomplish this, government and industry must earmark adequate funds to conduct large-scale studies of these off-label uses of existing drugs, both as standalone therapy and when combined with other technologies such as VR therapy.*

Dear Reader,

I would firstly like to warmly thank new and returning readers to CyberTherapy & Rehabilitation Magazine (C&R), the official voice of the International Association of CyberPsychology, Training and Rehabilitation (iACToR). Main focuses of iACToR include the promotion of Virtual Reality (VR) and advanced technologies to be used as an adjunct to more traditional forms of healthcare, as well as the resulting issues of technologies on an individual, as well as societal, level.

In this issue of C&R, we explore the emerging field of cognitive enhancement. Much attention has been given to cognitive enhancement drugs and their various applications. There is emerging evidence that combining off-label drug therapy with VR therapy will produce faster and more lasting results for a variety of conditions. For example:

– A VR/drug Posttraumatic Stress Disorder (PTSD) protocol could begin with a single, intensive session in which the patient takes a pill before retelling his/her experience, then reenacts it in a VR world. Such a study could document the combined effects of VR with propranolol through physiological monitoring, perhaps producing remission in as few as two sessions. The drug blocks the naturally occurring hormone adrenaline, which is released when there is intense emotion (e.g., fear), thus giving memories their emotional charge.

– To prevent PTSD in combat troops, VR researchers have tested stress inoculation protocols in which the service member completes simulated training (e.g., clearing a building) while under enemy attack, learning techniques such as combat breathing. A study conducted by the Virtual Reality Medical Center (VRMC) showed that troops trained via the VRMC simulation cleared a real-world building four times faster than those not receiving simulated training. Using this VR simulation in combination with a drug such as modafinil (Provigil) will increase alertness and may produce an even faster building-clearance rate and steeper learning curve.

– Using a drug in combination with VR may improve outcomes in stroke patients. Under a National Science Foundation grant, a mixed reality (MR) rehabilitation system for stroke patients is being designed and developed. In mixed reality, virtual enhancements, overlays, and contexts rendered through a head-mounted display convert the real world into an altered reality without losing the properties of a physical setting. This MR system includes both hardware and software designed to increase upper-arm movement and result in positive brain changes through continued use. A future study protocol could add small doses of amphetamines, administered a half-hour before a therapy session to promote neuroplasticity, thus accelerating stroke patients' relearning of motor skills.

For the most part, researchers have discovered these and other uses of "neuroceuticals" serendipitously, while conducting unrelated studies. As the 75 million Baby Boomers in America turn 60 and fear the consequences of Alzheimer's and other types of dementia, interest in neuroceuticals' brain-enhancing poten-

# President's Note (continued from page 1)

tial may turn this into a significant niche industry. Already, classifications have been proposed – *cogniceuticals* to improve memory, learning, attention, and decision-making processes, *emoticeuticals* to affect awareness, mood, feelings, and motivation, and *sensoceuticals* to enhance and restore our senses. Marketing neuroceuticals for these purposes will likely be successful, as this new group of neuromodulators has negligent side effects and emerging evidence of high efficacy. To learn more about cognitive enhancement drugs, see our Product Comparison Chart on page 23.

*A study conducted by the Virtual Reality Medical Center (VRMC) showed that troops trained via the VRMC simulation cleared a real-world building four times faster than those not receiving simulated training. Using this VR simulation in combination with a drug such as modafinil (Provigil) will increase alertness and may produce an even faster building-clearance rate and steeper learning curve.*

Of course, ethical questions remain. For example, if drugs can erase horrifying memories, sharpen attention, and enhance physical therapy, should physicians prescribe them? If we know an airline pilot will have a better safety record after taking a drug to increase alertness while using VR in a simulator, will we choose the airline that advertises that its pilots are trained this way?

At C&R, we believe in letting efficacy drive the market for neuroceuticals. Some of the most promising results are emerging from animal studies, and need to be proven in human subjects. To accomplish this, government and industry must earmark adequate funds to conduct large-scale studies of these off-label uses of existing drugs, both as standalone therapy and when combined with other technologies such as VR therapy. In this manner, we can improve the outcomes for various diagnoses and produce attendant cost savings. For example, we may be able to avert or at least delay the onset of Alzheimer's and other dementias, which cost Americans $148 billion per year.

For my part, I think I'll raid the medicine cabinet, pop that pill, and play that VR brain game tonight.

*Create your own reality!*
**Brenda Wiederhold**

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# Cyberpsychology, Behavior, and Social Networking

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

# INTERSTRESS

Interreality in the Management and Treatment of Stress-Related Disorders

**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 feed-back 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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# Become a MEMBER

## International Association of CyberPsychology, Training & Rehabilitation

www.myiacr.com | http://iactor.ning.com

***iACToR is the official voice and resource for the international community using advanced technologies in therapy, training, education, prevention, and rehabilitation.***

## MISSION

Our mission is to bring together top researchers, policy makers, funders, decision makers and clinicians, pooling collective knowledge to improve the quality, affordability, and availability of existing healthcare.

Ultimately, through international collaboration with the most eminent experts in the field, we are working to overcome obstacles and increase access to top-quality healthcare for all citizens. By enhancing public awareness of the possibilities that technology offers, we move toward changing and improving healthcare as it currently exists.

## MEMBERSHIP

As the only international association dedicated to CyberPsychology, Training & Rehabilitation, iACToR offers its members unique opportunities.

- *Network with other experts and industry leaders in CyberPsychology, Training & Rehabilitation*
- *Be the first to know about important events, funding opportunities and other news*
- *Share your knowledge with industry peers*
- *Learn industry best practices and standards*
- *Attend the international CyberPsychology & CyberTherapy Conference and other special events at a discount*
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## GENERAL INFORMATION

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CyberTherapy & Rehabilitation Magazine is published quarterly by the Virtual Reality Medical Institute (VRMI), 64 Rue de l'Eglise, Boite 3, 1150 Woluwe-Saint-Pierre, Belgium. The magazine explores the uses of advanced technologies for therapy, training, education, prevention, and rehabilitation. Areas of interest include, but are not limited to, psychiatry, psychology, physical medicine and rehabilitation, neurology, occupational therapy, physical therapy, cognitive rehabilitation, neurorehabilitation, oncology, obesity, eating disorders, and autism, among many others.

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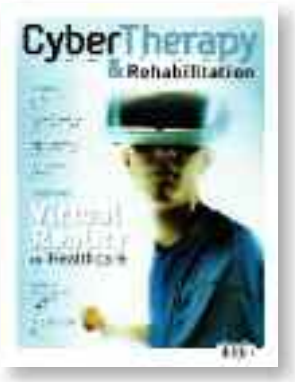

### Brain-Computer Interface

Exciting advancements are being made in the field of brain-computer interface in which a subject can simply use their brain to operate external devices. Two important applications, spelling and environmental control, are discussed as well as the possible applications for paralyzed patients who could benefit from this type of technology.

### Doppelgängers to Promote Health Behavior Change

Doppelgängers, a virtual self created using photographs of an individual that can be programmed to behave independently of the physical self, are being used to study changes in behavior. By observing themselves adopting certain habits or behaviors, subjects are more likely to copy these actions in real life. Researchers are hoping to encourage a new form of treatment in diverse areas such as social phobias and making a commitment to exercise.

# Conference Participation Report Spring 2010

## Med-e-Tel 2010

### Annual, international Telemedicine and eHealth Forum

*Luxembourg*/ April 14-16, 2010

The 8th edition of Med-e-Tel, the International eHealth, Telemedicine and Health ICT Forum, took place on April 14-16, 2010 in Luxembourg. Med-e-Tel, organized by the International Society for Telemedicine & eHealth (ISfTeH), is one of the premier events worldwide in the field of Telemedicine and eHealth and brings together participants from over 50 countries around the world each year. The ISfTeH is the international federation of national Telemedicine/eHealth associations and is recognized as an NGO in Official Relations with the World Health Organization (WHO).

Med-e-Tel is endorsed by the Luxembourg Ministry of Health, the European Commission, the International Council of Nurses (ICN), the International Association for CyberPsychology, Training and Rehabilitation (iACToR), and European Health Telematics Association (EHTEL), and works together with a wide range of local and international partners who are all involved in Telemedicine and eHealth research, development, funding or implementation.

Through its extensive conference program including 200 presentations and an industrial exhibition and networking area, Med-e-Tel presents and showcases practical experiences, ongoing projects and recent research results of great interest to its international audience of healthcare providers, industry representatives, consultants, researchers and policy makers. Topics and sessions included "New Models of Care and the Use of New ICT Solutions," "Using Digital Pen and Paper to Improve Electronic Care Record Keeping," a "Clinical Telemedicine Course," "Benefits of Open Source Software in Health Care," "E-Mental Health: Enhancing Mental Health Services Through ICT," and "Virtual Reality and Rehabilitation."

According to Yunkap Kwankam, Executive Director of the ISfTeH, "The International Society for Telemedicine & eHealth is all about facilitating the dissemination of knowledge and experience in Telemedicine and eHealth. Med-e-Tel is one of the instruments that help us to realize this mission. The Med-e-Tel credo of providing information and education, enhancing networking opportunities and facilitating business relationships, is fully in line with the ISfTeH strategy of establishing and fostering relationships on a global scale between all actors and organizations involved in Telemedicine and eHealth and advancing the knowledge and use of ICT tools in the delivery of health and social care.

Program details and presentations are still available at **www.mede-tel.eu**. The next edition of Med-e-Tel is scheduled for April 6-8, 2011 in Luxembourg.



## eHealth Week

### Health IT Conference & Exhibition

*Barcelona, Spain*/ March 15-18, 2010

Before March 15th, there was a lot of speculation into how the first collaboration between the European Commission's High Level Ministerial Conference and the World of Health IT Conference & Exhibition would proceed.

On Thursday, March 18th, all skeptics were convinced. The Barcelona event was an immense success. Throughout the week, the conference was hailed as the largest pan-European eHealth conference, and by many, the best.

eHealth week 2010 gathered 3,200 delegates and 95 exhibitors, and was visited by an astounding 150 international journalists. Press articles appeared on a daily basis across Europe, and television and radio stations were broadcasting live from the event. Important attendees included the Vice President of the European Commission and Commissioner for the Digital Agenda, Neelie Kroes, and Commissioner for Health and Consumer Policy, John Dalli. The conference also hosted Ministers of Health and State Secretaries from the 27 member states and a number of high level key note speakers.

Jeremy Bonfini, Senior VP, HIMSS Global said, "Never in the history of World of Health IT have we experienced such a high number of delegates and media interest, not to mention the fact that the exhibition show floor was sold out weeks before the event took place. These facts confirm that there is a need for a truly European eHealth conference which offers solutions and demonstrates the convergence of healthcare systems on a local, national and international level."

On Wednesday, March 17th, the HIMSS Europe eHealth Leadership award was presented to Niels Rossing, a Danish champion in eHealth. Mr. Rossing said that he was accepting this on behalf of the entire European eHealth Community, who have already paved the road to eHealth with many significant achievements.

The event ended with the announcement that eHealth week 2011 will be held in Budapest, during the Hungarian Presidency.

The World of Health IT Conference & Exhibition is the leading forum for the advancement of Health IT in Europe. Addressing the needs of key stakeholders in the European eHealth Community, The World of Health IT Conference & Exhibition offers professional development sessions, vendor exhibitions, best practice exchanges, networking sessions, and debates and discussions on the issues that will shape the future of eHealth information can be found at **www.ehealthweek2010.org** and **www.worldofhealthit.org**.

# 15th Annual CyberPsychology & CyberTherapy Conference

*Seoul, Korea*
June 13 – 15, 2010

The 15th Annual CyberPsychology and CyberTherapy Conference (CT15), the official conference of the International Association of CyberPsychology, Training & Rehabilitation (iACToR) was co-organized by Brenda K. Wiederhold, Ph.D., MBA, BCIA of the Interactive Media Institute and Sun I. Kim, Ph.D. of Hanyang University. CT15 was hosted at the President Hotel in downtown Seoul, Korea, and attracted researchers, experts, and students from 23 countries around the world. CT15 was truly an international success setting directions for advancements in the growing disciplines of cyberpsychology, cybertherapy, training, and rehabilitation.

The quality and significance of the work presented at CT15 reaffirms that virtual reality is already playing a significant role in healthcare. CT15 further strengthened and advanced efforts to improve health care through technology, and explored ways to take advantage of remarkable transformations that are occurring.

CT15's theme was two fold: First, CT15 explored technologies as enabling tools. This included the use of advanced technologies such as virtual reality simulations, videogames, telehealth, videoconferencing, the Internet, robotics, brain computer interfaces, wearable computing, non-invasive physiological monitoring devices, in diagnosis, assessment, and prevention of mental and physical disorders. In addition, interactive media in training, education, rehabilitation, and therapeutic interventions were discussed. Second, CT15 explored the impact of new technologies.

Attendees at CT15 listened to welcoming remarks during a dinner at the President Hotel in downtown Seoul, Korea.

*The quality and significance of the work presented at CT15 reaffirms that Virtual Reality is already playing a significant role in health care. CT15 further strengthened and advanced efforts to improve health care through technology, and explored ways to take advantage of remarkable transformations that are occurring.*

CT15 investigated how new technologies are influencing behavior and society through cyberadvertising, cyberfashion, and cyberstalking to name a few. The conference also explored how social networking tools such as Twitter and Facebook are influencing individual behavior and personal relationships.

Under the direction of Tutorial Chairs, Prof. Luciano Gamberini and Dr. Alessandra Gorini, CT15 kicked off with pre-conference workshops on Sunday, the 13th of June, which focused on multiple aspects of cybertherapy. Professor Stéphane Bouchard led an important tutorial titled "Virtual Reality and Psychotherapy," while Dr. Xialoing Hu and Professor Andrea Gaggioli led the "Virtual Reality Cognitive and Physical Rehabilitation" tutorial. Sunday concluded with a welcome reception with a performance by the Chung-Ang University Gayastra.

The conference officially began on Monday, the 14th of June, with welcome remarks from the Conference Co-Chairs, Professor Brenda K. Wiederhold and Professor Sun I. Kim. This year's scientific chairs were Professors Stéphane Bouchard, José Gutiérrez Maldonado, and Giuseppe Riva.

Along with their invaluable help, we would also like to thank our sponsors including: Bionet, European Commission, DGINFSO, Hanyang University and Hanyang University's Institute of Aging Society Silver & u-Health Research Center, International Association of CyberPsychology, Training, & Rehabilitation (iACToR), Istituto Auxologico Italiano, Interactive Media Institute (IMI), Mary Ann Liebert, Inc., National Institute on Drug Abuse, Osteosys, Université du Québec en Outaouais, Canada, Virtual Reality Medical Center (VRMC), Virtual Reality Medical Institute (VRMI), Chung-Ang University, and the National Research Foundation of Korea (NRF).

Monday's program included two plenary sessions and two parallel sessions on the use of advanced technologies in anxiety disorders, eating disorders, and addictions as well as an online interaction symposium. Two attractive and innovative events of the conference took place during lunch on Monday. The poster

session and Cyberarium gave opportunities for developers and scientists to demonstrate their work and converse, one-on-one, with interested spectators and colleagues. Monday was closed by the 2nd Annual General Assembly of the International Association of CyberPsychology, Training, & Rehabilitation (iACToR), which was coordinated by Secretary General Brenda K. Wiederhold and led by newly elected President Professor Giuseppe Riva. The General Assembly invited members from over 20 countries to convene to review relationships made with other associations, conferences and publications. The General Assembly then discussed how to bring about more rapid innovation in the advanced technologies and healthcare arenas.

Tuesday's events included five symposiums on motor rehabilitation, how to study warfighters, training, education, presence, cybersickness, and cognitive rehabilitation. An awards ceremony took place during lunch on the 15th of June. Three categories of awards were give for outstanding achievements in CyberPsychology & CyberTherapy including the 6th Annual CyberTherapy Lifetime Achievement Award, the Annual CRC-Clinical Cyberpsychology New Investigator Award, and four student poster awards sponsored by the Virtual Reality Medical Institute and Mary Ann Liebert, Inc. The scientific program ended with an "Ask the Experts" panel with discussions led by Prof. Brenda K. Wiederhold, Prof. Giuseppe Riva, and Prof. Stéphane Bouchard.

The conference concluded on the evening of the 15th with a social dinner in the North Seoul Tower, the highest building in Seoul, providing participants with a 360-degree view of the entire city as they enjoyed their dinner.

The 16th Annual CyberPsychology & CyberTherapy Conference will take place in Gatineau, Canada, on June 20 – 22, 2011. Brenda K. Wiederhold, Ph.D., MBA, BCIA and Stéphane Bouchard, Ph.D. of Université du Québec en Outaouais will serve as co-chairs.

A performer from Hanyang University plays the gayageumam, a traditional Korean zither-like string instrument with 12 strings, during the opening ceremony for the conference.

*For more information on the conference, please visit the Interactive Media Institute's website at www.interactivemediainstitute.com or iACToR's website at http://iactor.ning.com. Please e-mail cybertherapy@vrphobia.com with your questions or information requests about CT16.*



# News from iACToR Members

## Organization grows worldwide as Special Interest Groups/Regional Chapters are established

As the official association of CyberTherapy & Rehabilitation, we will be bringing you updated news of various special interest groups and regional chapters of the International Association of CyberPsychology, Training & Rehabilitation as they grow and expand throughout the year. As the organization becomes more well-established, it is further strengthened by growing numbers from around the globe. We welcome iACToR members, as well as our readers, to submit content and updates, as well as suggestions for new groups. You can do so by reaching the Managing Editor at office@vrphobia.eu.

### Mexican iACToR Chapter

2010 update on organization

Made up of 29 members of the Republic of Mexico from eight states, The Mexican chapter of iACToR is made up of a multidisciplinary group integrated by physicians, researchers, scientists, engineers, psychologists, teachers, students from prestigious publics and privates universities, hospitals, national medical centers, and institutes for health. We are open to integrate all interested individuals and organizations to collaborate for health in this society. The mission of the chapter is to promote science and technological developments in Cyberpsychology, Training and Rehabilitation for health applications in Mexico.

# One pill makes you larger

**One pill makes you larger**
**And one pill makes you small**
**And the ones that mother gives you**
**Don't do anything at all**
**Go ask Alice**
**When she's 10 feet tall**
**– "White Rabbit," Jefferson Airplane**

By Mark D. Wiederhold & Brenda K. Wiederhold

As cognitive neuroscience has advanced, so, too, has the list of possible internal, biological enhancements. Stimulants such as nicotine, which interacts with attention and memory, and caffeine, which reduces tiredness, have long been used to improve cognition. Certain off-label drugs, such as mixed amphetamine salts (Adderall) and modafinil (Provigil®), which have gained popularity on college campuses, are now being used in the workplace as cognitive enhancers.

Cognitive enhancers, also known as nootropic drugs, are chemicals designed to increase brain metabolism. Individuals using such substances aim to increase memory, concentration, and attention span, and to enhance the decision-making process. In general, the mechanism of action is through regulating the release of neurotransmitters, modulating the receptors and ion channels, or affecting neuronal gene expression. Most cognitive enhancers in current use are off label because they were discovered to have cognitive-enhancing properties as a side benefit of their original, intended use.

Cognitive enhancers have been in wide use for more than 50 years. Beta blockers, among the first, are a class of drugs in which the initial use was for the control of cardiac arrhythmias and cardiovascular protection after heart attacks, and to treat hypertension. Propranolol, a beta blocker, was invented by Sir James W. Black in the late 1950s and is valued as one of the most significant contributions to pharmacology and clinical medicine of the 20th century. Although the initial use of beta blockers was to manage the heart, many people such as musicians, public speakers, actors, and dancers used and still use propranolol to mitigate the effects of stage fright and tremors during auditions and public performances. Since the 1950s, researchers have discovered many new cognitive enhancement drugs.

### How Cognitive Enhancers Can be Used in Virtual Reality Therapy

The following substances with potential to enhance the effects of virtual reality (VR) therapy are presented as examples of possible applications. Many of the studies reviewed have small sample sizes and small effect sizes, and/or the substances have been tested in animals only. Moreover, there are no data available about nootropics currently in the pipeline at pharmaceutical companies. Therefore, current scientific literature is a limited guide to the eventual usefulness of these drugs.

Substances used for cognitive enhancement may potentiate the results of certain types of VR therapy. For example, DCS (D-cycloserine), which helps those with social anxiety learn more from therapy, is aimed at reinforcing learning in cognitive-behavioral therapy. Anisomycin injections, calcium channel agonists, cortisol, dopamine, endogenous cannabinoid modulators, and yohimbine facilitate in the extinction of fear. Glucocorticoids are released during fearful situations to modulate fear, and when clucocorticoids (e.g., cortisol) are given to patients before exposure to a fearful situation or phobia, the cortisol facilitates the reduction of phobia-related anxiety.

Unlike fear reduction and phobia extinction drugs, cognitive enhancement drugs such as Adderall, Ritalin, and ephedrine increase the user's concentration on an outside task, which in turn reduces their self-awareness. The outcomes of VR-enhanced public speaking practice sessions and combat training in a virtual environment may be enhanced through the use of these drugs.

VR therapy aimed at enhancing motor skills needed in learning to drive could benefit from the use of amphetamines and dextroamphetamine. Scientists have found that in small doses amphetamines help stroke patients relearn motor skills better and faster than they would with physical therapy alone. Amphetamines seemingly promote neuroplasticity, which is the ability of the brain to create new connections and strengthen existing connections between neurons that enable simple or complex movement.

VR-assisted exposure therapy aimed at reducing the effects of Posttraumatic Stress Disorder could also benefit from augmentation with cognitive enhancement drugs. Cannabinoid antagonists, CREB (transcription factor cAMP-response-element-binding protein) inhibitors, propranolol hydrochloride, and sulpiride may help to prevent, select, or block emotionally charged memories, thus decreasing fear of past memories.

Modanafil (Provigil®), originally aimed at narcoleptics who uncontrollably fall asleep,

and donepezil (Aricept®) aimed at slowing the progression of Alzheimer's disease, are proven to increase alertness and boost learning. The effects of modanafil in healthy people are increases in concentration, alertness, short-term memory and focus. Donepezil improves cognition and slows the decline of overall function. Adaptogens can increase tolerance to mental exhaustion and may enhance attention in fatigue. Beneficial effects are primarily associated with the hypothalamic-pituitary-adrenal axis, a part of the stress-system that is believed to play a primary role in the reactions of the body to repeated stress and adaptation. Single doses of ginseng extract can affect cognitive performance and exert a direct effect on central nervous system (CNS) functioning, as seen in the modulation of cerebroelectrical activity. Adaptogens, donepezil, ginseng, and modanafil could enhance VR combat training by increasing alertness and enhancing mental acuity and performance for combat training.

Varenicline, an alpha(4)beta(2) nicotinic acetylcholine receptor partial agonist, promotes smoking cessation. Use of the drug could increase the effectiveness of a VR-assisted cognitive-behavioral therapy smoking cessation program.

### *Drugs for Cognitive Rehabilitation*

Ampakines, under development by pharmaceutical laboratories, amplify memory by increasing the activity of brain chemicals such as the neurotransmitter glutamate, which is important for memory formation. Upon repeated exposure to glutamate within a short period of time, one receptor triggers another, and calcium molecules enter the brain cell. This causes the synaptic connection to change, and is believed to be the basis of memory formation and consolidation.

In animal studies, acute administration before a training session of two different 5-HT6 receptor antagonists improved memory formation. Effective doses of both antagonists ranged from 1 to 30 mg/kg. One of the formulations elicited a 7-fold increase relative to the control saline group.

Studies have shown that brain opioid systems can modify memory and learning processes. In one study, physiologically aroused participants receiving naltrexone, an opioid receptor antagonist, recognized incidental material from a presented story better than did participants receiving placebo, at no expense to memory for thematic material. As a result, naltrexone improved overall recognition memory.

Piracetam, originally designed as an antiepileptic drug, was one of the first drugs to be used off label for cognitive enhancement. Results from animal studies are promising. However, results from studies in which it was used to treat children with Down syndrome were equivocal, with only certain populations showing improved function.

One study of 24 healthy young adults showed that administration of S. lavandulaefolia (sage) resulted in a consistent improvement for both the 25- and 50-µl dose on the "speed of memory" factor. There was also an improvement on the "secondary memory" factor for the 25-µl dose. The data suggest that previous reports of memory enhancement by Salvia may be due to more efficient retrieval of target material.

A soya diet containing high levels of isoflavone phytoestrogens significantly improved memory and frontal lobe function in young healthy male and female volunteers compared with volunteers receiving a soya-free diet for 10 weeks. Soya phytoestrogens have been shown to act like estrogen in the brain, which has a number of direct and indirect receptor-mediated genomic effects that could affect cognition. In addition, estrogen potentiates glutamate-induced calcium signaling. Although it is unlikely that phytoestrogens will mimic all the CNS effects of estrogens, there are sufficient potential mechanisms that could mediate cognitive improvement.

VR has been used as a way to assist patients with brain damage and intellectual disabilities. For example, VR has been used to train cognitive tasks in brain-damaged and intellectually disabled patients by training them in the performance of activities of daily living, such as grocery shopping, food preparation, orientation, road crossing, and vocational training. At The Virtual Reality Medical Center (VRMC), researchers plan to create VR cognitive training tools that specifically target and train working memory, selective attention, and sustained attention processes. Such tools would no doubt benefit from the use of one of the cognitive enhancers discussed in this section.

### Controversies Surrounding Cognitive Enhancers

Safety is a primary concern, as the long-term effects of these drugs for the purpose of cognitive enhancement are unknown, even if no adverse events are apparent in the short term. However, there is medical precedent for accepting risk for the purpose of enhancement, as in the case of cosmetic surgery. The patient may decide that the benefits outweigh the risks.

Fairness in competition is another issue: Could athletes or other competitors gain unfair advantage by "brain doping" before a match? The Olympic Games have banned the use of stimulants during competition, but other sports such as poker have yet to adopt the World Anti-Doping Code. In addition, such drugs may be used prior to competition in practice sessions.

Further, unauthorized users of certain drugs may face fines or even imprisonment. For example, Adderall and Ritalin are Schedule II controlled substances, and Provigil® is a Schedule IV substance due to its lower potential for dependence and misuse. Students with attention-deficit hyperactive disorder (ADHD), who have a legitimate reason for taking a drug such as Adderall, complain about their healthy friends who take it, saying that it gives their friends an unfair advantage while they need the drug to be "normal." If schools begin testing students for such drugs in the days before an exam, will legal stimulants such as caffeine be banned as well?

### Future Directions

Substances that promote cognitive enhancement have the potential to benefit a variety of VR therapy protocols. For example, VRMC may use its fMRI-safe VR device to study the brain's activity when, for example, a smoking virtual environment is used in combination with a cognitive enhancer to treat addiction. As another example, the Virtual Reality Medical Institute eventually may experiment with propranolol to augment the Interreality in the Management and Treatment of Stress-Related Disorders (INTERSTRESS) device under development by its partners.

## Drugs and Supplements with Potential to Enhance Virtual Reality Therapy

| Substance | Performance-enhancing properties | VR therapy potential |
|---|---|---|
| Adaptogens (herbal preparation) | Improves attention, speed, and accuracy | Combat training, Driving |
| Ampakine, glutamate booster (still in development) | Improves memory | Cognitive rehabilitation |
| Amphetamine and dextroamphetamine (Adderall, Dexedrine) | Promotes neuroplasticity; improves concentration, alertness, motor skills, and language learning skills | Combat training, Driving, Public speaking |
| Anisomycin (ANISO) injections (protein synthesis inhibitor tested in animals only) | Affects fear memory consolidation when in the presence of direct memory activation | Phobias, PTSD |
| Calcium channel agonist BayK8644, L-type voltage-gated | Facilitates extinction learning | Phobias |
| Cannabinoid CB1 receptor antagonist AM-251 (at a dose of 1.0 mg/kg or higher) | Blocks neuronal emotional associative learning | Prevention of PTSD |
| Cortisol/cortisone | Reduces/inhibits retrieval of fear memory | Phobias |
| CREB (transcription factor cAMP-response-element-binding protein) inhibitors (still being researched) | Has selective effect on negatively charged memories | PTSD |
| D-cycloserine (DCS) | Reduces fear learning and increases extinction | Phobias |
| Donepezil (Aricept) | Boosts learning | Combat training |
| Endogenous cannabinoid (eCB) breakdown and reuptake inhibitor AM404 and other eCB modulators | Enhances extinction of conditional fear | Phobias |
| Ephedra/ephedrine | Increases concentration | Combat training, Public speaking |
| 5-HT6 receptor antagonists (tested in animals only) | Improves memory consolidation | Cognitive rehabilitation |
| Ginseng | Can modulate stress, fatigue, and learning | Combat training, Cognitive rehabilitation |
| Methylphenidate (Ritalin) | Increases concentration, boosts spatial working memory | Combat training, Public speaking |
| Modafinil (Provigil®) | Improves alertness | Combat training |
| Naltrexone | Opioid peptides mediate alterations in specific aspects of human memory during heightened emotional states | Cognitive rehabilitation |
| Piracetam (significant results in animal studies only) | Enhances memory, improves spatial learning, increases attention and cognition | Combat training, Cognitive rehabilitation |
| Propranolol hydrochloride | Prevents strong emotions from making strong memories | PTSD |
| Sage (Salvia) | Improves speed of memory retrieval | Cognitive rehabilitation |
| Soya isoflavones (supplement) | Improves memory and frontal lobe function | Cognitive rehabilitation |
| Sulpiride, a dopamine D2-like receptor antagonist (animals tested only) | Facilitates extinction of conditional fear | PTSD, Phobias |
| Varenicline | Selective alpha4beta2 nicotinic acetylcholine receptor partial agonist | Smoking |
| Yohimbine | Facilitates extinction of conditional fear | Phobias |

Cognitive enhancers may have important consequences for society, and perhaps even profound implications for the future of all people. It is exciting to be involved in neuroscience research in the so-called Age of the Brain, helping patients create achievements that indeed make them feel as if they're 10 feet tall.

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# Brain-computer Interface for Spelling and Environmental Control

*With work becoming more and more "futuristic," the field of Brain-computer Interface allows users to operate external devices simply using their thoughts. Whether operating a wheelchair or prosthetic device, or spelling on a screen, as is discussed in the following article, exciting possibilities will soon be available for paralyzed and disabled patients.*

By Christoph Guger



A brain-computer interface (BCI) is a communication channel between the human brain and external devices based on the Electroencephalogram (EEG). Such a system allows a person to operate different applications just by thinking. Two of the most important applications are spelling and environmental control for totally paralyzed patients.

**Figure 1:** Intendix running on the laptop and user wearing the active electrodes.

**The Spelling System**

Such a system was developed recently. The Intendix BCI system was designed to be operated by caregivers or the patient's family at home. It consists of active EEG electrodes to avoid abrasion of the skin, a portable biosignal amplifier and a laptop or netbook running the software under Windows (see Figure 1). The electrodes are integrated into the cap to allow a fast and easy montage of the equipment. The system allows viewing the raw EEG to inspect data quality, but indicates automatically to the unexperienced user if the data quality on a specific channel is good or bad.

This control can be realized by extracting the P300 evoked potential from the EEG data in real-time. Therefore, the characters of the English alphabet, Arabic numbers and icons were arranged in a matrix on a computer screen (see Figure 2). Then the characters are highlighted in a random order and the person has the task to concentrate on the specific character he/she wants to spell. At the beginning the BCI system is trained based on the P300 response of several characters with multiple flashes per character to adapt to the specific person.

If the system is started up for the first time, a user training session has to be performed. Therefore, usually five to ten training characters are entered and the user has to copy and spell the characters. The EEG data is used to calculate the user specific weight vector which is stored for later usage. Then the software switches automatically into the spelling mode and the user can spell as many characters as wanted. The system was tested with 100 subjects who had to spell the word LUCAS. After five minutes of training 72 % were able to spell it correctly without any mistakes.
The user can perform different actions such as copy the spelled text into an Editor, copy the text into an e-mail, send the text via text-to-speech facilities to the loud

speakers, print the text or send the text via UDP to another computer. For all these services a specific icon exists.

The number of flashes for each classification can be selected by the user to improve speed and accuracy or the user can also use a statistical approach that automatically detects if the user is working with the BCI system. The latter has the advantage in that no characters are selected if the user is not looking at the matrix or does not want to use the speller.

**VR Control**

Recently, BCI systems were also combined with Virtual Reality (VR) systems. VR systems use either head mounted displays (HMDs) or highly immersive back-projection systems (CAVE like systems). Such a CAVE has three back-projectors for the walls and one projector on top of the CAVE for the floor. The system projects two images which are separated by shutter glasses to achieve 3-D effects.

There are several issues that must be solved to use a BCI system in such an environment. The biosignal amplifiers must be able to work in such a noisy environment, the recordings should ideally be done without wires to avoid collisions and irritations within the environment, the BCI system must be coupled with the VR system to exchange information fast enough for real-time experiments and a special BCI communication interface must be developed to have enough degrees of freedom available to control the VR system.

**Figure 2:** User interface with 50 characters like a computer keyboard.

Figure 3 illustrates the components in detail. A 3-D projector is located behind a projection wall for back projections. The subject is located in front of the projection wall to avoid shadows and wears a position tracker to capture movements, shutter glasses for 3-D effects and the biosignal amplifier including electrodes for EEG recordings. The XVR PC is controlling the projector, the position tracker controller and the shutter glass controller. The biosignal amplifier is transmitting the EEG data wirelessly to the BCI system that is connected to the XVR PC to exchange control commands.

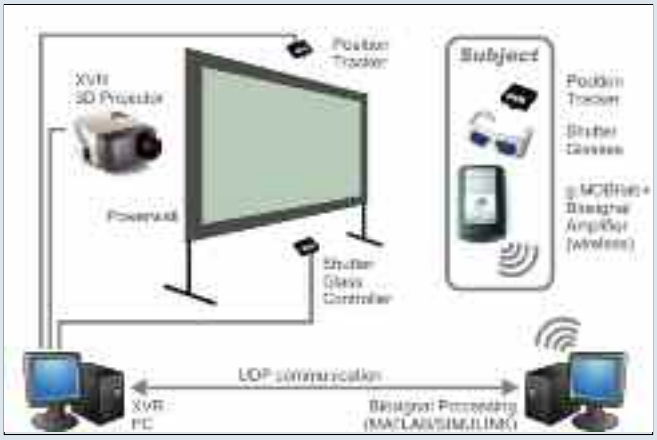


**Figure 3:** Components of a Virtual Reality system linked to a BCI system.

**Figure 4:** Smart home control sequence and VR representation. The VR environment was developed by Chris Groenegress and Mel Slater from University of Barcelona, Spain.

In order to show that such a combination is possible, a virtual version of a smart home was implemented in eXtreme VR (VRmedia, Italy). The smart home consists of a living room, a kitchen, a sleeping room, a bathroom, a floor and a patio as shown in Figure 4. Each room has several devices that can be controlled – a TV, MP3 player, telephone, lights, doors, etc. Therefore, all the different commands were summarized in seven control masks – a light mask, a music mask, a phone mask, a temperature mask, a TV mask, a move mask and a go to mask. Figure 4 shows the TV mask and as an example the corresponding XVR image of the living room. For example, the subject can switch on the TV by looking first at the TV symbol. Then, the station and the volume can be regulated. A special go to mask consisted of a plan of the smart home and of letters indicating the different accessible spots in the smart home. The letters flash during the experiment.Inside the mask, there are letters indicating the different accessible spots in the smart home which flash during the experiment. Therefore, the subject has to focus on the spot where he wants to go. After the decision of the BCI system, the VR program moves to a bird's eye view of the apartment and zooms to the spot that was selected by the user. This is a goal-oriented BCI control approach, in contrast to a navigation task, where each small navigational step is controlled.

Currently the BCI technology is interfaced with real smart home environments within the EC project SM4all. The project aims at studying and developing an innovative middleware platform for inter-working of smart embedded services in immersive and person-centric environments.

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# The Use of Doppelgängers to Promote Health and Behavior Change

*"Doppelgängers are virtual humans created using photographs of the participant so that they are realistic and bear a strong resemblance to the self … greater similarity and identification with a model leads to more social learning and imitation of modeled behaviors … Additionally, this virtual self can be programmed to behave independently of the physical self, maximizing its utility as a persuasive agent."*



By Jesse Fox & Jeremy N. Bailenson

You don't like parties: there are too many people and it makes you anxious. Who do you talk to? What do you do? As your eyes scan the virtual party environment, you notice a familiar face across the room. It's you. There you are, chatting with a group of three strangers. You're making eye contact, nodding, laughing even. Wow, you're really having a good time.

Doppelgängers are virtual humans created using photographs of the participant so that they are realistic and bear a strong resemblance to the self. According to Bandura's social cognitive theory, greater similarity and identification with a model leads to more social learning and imitation of modeled behaviors. Consequently, doppelgängers, which are maximally similar to the self, have many advantages over traditional models. Additionally, this virtual self can be programmed to behave independently of the physical self, maximizing its utility as a persuasive agent.

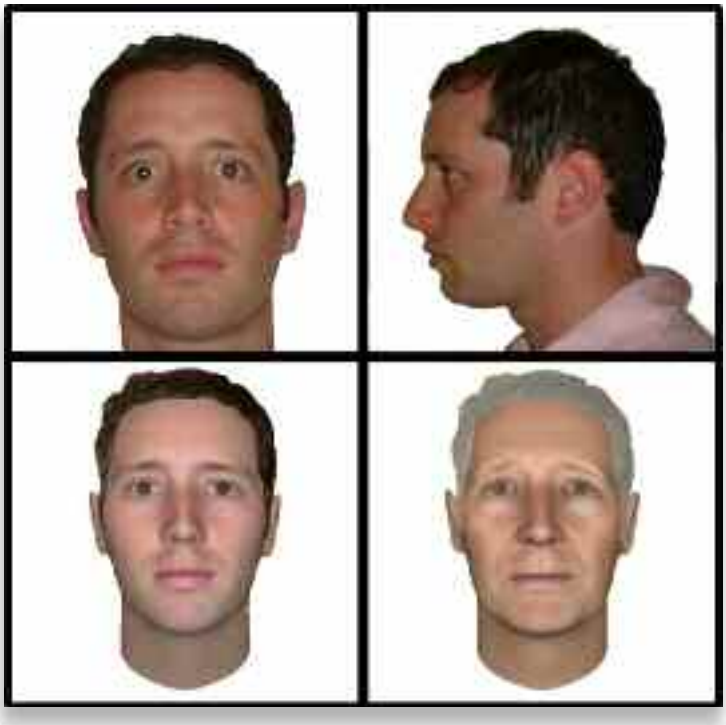

**Figure 2:** A participant's photographs (top) are used to create a virtual doppelgänger (bottom left), which can be aged (bottom right) or otherwise transformed to achieve health outcomes.

### Using Doppelgängers for Behavioral Modification

Our first series of studies addressed whether or not these doppelgängers could be used to promote exercise. Findings across five separate studies demonstrated a doppelgänger who gained and

lost weight in accordance with the physical actions of a participant in the lab caused real changes in physical behavior. Compared to various control conditions, watching one's doppelgänger lose weight as a reward for activity or gain weight as a punishment for inactivity caused more exercise. This change in health behavior was observed immediately after the treatment in the lab as well as twenty-four hours afterwards.

A similar technique can be used to change eating habits. We had participants observe their doppelgängers eating, and afterwards they responded to survey questions while seated at a desk with a large bowl of candy. We observed a replication of social facilitation effects on eating, wherein men consumed more candy and women suppressed their appetites, eating no candy after the virtual treatment. These studies suggest that doppelgängers may be used for the treatment of obesity, compulsive eating, or eating disorders and could be incorporated in existing diet-based virtual environments (VEs).

In a third line of work, conducted with Hal Ersner-Hershfield and Laura Carstensen, we used doppelgängers to influence future financial decision-making. Participants embodied either a current doppelgänger or an aged doppelgänger. Those who saw an aged doppelgänger became more future-oriented and demarcated more funds for retirement than those who saw a current doppelgänger. These same aging models could be used to promote long-term health goals, such as quitting smoking or staying physically active, to promote positive outcomes rather than negative consequences in the future.

**Future Directions**

Given our success in modifying exercise, diet, and financial behaviors, we feel that doppelgängers should be explored more widely within the fields of therapy and rehabilitation.

Bandura originally used social modeling as a method of phobia desensitization, and virtual reality exposure therapy has been successfully used for this purpose. Doppelgängers could be incorporated in VEs for acrophobia (the fear of heights), agoraphobia (fear of open spaces), aviophobia (fear of flying), or social phobia. Participants could see their doppelgängers coping with stressful environments, thus bolstering their sense of self-efficacy. They may also observe their virtual self experiencing the rewards associated with successful phobia management, which may serve as an additional incentive to work towards managing the phobia.

Physical rehabilitation VEs present another use for doppelgängers. Although many embody a first-person perspective, some physical movements may be better learned from a third-person perspective. In these cases, incorporating a doppelgänger as a model may promote more self-efficacy and learning.

Doppelgängers have shown great potential for changing physical behaviors. Much work in cybertherapy successfully implements a first person, real-time controlled avatar view during therapy. These researchers should consider the potential of incorporating autonomously behaving doppelgängers in their treatments.

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# Deep Brain Stimulation:

## From Parkinson treatment to personality enhancement?

▸ By Frederic Gilbert

*Recognized for its proven effectiveness in treating disease, Deep Brain Stimulation (DBS) is now being considered for use in healthy patients in areas such as memory and mood enhancement. Here, the author discusses ethical implications that may arise with this type of application.*

In recent years, Deep Brain Stimulation (DBS) treatments have attracted great interest in the medical community, not only for their effectiveness, but also for their expanded, potential future applications. With these great hopes come various accompanying ethical challenges.

DBS is a psychosurgical invasive intervention commonly used to treat various symptoms of neurodegenerative diseases. For instance, the most common application of DBS treatments has targeted Parkinson's symptoms such as tremor, rigidity, stiffness, slowed movement, or even walking problems. The technique consists of implanting a battery-operated neuromedical device which delivers an electrical stimulation to a specific area of the patient's brain. However, due to its invasive nature, in order to qualify for DBS treatment, patients must be in an advanced phases of a neurodegenerative disease and have demonstrated resistance to pharmacological treatment. However, in the future, developments in medical nanotechnologies hold the potential to render the DBS procedure less invasive, thereby expanding the safety and range of applications for these technologies.

Indeed, besides being used to diminish Parkinson's symptoms, DBS procedures have also been used to treat severe depression, obsessive-compulsive disorder, obesity, epilepsy and Tourette syndrome, among countless other applications. Moreover, in some cases, DBS has been found to be correlated with cognitive (e.g. memory) and mood enhancements (e.g. decrease in major depressive tendencies). These discoveries have sparked great interest. Given these neuroscientific findings, one could ask what if one day, DBS were not strictly reserved for treating patients with neurodegenerative diseases? What if its applications are expanded for cognitive and personality enhancement in healthy subjects? Given this possible extension of the uses of DBS, it behoves us to ask: Is there something intrinsically unethical about using DBS for enhancement purposes with perfectly healthy, fully informed, free, consenting subjects? Is there a risk that these novel technologies may even transform the personal identity, or even the "true nature" of these subjects?

*"Is there something intrinsically unethical about using DBS for enhancement purposes with perfectly healthy, fully informed, free, consenting subjects? Is there a risk that these novel technologies may even transform the personal identity, or even the "true nature" of these subjects?"*

If there is a genuine ethical problem associated with the use of DBS for enhancement of cognitive capacities in healthy subjects, it is not on account of the risks of transformation of personal identity. Indeed, it would be a philosophical blunder to believe that the risks of upsetting personal identity through DBS are categorically different from that which might be achieved through pharmacological enhancements. Concerns that technology may threaten personal integrity are sometimes overstated. Comparatively speaking, a glance at how religion or cultural identity can permanently affect personality tells us that DBS may not be more damaging to the integrity of one's person than, say, unconscious social pressure in a healthy individual's life.

Given that every type of medical treatment aims to enhance or improve a patient's quality of living, it follows that every treatment is a form of enhancement. To speak about the distinction between treatments versus enhancement is neither necessary nor helpful in order to find the appropriate ethical framework for the use of DBS in healthy, informed and consenting subjects. DBS will only be ethically approved for healthy subjects if these subjects make unsolicited and informed decisions; only this approach to conditions for access to DBS will ensure ethical approval for the field. If this procedure were to be made available to a larger population and thus become an elective procedure, the DBS field should avoid being inspired by pure mercantile profit; it should avoid the less-than-noble model of the field of plastic surgery, where recently disorders of what is termed "plastic surgery addiction" have been observed, thus creating a new pathology.

On the other hand, the invasive nature of DBS procedures exacerbates the bona fide concerns of safety as compared to non-invasive pharmacological interventions, such as selective serotonin reuptake inhibitor drugs or beta-receptor blockers. Since pharmacological intake implies less severe risks and adverse complications, both in the short and long term, it stands to reason that a non-invasive method is undeniably preferable to surgical interventions for enhancement. Although the application of DBS does not seem to raise novel ethical problems, significant ethical concerns are nonetheless at stake. Most notably, are the age old concerns of safety tied to the very invasive nature of the involved procedures. Besides the technical difficulties involved in making risk assessments which try to project the likelihood and extent of harms that could result for patients, there are also ethical difficulties to face. These include questions such as: 1. Under what circumstances should patients be rightfully offered DBS? 2. What level of prospective benefit could justify such dangerous, invasive treatments? 3. Are patients who might be interested in DBS desperate, and in this state are they likely to succumb to what is termed the "therapeutic misconception" – the misconception that a treatment holds real promise of either a cure or substantial therapeutic benefit when in fact what is on offer is not proven, but simply a tool being tested as a function of research? 4. How should DBS be regulated in such a way to assure first and foremost patient safety, without stopping the research altogether in this field? These questions require detailed ethical analysis and should receive answers based on the bioethical principles of beneficence—promoting well-being or benefit—and Non-maleficence—refraining from harm. These questions must be thought through and given serious ethical attention, before applications for DBS can be approved for use in healthy human subjects.

Concerning the principle of beneficence, it must be proven that DBS, in fact, enhances mood and cognitive abilities in healthy subjects; additionally, DBS has to be proven more effective than pharmacological measures. Concerning the principle of non-maleficence, severe short- and long-term effects have to be eradicated on both a physical and psychological level before DBS can be considered a viable option for healthy subjects. Yet, to meet the ethical requirements of beneficence and non-maleficence, DBS must prove itself, and part of doing so means that it must pass scientific muster. At this point, assurances of the safety and efficacy of DBS are not borne out in the literature. In this regard, current reporting on DBS is particularly vulnerable to researcher/investigator bias because of an excessive reliance on single-patient case reports. Although the risk selective publishing poses is by no means unique to DBS, it is essential for safety and efficacy to be proven, and for this higher powered studies will be needed. Ethical patient selection for such studies will of course be a challenge. Alternatively, without higher powered studies, investigator bias and wrongful suasion may drive development of this research.

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# Augmenting Mental Models

By Egon L. van den Broek et al.

*The complexity of conceptualizing mental models has made Virtual Reality an interesting way to enhance communication and understanding between individuals working together on a project or idea. Here, the authors discuss practical applications of using VR for this purpose.*

With recent technological developments, Virtual Reality (VR) has become more and more accessible for various application fields such as medicine, military, education, and product design. The possibility to interactively explore virtual worlds has become an important concept to support education, improve training of skills, or enhance human communication. It is generally acknowledged that the interactive characteristic and vivid imagery of VR improves the user's subjective experience, not only increasing learning performance but also encouraging discussions with other users. However, despite all technological developments, creating VR remains a complex and expensive business. For many companies the practical implications of VR outweigh the practical benefits. Therefore, after decennia of VR research, the question remains:

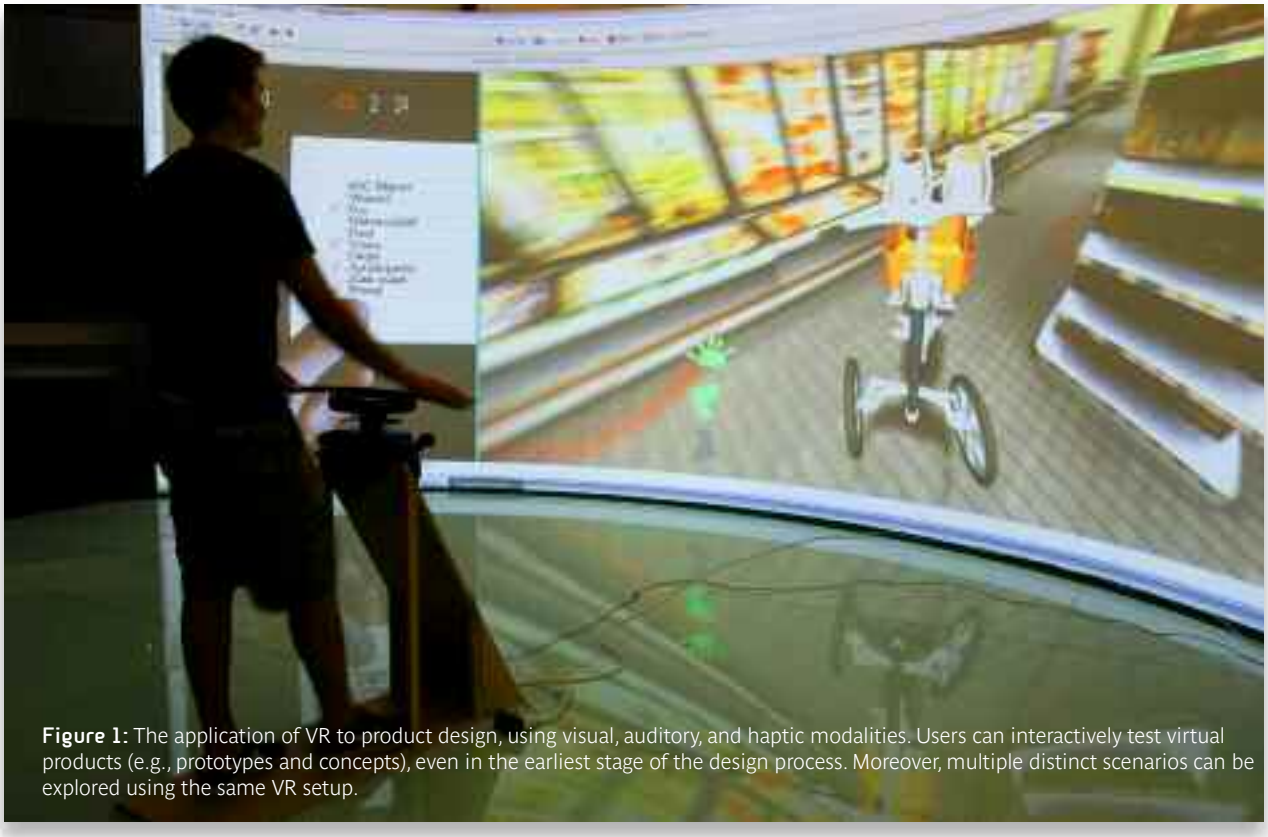

**Figure 1:** The application of VR to product design, using visual, auditory, and haptic modalities. Users can interactively test virtual products (e.g., prototypes and concepts), even in the earliest stage of the design process. Moreover, multiple distinct scenarios can be explored using the same VR setup.

*What benefits does VR provide that is are not provided by other, less advanced technologies?*

To understand the benefits of low-fidelity VR for its users (e.g., see Figure 1), we must first understand the effect VR has on human cognition. The main effect of VR on human cognitive processing is three folded, as VR can augment users':

1. *(multimodal) perceptual information processing* by presenting information via, multimodal displays; e.g., large immersive visual displays that surround the users. Moreover, unlike other computer-mediated environments, VR provides the users with auditory, haptic, tactual, or even olfactory feedback, stimulating other perceptual processes as well.

2. *motor processing* by facilitating the users to perform natural interactions. Not only can users practice specific skills in VR, but also they can learn about the functionality of complex objects.

3. *memory processing* via increased perceptual and motor processing in VR, which facilitates the information storage in memory in a more accurate and complete manner than in other computer-mediated environments. Thus, VR aids the generation of ideas or mental models.

A mental model is a complex concept for which a broad range of definitions have been used. We define a mental model as the (partial) mental representation of the dynamics of the external world. As such, mental models aid understanding, provide explanations, and help predicting future situations; see Figure 1 and 4.

In many application fields such as medicine, VR can improve mental models. However, people have mental models of almost everything in their environment ranging from simple to complex items. Without aiming to present an exhaustive list, we present three characteristics that indicate the potentially added value of VR in generating mental models:

**Figure 2:** VR's visualization techniques improves the users' mental model of a product in development, improving their understanding of potential design problems and solutions.

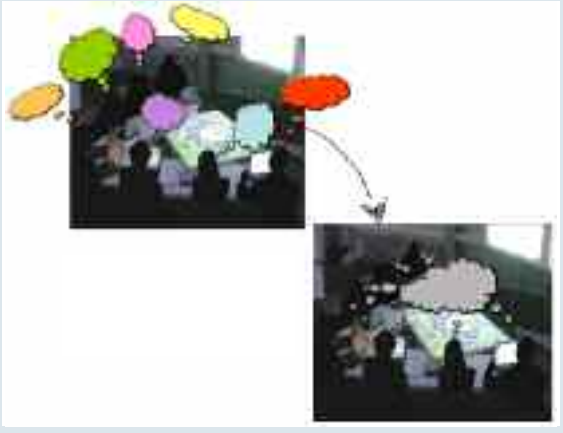

**Figure 3:** Team members with different backgrounds and different mental models can use VR to create a shared mental model, which can be beneficial when trying to make a decision.

### Team Work

When starting a project in which a new team is formed, the members might have different backgrounds, use their own jargon, and adopt their own mental models, see Figures. 2 and 3. Communication might be difficult and miscommunication and misunderstanding lie in wait. Having a shared mental model might prevent these problems as it contains the understanding and/or the commonality of individual mental models (at least by a part of the group). Shared mental models are created by shared experiences or shared familiarization and/or by communication and negotiation. VR fully supports these processes and is, therefore, considered an important means in problem-solving and decision-making processes.

### Describing Abstract Concepts

VR is useful when abstract concepts are involved. It is easier to outline a mental model of something when different channels of information can be used; i.e., the principle of triangulation. Using solely words to explain an abstract concept might lead to different interpretations, as the interpretation of these words depends on individuals' mental models. Using VR can help avoiding these different interpretations.

### Complex Environments

As already was denoted and is long known in psychology, people benefit from multimodal information as opposed to unimodal information; see Figure 1. VR is per definition multimodal and, as such, is par excellence suitable in presenting information, in particular complex information. However, multimodal presentation of information has its downside. Humans are very sensitive to asynchrone presentation of modalities. A latency of even 50 msec. can cause a disturbance with the user, possibly without that the user is consciously aware of it.

In practice, these three characteristics are often intertwined. An example of an area where these characteristics often come together is risk management; i.e., the logical and systematic identification, analysis, treatment, and monitoring of the risks involved in an activity. In short, risk management is providing decision support. In general, crisis management involves i)


**Figure 4:** Placing virtual products in a realistic context can further improve the users' mental model.

teamwork as various stakeholders participate; e.g., police, firemen, and healthcare personal; ii) abstract concepts; e.g., people's experience with events; and iii) complex environments; a crisis takes place under highly dynamic, often hectic circumstances. Therefore, (government) agencies often have real world practice drills to ensure all stakeholders are trained to handle such crisis. VR reality has already shown its use under such circumstances.

Although mental models are a well known concept, the operationalization of this concept is weak. Consequently, although always relevant, mental models are hardly ever applied explicitly in VR studies and remain an umbrella concept. Although touching upon the essence of VR, for the time being, the concept of mental models is bound to research and not applications. Par excellence, VR can be utilized to explore people's mental models further as it facilitates multimodal interaction; see Figures 1 and 4. Exploration of concepts and thoughts as well as the communication of them with other people is all supported by VR technology. As such, VR is deemed to bring science a significant step further in understanding and applying mental models in practice.

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# Put to the Test: "Brain Training"

By Madeleine Grealy

*Cognitive enhancers marketed in the form of "brain games" have become increasingly popular in recent years. But the question remains: Do they really work?*

Earlier this year 11,430 healthy adults took part in an experiment to test whether "brain training" using computerized games could improve reasoning, memory, planning, spatial skills and attention. After six weeks of training the results showed no evidence that this type of "brain training" resulted in cognitive enhancement. This suggests that using Virtual Reality (VR) to improve the cognitive abilities of fit young adults is not likely to be successful, however, there are many people in society for whom this may not be the case. People with brain injuries or people who are experiencing age-related cognitive decline are two likely groups of individuals who might benefit greatly from using VR to enhance, or prevent the decline of, their cognitive powers.

My own interest in this area is in helping people with brain injuries to reach their optimum level of recovery. Following a brain injury there is a critical time during which the brain undergoes some regenerative growth and reorganization. Whilst this critical period will differ for each individual, it is generally accepted that the greatest rates of recovery will occur during the first year or so after the injury has occurred. However, during these early weeks and months following the injury, the patient is most likely to experience high levels of fatigue, low levels of concentration and low levels of activation. The last thing they feel like doing is engaging in cognitive rehabilitation tasks such as trying to remember lists of words, plan a journey using a map or solve complex puzzles. Attention grabbing and engag-

***Continued on page 24***

# Product Comparison Chart:
# Cognitive Enhancement Trainers

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"Brain Games" and cognitive enhancers come in many forms, from software programs to puzzle games and exercises, and even CDs designed to improve listening and communication skills. Here, we provide a comprehensive list of examples of available cognitive enhancers currently on the market. The multitude of forms offered ensures anyone interested in exercising their brain will find something that sparks their interest.

| PRODUCT | DESCRIPTION OF PRODUCT | MANUFACTURER |
|---|---|---|
| MindFit | interactive software program of exercises that boost cognitive skills: short-term and location memory, attention, dual tasking, visual search, time estimation, spatial orientation, planning and more | CogniFit Mind Fitness Solutions Ltd |
| Brain Age: Train Your Brain in Minutes a Day | puzzle game for the handheld Nintendo DS system that presents quick mental activities to stimulate your brain – "acts like a treadmill for the mind" and "measures your brain's mental age" | Nintendo |
| Brain Fitness Program | computer program consisting of six program mental exercises that trains your brain over a forty sessions | Posit Science |
| BrainBuilder PC Game | "neurobic" computer-based training program that is designed to assess and develop auditory and visual sequential processing abilities | Advanced Brain Technologies |
| Captain's Log | 33-program set of computerized exercises designed to improve attention skills, visual motor skills, conceptual skills, numeric concept with memory skills, and higher level cognitive skills | BrainTrain |
| Brain Fitness PC game | 28 different exercises designed to improve logic, language, and attention skills | Scientific Brain Training |
| Buzz! Entertaining brain games for a cognitive workout | 16 fast-paced mini games designed for all ages within the four categories of analysis, operation, memory, and calculation, can include up to six players | Playstation |
| MyBrainTrainer.com | online Web site with paid membership login to access 10 different brain exercise games | MyBrainTrainer, LLC |
| The Listening Program | eight 60-minute CDs with "psychoacoustically modified classical music" designed to improve listening, learning, and communication abilities through plasticity | Advanced Brain Technologies |
| IQ Academy game for mobile phone | IQ Academy gauges the player's performance in various tasks of recognition, logical prediction, and spatial resolution with puzzles. Multiple choice game for the mobile phone | Upstart Games |
| Mind WorkOut Coaching kit | personal coaching kits on mental workouts for businesses designed to improve mental acuity | Behavioral Coaching Institute |
| BrainFit book | book of games/brain teaser/mental exercises, weekly exercise planners, lifestyle planner, anti-aging health tips and risk assessment | BrainFit |
| Games and brain assesment | online membership gives you access to over 20 games within the categories of speed, problem solving, attention, memory, and flexibility, offers feedback and tracking of improvement | Luminosity |

# Product Comparison Chart:
# Cognitive Enhancement Drugs

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For various reasons cognitive enhancement drugs have widely been in use by various individuals for over fifty years. Their ability to help those with social anxieties learn more from therapy means that virtual reality (VR) therapy has the potential to benefit from these drugs by increasing the positive results patients receive when coupling the drugs with the therapy. VR usage of the drugs is aimed at making learning in therapeutic cognitive-behavioral therapy stronger.

Different drugs harbor different functions ranging from increased alertness and concentration, to improving memory and learning. Cognitive enhancement drugs have been, and are prescribed for, various reasons such as ADHD, narcolepsy, depression, anxiety, etc. The potential benefit VR therapy can gain from cognitive enhancement drugs is extremely significant. Many studies directly related to the effects of cognitive enhancement drugs in individuals continue to be carried out, studied, and published.

For example, VR therapy aimed at enhancing motor skills needed in learning to drive could benefit from the use of Amphetamines, originally prescribed for narcolepsy and obstructive sleep apnea. Amphetamines seemingly promote the ability of the brain to create and/or strengthen connections between neurons (neuroplasticity). These connections are the underlying cause of simple and complex movement, and can therefore improve the effects of the VR therapy.

The use of cognitive enhancement drugs is multiplying rapidly among people of all ages and locations, and as a result their uses, benefits, and side effects are being made known in the public and scientific communities. The degree to which VR therapy could avail with the use of cognitive enhancement drugs is an exciting discovery.

| DRUG and TYPE | WHAT IT DOES (NUEROLOGICALLY) | ORIGINAL USE |
|---|---|---|
| Adderall – Stimulant | increase alertness, libido, concentration and overall cognitive performance while decreasing user fatigue | ADHD |
| Ampakines – Stimulant | increase Concentration, boosts spatial memory | ADHD |
| Amphetamines – Stimulant | increases alertness | Narcolepsy, shift work sleep disorder, obstructive sleep apnea/hyperpnoea syndrome, Alzheimer's disease |
| Donepezil (Aricept) – Cholinesterase Inhibitors | improves learning | Alzheimer's disease |
| Ephedra/Ephedrine | enhances attention span and alertness, and facilitate learning and memory | Potential treatment for Alzheimer's disease, Parkinson's disease, schizophrenia, TRD, ADHD |
| MemoProve | influences neuronal and vascular functions and influences cognitive function without acting as a sedative or a stimulant | Myoclonus, and other cognitive disorders |
| Methylphenidate (Ritalin) | promotes nueroplasticity in response to injuries, enhance motor learning skills | Weight control, suppress appetite, narcolepsy, ADHD |
| Modafinil (Provigil) | improve reaction time and alertness | Depression, anxiety |
| Paroxetine (Paxil) | induces neuroplasticity/possible regeneration of axonal growth | Depression, anxiety, OCD |
| Piracetam | improves memory | Dietary supplement for memory |
| Sertraline (Zoloft) | improves concentration | Depression, anxiety, OCD |

ing virtual environments on the other hand can be both motivational, enjoyable and provide the required therapy in a manner that is accessible to the patient. The environments virtual nature means that it can be tailored to meet the individual's needs, and changed as their rehabilitation progresses.

So is there compelling evidence that VR can assist in brain injury rehabilitation processes? Whilst the existing research studies suggest that it might, it is still too early to tell which executive functions can be improved and the best way to do this. Professor David Rose's group at the University of East London have been very influential in this field, and in a review paper in 2005 they described 101 studies that have been concerned with using VR to assist in the assessment and rehabilitation of brain injured patients abilities to plan, form strategies, memorize and perform spatial orientation tests. They concluded that there are many promising signs that VR can enhance cognition during brain injury rehabilitation, but there are still many challenges that have to be overcome before "VR rehab" becomes widely available. By far the most common brain injury is caused by stroke and in 2007 Dr. Jacqui Crosbie and colleagues from the University of Ulster also published a review which looked at the VR intervention studies that have been conducted for stroke rehabilitation. They found 11 studies which had been published in peer-reviewed journals and all of these reported positive results for the use of VR interventions. However, like Rose et al,. the authors noted a series of issues with many of these studies which led them to be somewhat cautious in drawing definitive conclusions.

*"... VR holds great potential to enhance the cognitive capabilities of people with brain injuries and hopefully as it becomes easier for non-specialists to create and use VR technology, the evidence base for its effectiveness will increase as will its availability to all who could benefit from it."*

Many studies suffer from small sample sizes and not all have been able to adopt rigorous enough experimental designs to be able to make comparisons between those who have received a VR intervention and a control group who have not. These are fair criticisms but in defense of many of the researchers working in this area, it is worth noting that this is still a new field of research and conducting large robust studies is not at all easy. There are many things to consider. First, there is the type of VR experience that the patient should receive. The use of immersive displays seems favorable but this has to be counteracted by the potential adverse effects of using immersive VR, particularly head-mounted displays. The second issue concerns the content of the VR task, that is what the person is asked to do. For the purposes of designing a research study it is better that every participant receives the same type of intervention, but in reality it is unlikely that one VR memory task or one VR planning task will be suitable for all patients and specifically tailoring the virtual environments to meet the individual needs of each patient seems the best way to produce the most gains. The other big issue is in trying to have matched control groups for the purposes of comparison. Matching for type of injury, time since injury, other aspects of treatment, hospital/clinic experience, age, gender etc. is by no means an easy task, and those researchers who have tried to do this should be commended for their efforts.

At present, we can only really speculate on how VR rehabilitation programs influence the structure and function of the human brain, but as brain scanning technologies improve we are moving towards more sophisticated ways of determining this. Undoubtedly though, VR holds great potential to enhance the cognitive capabilities of people with brain injuries and hopefully as it becomes easier for non-specialists to create and use VR technology, the evidence base for its effectiveness will increase as will its availability to all who could benefit from it.

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# Virtual Environments for Brain Injury: Virtual Reality's Forgotten Silver Bullet?

▸ By Paul Penn & David Rose

**Neuropsychological Applications of VR**

In 1998, researchers from the University of East London pointed to studies indicating that hospitalization following brain damage is often characterized by long periods of inactivity where the patient has minimal stimulation and interaction with their immediate environment. It was argued that such conditions were akin to environmental impoverishment, which is deemed to be deleterious to recovery from brain damage. The authors argued that Virtual Reality (VR) could be used to reduce such long periods of inactivity and, in doing so, raise

the levels of cerebral activation and arousal upon which the success of subsequent rehabilitative attempts rest.

The intervening twelve years of research has witnessed much progress in examining the utility of VR in numerous specific domains of neuropsychological assessment and rehabilitation (attention, memory, and executive function). However, it is the contention of this short article that researchers have missed arguably the greatest single contribution that VR could make to brain damage rehabilitation: simply improving the environment that the patient is exposed to between formal rehabilitation sessions.

**Recovering from Brain Damage: the Role of the Recovery Environment**

For the past 60 years, animal based research has indicated that the extent of recovery that is achieved following brain damage is significantly influenced by the quality of the environment in which the recovery occurs. Put very crudely, researchers make the distinction between enriched environments and impoverished environments. An enriched environment is actually a composite of a number of elements including opportunities for increased exercise, sensory stimulation, learning/training, and social interaction. An impoverished environment is one that is lacking in all of the above respects. A full review of the literature is well beyond the scope of this article. Simply stated, research into enriched environments has pointed to their effectiveness in ameliorating the impairments associated with a diverse range of different types of CNS damage - spinal cord contusion, brain damage of genetic/developmental origin, traumatic brain injury, degenerative disease, and damage of pharmacological or teratogenic origin. Research has also consistently pointed to the deleterious effects of impoverished environments on the recovery from brain damage.

In terms of the rehabilitation of human brain damage, consider that research has indicated that patients can spend as little as an hour a day in formal rehabilitation and a significant proportion of the remainder of the day not engaged with activities, social interaction, or their immediate environment. Such conditions can be conceptualized as an impoverished environment. Researchers have argued that low levels of cerebral activation and arousal associated with impoverished recovery environments essentially handicap any rehabilitative strategies from the outset - the patient is very easily fatigued and unaccustomed to having to concentrate and allocate their attention resources to different tasks. In other words, raising levels of cerebral activation/arousal is a pre-requisite for optimally effective rehabilitation following brain damage and environmental enrichment is the obvious means to achieve this.

**Figure 1:** Screenshot of the virtual kitchen environment.

**Providing Enriched Environments for Humans: VR's Silver Bullet?**

In contemplating the use of environmental enrichment in the rehabilitation of brain damage in humans, it should be noted that no direct extrapolation from the animal research to humans is being advocated. The authors simply suggest that the volume and breadth of the animal literature should constitute strong impetus to conduct enrichment research in human populations and serve as a means of identifying practical, conceptual and methodological issues associated with how enrichment might be implemented with humans.

The first and most obvious barrier to implementing enriched environments in human populations is economic. Given constraints on budget, time, and resources, in addition to limitations imposed by health and safety concerns, it is very difficult to modify the physical environment of a hospital ward, or physically transport a patient to a less impoverished environment. However, if one cannot take the patient to an enriched environment in the real world, then we can bring an enriched virtual environment to the patient. This could be achieved with something as simple as a laptop PC based VR set up. Such a system could potentially eliminate all of the practical constraints that have inhibited the development of a body of research on the use of enriched environments in human populations. One might go so far as to suggest that this simple idea might well be VR's "silver bullet" - the application that finally exploits the real potential of the technology in the context of neuropsychological rehabilitation.

**Issues with the Implementation of Enriched Virtual Environments**

VR may well be able to overcome the practical issues associated with the provision of enriched environments. However, there are also theoretical and methodological issues to consider. A full review of these issues is beyond the scope of this paper, but the most fundamental one will be briefly addressed here. The issue of what constitutes an enriched environment for human populations, as opposed to the rodent based populations the research has predominantly been conducted on in the past.

Any meaningful research rests on the specification of parameters that differentiate an enriched environment from a standard rehabilitation environment. In broad terms, perhaps suggesting that the factors that distinguish enriched and standard environments in rodent based research constitute appropriate initial parameters for the manipulation of enrichment in humans is not stretching credulity too far. The significance of these factors within brain damage rehabilitation is not based purely on speculation. For example, research has pointed to the

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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

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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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importance of physical exercise, social interaction and multi-sensory information on the recovery of both motor and cognitive functions in addition to cerebral reorganization. As a brief glance through any VR related publication will attest, the characteristics of VR are amenable to creating a diverse range of virtual environments highly relevant to patients' daily lives. The characteristics can be orientated to support exercise programs, utilize several sensory modalities, provide automated rudimentary social interaction, or serve as a forum for real time social interaction (e.g. Second life).

Using VR to enrich the environments of people with brain damage is a topic far too large to entertain fully in this article. However, it is fair to say that enriched virtual environments in neuropsychological rehabilitation hold the promise of enhancing recovery from brain damage at very little financial cost and with minimal risk. This idea was originally proposed over a decade ago - the authors would argue that it is high time to make serious in-roads into this area of research.

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# Brain Health and Neural Energies

*Here, the author looks at ways to maximize and maintain brain health, placing special emphasis on the effects of physical exercise, mental stimulation and socialization. He also presents an argument for lasting placticity, even as we age.*

## By Paul D. Nussbaum

One of the most active areas of scientific, clinical, and general consumer interest is the human brain and methods or behaviors to maximize and maintain brain health. Surveys by the American Society on Aging have indicated that memory loss is one of the leading concerns for the baby boom generation, many of whom are now serving as caregivers for a parent with Alzheimer's disease (AD) or related dementia. Indeed, there are approximately five million Americans suffering from AD today with another five million at risk and this number will balloon to 15 million by the middle of this century. We have no cure for AD and no cure for any type of dementia at this time. Our treatments are reactive and symptom-based, offering some help to those who begin such medication-based treatments early in the course of their progressive dementia. As with nearly all diseases, AD and related dementias are not really a disorder of late life. Rather, they most likely begin to invade the brain or other parts of the body depending on the type of disease process very early in life. We must begin to think about disease as a proactive and often lifelong process. This conceptual framework for disease then demands a proactive and lifelong pursuit of health promotion.

**Neural Plasticity**

Donald Hebb wrote about cellular plasticity and learning in the early to middle 1900's and his work remains pioneering. He was among the first to champion the idea that environment can affect the structure of a cell and thereby produce learning. Plasticity in this sense refers to a brain that is highly

dynamic, constantly reorganizing, and malleable, capable of being shaped by environmental input. There is no special or critical period for this shaping as the environment-brain interaction can occur at any age across the lifespan.

The 1950's found continued evidence for neural plasticity in the animal model as rodents exposed to an enriched environment

were found to have a larger cortex, more synaptic connections, and even new brain cells (neurogenesis) in their hippocampus as measured at autopsy. This was in comparison to rodents raised in unenriched environments. These scientists, including Marion Diamond, defined the enriched environment as having other animals to interact with, having a running wheel to exercise, and having toys to play with. These three factors were not present in the unenriched environment. I have characterized these three factors as "socialization, physical activity, and mental stimulation" respectively. This work helped to reinforce the idea that environment shapes the structure and function of the animal brain and can help the animal brain generate new brain cells in a region critical to learning and memory.

*"Our brains are shaped by technology and indeed, our brains shape the latest technological trends. Too much stimulation can be damaging while proper use of technology with proper content can be health promoting. This is the fine balance that is not yet a science and is most likely subjective or idiosyncratic."*

Neurogenesis in the animal brain is a given with substantial research to support the sensitivity of the hippocampus for new brain cell development. Support for human neurogenesis was lacking until Eriksson and colleagues reported similar sensitivity in the human hippocampus in 1998. This finding revolutionized thinking on the human brain and directly challenged the traditional ideas about human brain function and its limitations. Neurogenesis is one product of a brain that has plasticity and prompts the question "does environment shape the human brain and can the human brain be shaped for health?"

**Brain Health Promotion**

Research has demonstrated robust support for physical exercise, mental stimulation, socialization and brain health in humans. This parallels the same finding in animal brains. In addition, humans who reduce stress and eat brain healthy foods derive additional benefit to the function and even structure of their brains. I have put together a proactive and comprehensive brain health lifestyle ™ that has been published for the general public. Our approach to health needs to be proactive and this is particularly true for the human brain. As we are now fully engaged in a technology-based environment we need to pay attention to the types and utilization of technology as one part of the environmental-brain shaping process. This is true within and outside of the medical field.

Our brains are shaped by technology and indeed, our brains shape the latest technological trends. Too much stimulation can be damaging while proper use of technology with proper content can be health promoting. This is the fine balance that is not yet a science and is most likely subjective or idiosyncratic. Children text as a primary means of communication and this behavior will likely shape their brains in different ways than their parents and grandparents who did not use such technology for such purposes. Negative and violent imagery can affect the emotional and sometimes the behavioral status of the human brain. The critical issue for medicine and for health is "what are the types of environmental shaping that can best promote the health of the human brain?"

**Neural Energies for Health of the Human Brain**

As the human brain is the single greatest and most complicated system ever designed it is safe to presume we do not yet understand its full potential. The brain is a chemical and electrical source of energy that can be tapped. Neural Energies refers to the energy of the human brain being used to affect matter within and external to the human body. This is perhaps the most salient example of "CyberTherapy" as it does not entail any external or internal human-based instrumentation. It reflects a more advanced process that uses the brain's energy to shape a particular condition towards health and to orchestrate the implementation of the body's natural defenses against disease. The same sources of energy should also be able to shape outcomes outside of the body.

Current therapies that utilize primitive examples of neural energy include neurofeedback to help create internal homeostasis, EMDR that helps with anxiety and posttraumatic stress disorder, visualization, and even using the electrical energy of thought to transmit to computers for purposes of communication in patients who are paralyzed. This represents an entirely new arena for study and application that relies on harnessing the power of the human brain. Mental focus, visualization, telepathy, and control of internal body function represent a most advanced use of technology to health. In this case, however, the technology is the two to four pound miracle that is comprised of nearly 60% fat and demands 25% of the blood from each heartbeat, the human brain.

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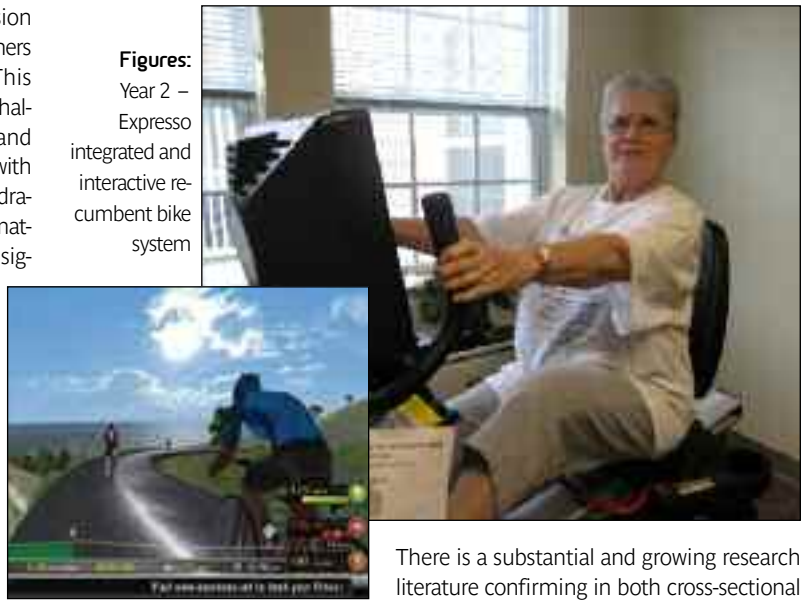
# Seniors Cybercycling for Enhanced Cognitive Performance

By Cay Anderson-Hanley & Paul Arciero

*"... one of the most widely recognized and cost-effective strategies for preserving quality of life into old age is exercise, but this is often neglected or underutilized as a strategy ... exercise is linked to cognitive enhancement, brain health, and even neurogenesis."*



**Figures:** Year 2 – Expresso integrated and interactive recumbent bike system

The graying of America will lead to an explosion of the older adult population as the baby boomers begin to reach retirement age in 2011. This changing demographic will bring increased challenges for this segment of the population and society as a whole, as the number of persons with cognitive compromise will begin to increase dramatically. While cognitive decline is not automatic with aging, the rate of dementia increases significantly around retirement age, and rises exponentially after age 80.

The baby boom generation is largely tuned in to the possibility of mental and physical decline, and many are actively working to take care of themselves in hopes of preserving their faculties and avoiding descent into dementia and nursing home placement. From learning a new language after retirement, to consuming nutritional supplements at an unprecedented rate, the new 50+ crowd is not planning to take this turning of the clock lying down. Additionally, the boomers represent an important market and savvy businesses are carefully tailoring services and products to match their goals. Take the vast array of brain fitness computer programs on the market which are popular among boomers, but which have questionable efficacy for staving off long-term cognitive decline.

On the other hand, one of the most widely recognized and cost-effective strategies for preserving quality of life into old age is exercise, but this is an often neglected or underutilized as a strategy.

There is a substantial and growing research literature confirming in both cross-sectional studies and randomized trials what most would suspect, that exercise is linked to cognitive enhancement, brain health, and even neurogenesis. In 2007, the American College of Sports Medicine and the American Heart Association updated the recommend amount of exercise for seniors, suggesting 30 minutes, five times a week of moderate and vigorous cardio exercise and strength training twice a week. However, research reveals that only 4-14% of seniors exercise at recommended levels.

The question becomes: How can exercise participation be increased among older adults? Researchers have identified a vari-

ety of barriers to exercise behaviors, ranging from costs and location, to lack of self-efficacy, discomfort and boredom. With the advent of virtual reality technologies, innovative equipment has been developed that has the potential to address some of these barriers. In particular, being able to explore a variety of 3D terrains while exercising can address boredom, and competing with avatars on the screen can distract one from the discomforts of exercise.

In 2008, with a grant from the Pioneer Portfolio of the Robert Wood Johnson Foundation, through the Health Games Research national program, the Neuropsychology Lab at Union College teamed up with the Exercise Science Lab at Skidmore College to investigate the effectiveness of "cybercycling" for seniors. The cybercycle consists of a stationary bike, paired with a computer such that videogame features become interactive with the pedaling and steering components of the bike. Riders can experience virtual 3D tours of various landscapes including oceanside bikeways, forested trails, and desert pathways; and riders can also compete (or not) with other avatars on the screen. Depending upon the equipment, riders may also be able to compete in real time with another live rider or team of riders. Initially, we piloted the FitClub interactive system, but our older adult sample required a walk-through bike, where they would not have to lift a leg over a center bar. In year 1 of the study, we utilized Netathalon's interactive riding software on a laptop connected to a recumbent bike. Due to challenges mousing and navigating on the laptop for some novice computer users, in year 2 of the study we switched to Expresso's fully integrated recumbent bike.

We are in the process of completing the second year of the randomized clinical trial, examining the cognitive, physiological, and behavioral effects of cybercycling for seniors. Participants exercised three to five times week for three months, and were randomly assigned to either ride the cybercycle or a traditional stationary bike. Approximately 100 independent living seniors were enrolled in the study over two years, and approximately 60 participants completed the three-month exercise intervention and pre- and post-evaluations. Participants completed full day evaluations of their physical and mental state, including tests of muscle, bone, and blood, as well as neuropsychological tests of thinking processes such as executive functions, memory, and attention. Preliminary results from year 1 were presented in 2009 at the annual meeting of the Society of Behavioral Medicine in Montreal, and suggest significant cognitive, behavioral and physiological changes. We are awaiting results from the complete sample to confirm the apparent cognitive benefits of cybercycling over and above standard static cycling. The implications of this line of research are exciting, since the potential is there for cybercycling to increase exercise among the aging population and lead to cognitive enhancement along with many other known benefits of exercise.

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# Integrative Rehabilitation through Gaming

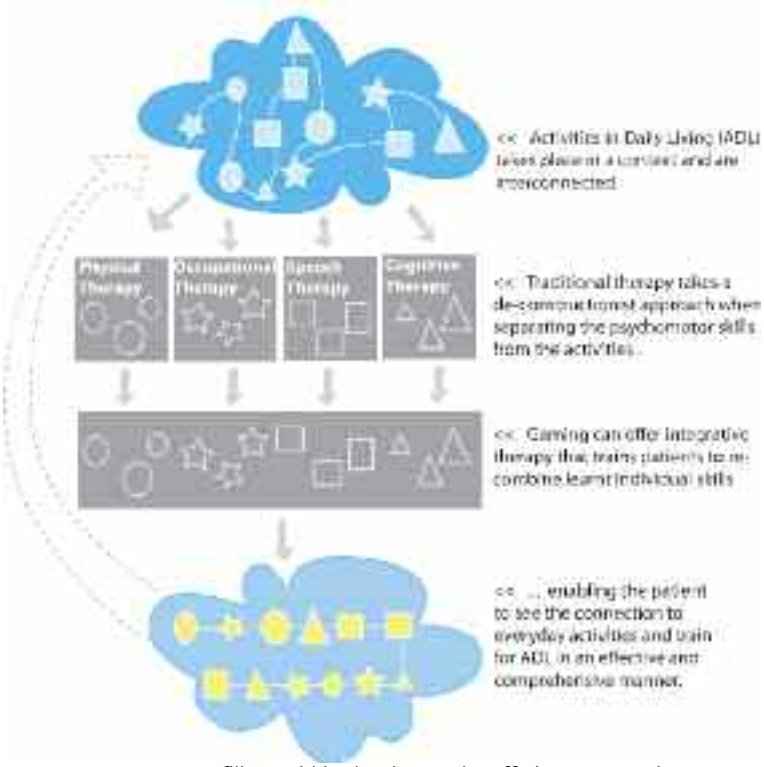
▸ By Kanav Kahol et al.

**Integrative Therapy: Combining Different Modalities to Offer Comprehensive Rehabilitation**

Traditionally, rehabilitation therapy has been based on a deconstructionist approach wherein complex activities in daily life have been divided into simpler units of activities. This division process allows therapists to focus on individual movements and activities, measure the progress of patients, and train the patients to perform these individual activities. This approach has been very successful in the past few decades and has been supported by third party payers. However, there is a lack of therapy that trains patients to combine these individual modular activities into complex activities. Patients are expected to naturally achieve this combination through self-practice. Yet lack of actual feedback on completed skills and the ability to link some of the complex activities, severely impedes patients' motivation and may be an important reason for a decline in compliance.

Studies have consistently shown that most patients do not complete their therapy due to a lack of engagement and feedback [Task Force Traumatic Brain Injury 2007]. Research has shown that technology - such as Virtual Reality (VR) and imaging systems

- has potential benefits to therapy and is an interesting and effective way of providing rehabilitation to people with aneurism. A significant amount of research has been devoted to employing off-the-shelf games and game units such as the Nintendo Wii® and the Sony EyeToy® in rehabilitation. Some researchers have even recognized the problems and frustrations that people with impaired motor skills face when trying to play a commercial game targeted for a non-impaired audience; hence these scientists are developing customized games with a more suitable entry level. Examples of these games are the Rabbit Chase and the Arrow Attack games [Burke, 2008]. In most of these approaches, games have been employed to offer a motivational and persuasive environment for patients to practice skills that they traditionally practice in rehabilitation therapy.




We propose that gaming can actually offer a means of training patients on a combination of individual skills. Games such as Halo, God of War, etc., combine a variety of skills including both psychomotor and cognitive skills. Games that combine physical and cognitive exercises can actually be very effective in providing integrative therapy. This paradigm is shown in Figure 1. Our approach suggests viewing a given rehab exercise not only as a mechanical task-based skill, but an applied skill with both cognitive and psychomotor dimensions. There are several advantages to this approach of employing gaming and cybertherapy:

1. It fills a void in the therapy by offering an engaging means of providing integrative therapy.

2. It provides a means for patients to get a comprehensive score for a combination of activities. Unlike conventional approaches of gaming, wherein patients only receive a score per game or per activity, this paradigm can track the score of patients across different activities and generate a comprehensive score. This addresses a major concern of patients who may feel disillusioned at the end of a session in visualizing how the individual exercises they perform may help them in activities in daily living.

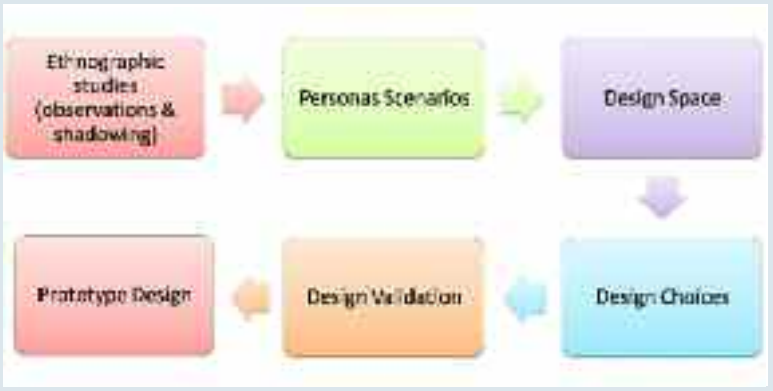
3. Gaming is ideal for offering integrative environments. Often in gaming, imperfect graphics, and sounds and vibrations can be combined to offer a realistic, immersive gaming experience. Games often contain stages that allow for testing different capabilities of a user. In a similar manner, gaming can be employed to allow users to combine different rehabilitation movements and progressively improve not only on individual rehabilitation activities but on combining them. A story-driven game can make the combination meaningful and seamless because it provides a context for the activities.

### Game Scenario: Helping Mother Earth

The patient wears movement sensors on legs, hands and head and is moved to cross-country skiing exercise unit. The patient is welcomed to an exercise driven towards increasing awareness of sustainability. In the first stage of the game, the patient skies to power an airplane that is carrying cans to the recycling plant nearby. The skiing offers physical therapy. To add the dimension of occupational therapy, the patient has to control the direction of the plane by moving his/her torso left or right to guide the plane. As the plane moves through the terrain, the patient gains virtual currency. When the patient reaches the factory (s)he opens the gates by repeating numbers that show randomly on the screen. This is integration of the digit span test. Inside the factory, the patient wears exercise bands and takes cans from the bag they brought on the plane and places them in receptacles that appear at different locations and heights. This exercise trains the patient's upper and lower limbs as some receptacles appear near the legs. At the end of this stage the patient has to open the door to the next stage by performing a mental rotation task wherein shapes appear on the screen and have to be matched to their rotated counterpart. Once the new stage of the game is opened, the patient's goal is to crush the collected aluminum cans to make a recycling bin or a metallic toy from the material. The patient physically stepping on a machine that virtually crushes the cans – while similarly using his/her hands to press the levers – actualizes this process. In this manner the patient goes through four stages that combine physical therapy, cognitive therapy, speech therapy, and occupational therapy.

### Creation of an Integrative Therapy Unit

In order to create an integrative therapy unit, we employed a scientific design methodology shown in Figure 2. In order to identify the issues of integrative therapy and its adoption, we performed an ethnographic study composed of observations and shadowing in a rehabilitation institute. We interviewed several stake holders and identified several factors. Using these interviews as well as an understanding of the workflow and environment as a basis, we designed personas and scenarios that guide the design process. Personas are design tools that help product designers and engineers visualize the characteristics of their final users (in this case therapists and patients), and helps design user-centered products. Scenarios are tools that help the designer visualize different conditions under which the product will be employed. Together scenarios and personas help in the creation of the design space, which outlines the specifications that a product may have and helps make critical design decisions. Once the design choices are made, we validate the design by ensuring that our choices will be in agreement with interviewed users and designed personas and scenarios.




▲ **Figure 2.** Design Process.

▼ **Figure 3.** Integrative Therapy Unit.

At the end of the iterative process of design validation and choices, a prototype design is created. Figure 3 shows the overall prototype design for our integrative therapy unit. In this design, a hexagonal central unit links a variety of exercise equipment together into a single unit. The choice of six units was arbitrary and could be as low as two units, to as high as required. A patient can start with any exercise equipment and then move in a counter clockwise or clockwise manner through the different exercises. LCD screens (46 inches full HD) give users visual feedback on their performance by providing a persuasive game scenario. In this prototype, every exercise can be visualized as a stage of a game where the story of the game links all the activities in a single cohesive unit. Sensors on the patient or exercise equipment help record movement and drive the games. An important design choice was that the transitions between exercises would actually provide an opportunity for cognitive therapy. As an example (see game scenario inset), a digit span test could be performed when shifting from one exercise station to another. This allows for seamless integration of the different types of therapy (see Figure 1) in a single unit. This system is analogous to circuit training, but with persuasive elements to encourage exercises and measure cross-platform and cross-therapy proficiency of the patient.

### Conclusions

A user-centered, integrative gaming therapy system design is proposed. The system addresses a void in modern-day therapy by using games and Virtual Reality as a basis to provide a means to offer comprehensive rehabilitation training environments. Initial results of the prototype have been very encouraging. While the system will require extensive testing, the provided design and concept has significant merit and may provide a novel research direction for gaming and rehabilitation.

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# Can Older Adults Enhance Their Cognitive Skills?

By Chandramallika Basak

*As the aging population increases, we are faced with the question of whether a "cognitively fit" lifestyle exists.*

With a growing population of older adults, we are faced with pragmatic concerns of managing an aging society. There is a growing interest in developing deeper understanding of cognitive and brain enhancement that may allow for a longer "cognitively fit" lifestyle. Ideally, research programs should focus on not only increasing the quantitative aspect, but also the qualitative aspect of our lifespan. Successful aging in some cognitive dimensions is related to early life-span experience, such as education, as well as various lifestyle factors from mid and later life, such as exercise. The solution is not only to explore lifestyle factors, where, sometimes, individual differences in multiple unknown aspects could be guiding our choices in such factors, but also to conduct randomized clinical trials to see if training induces brain and cognitive plasticity that offsets our age-related declines. That is, an effective training protocol should not only improve the targeted abilities that the person is being trained on, but also a varied set of untrained skills.


One such effective training paradigm in senior adults has been real-time strategy videogame training. In a recent study by Basak, Boot, Voss and Kramer (2008), we trained older adults age 65 or older in a real-time strategy video game for about 24 hours. We collected their performances on a variety of cognitive skills before and after training, and compared them to an age and gender matched group of older adults who did not receive any videogame training. The group that received video game training improved not only on the video game performance but also on some of the higher-level cognitive skills that are typically sub served by frontal and parietal cortices. Some of these untrained skills that the training group improved on more than the untrained group were reasoning, multitasking and working memory. Also, improved performance on the videogame was related to improved performance in multitasking and working memory.

More studies need to be conducted in this domain to understand what types of videogames improve various types of cognition (for example, attention vs. memory), how long an effective training should last, what are the neural correlates of the training induced cognitive plasticity, and how long do we retain the benefits of the training. It is also important to have a more appropriate control group that would receive the same hours of training in another set of skills, under similar social interaction, so that video game training related changes are not merely attributable to interaction with the computer or experimenter. For example, older adults can be trained on strategy based videogames, which could be the target group that is expected to improve in control processes, memory and reasoning, or on videogames that are less complex or tap into other skills, which would formulate the control group (see Figure, below left.)

The amount of training (x) could potentially vary to explore the effects of dose-response of the video game training in the aging population, and the retention period (y) could be varied as well to understand the long-term effects of transfer and learning. The improvement from baseline to post-testing in the various untrained tasks would assess the effects of transfer, whereas the improvements in the trained task itself (i.e., the video games) would assess learning of the game.

Given that with age, deficits in memory and control processes increase, and in many cases are pathological (e.g., dementia, Alzheimer's disease, Parkinson's disease), it is of interest to know whether computer-based training could offset these declines, and allow us to live a cognitively healthier life in old age. Computer-based training can also be an appropriate intervention for older adults who are not mobile enough to get much physical exercise. The neural correlates of these improvements would guide us further in understanding brain plasticity that goes hand in hand with cognitive plasticity.

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# The Use of ExerGames to Promote Active Aging

By Tiffany Shubert

*"Active Aging: The process of optimizing opportunities for health, participation and security in order to enhance quality of life as people age. " – WHO, 2002*

According to the World Health Organization, over 1.2 billion of the world's population will be age 60 or over in the next 15 years, and by 2050 that number will swell to 2 billion. The countries with the largest proportions of older adults are predicted to be Japan (35.1% of the population) and several Western European Countries (Italy, 34.0% Germany, 33%). This growth is not limited to developed countries, with predictions of 70% of the aging population living in developing countries, primarily concentrated in Asia. This unprecedented shift in world demographics from young to old will pose great challenges to the health care personnel and resources, especially because many of these older adults are not achieving the goals of active aging. The average American age 65 and over has 3.1 chronic health conditions requiring some form of medical management, and has a 30% chance of experiencing a fall which my result in hospitalization, morbidity and mortality. Similar statistics have been reported for other western countries. Several of these chronic health conditions (cardiovascular disease, hypertension, stroke, diabetes, arthritis, osteoporosis, etc.) and falls can be either avoided, or best managed with the appropriate health behavior interventions that empower the individual to perform appropriate exercises, increase physical activity levels, and make healthy lifestyle choices. Several programs have been validated as effective in managing health, preventing falls, minimizing physician visits, and decreasing hospitalizations due to illness or injury. However, there is minimal infrastructure and personnel to adequately disseminate these programs for the greatest impact on the individual and community health.

Gaming may be a viable health promotion dissemination mechanism for older adults. The unanticipated phenomenon of the popularity of the Nintendo Wii with older adults demonstrated older adults did have an interest in playing video games. Physical therapists have embraced the Wii, the Playstation, and other commercial games as well as virtual reality as effective interventions for older adults in several treatment settings.

Though the most popular, the Wii has several drawbacks for older adults. These drawbacks have not been discussed in the media clips highlighting the elderly playing Wii bowling. In our lab we have focus group data and usability studies which demonstrate older adults are interested in video games and exergames as a way to promote health and active aging. However the games in their current form are far too fast and cause much frustration among older players. One reason why older adults only play bowling is that they really cannot play the other Wii games with success. Even the reaction time and coordination required for Wii bowling can be problematic, and often the feedback from the avatars is so negative, that older adults discontinue playing. This sentiment was supported by data from a questionnaire distributed to physical therapists using the Wii with geriatric patients. For the most part, therapists felt that older adults enjoyed playing the games, but there was no continuity or follow through beyond the rehabilitation period.

In order for older adults to successfully change behavior, they must have support and guidance for an extended period of time. Studies show that 12 – 24 week interventions are the most effective for long term change. Physical therapy rarely lasts for that amount of time. The interest in gaming by older adults suggests that exergames may be a viable conduit to deliver these types of health promotion and behavioral change programs, as an effective adjunct to physical therapy with minimal resources and manpower hours required.

Our data suggest games which have options to increase the usability for older adults may be the easiest venue for dissemination. The ability to change font size, contrast, speed of play, and the ability to stop while playing, regroup, and start again, are all attractive qualities to an older adult player. A health game should be quite explicit as to the purpose of the game, and the desired outcomes after participating in the game. Feedback is another key component, and the ability to track progress and achieve milestones.

We are interested in using this information to develop exergames specifically for older adults to improve physical function and mobility. We feel that exergames can achieve the ultimate goal of maintaining independence for as long as possible, compressing the period of morbidity, and achieving the goals of Active Aging for as many older adults as possible.

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# ACROSS THE POND:
## "Don't Mess With Mother Nature": Evaluating the Moral Opposition to Cognitive Enhancement

By John Banja

Various surveys indicate that between four to more than 35% of American college students admit to using drugs like Adderall and Ritalin to improve their concentration, memory, and mental stamina. Jet-lagged sales managers who go straight from the airport to their sales meetings might take a drug like Provigil to rid themselves of their mental fog, while the Air Force makes Provigil available to pilots, especially ones flying long missions. A "transcranial magnetic stimulator," which looks like a halo and is placed on one's scalp to stimulate certain brain regions, has been used to help persons suffering from depression, Parkinson's disease, and auditory hallucinations from schizophrenia. It is also known, however, to improve drawing, proofreading, and memory among "normals."

Many individuals regard drugs like the selective serotonin re-uptake inhibitors as cognitive enhancers because of their sometimes remarkable effect on improving mood and remediating undesirable personality traits like shyness or social awkwardness. Psychiatrist Peter Kramer tells numerous stories in his marvelous book *Listening to Prozac* about patients who, once they begin experiencing the benefits of these mood and personality brighteners, beg him to continue their prescriptions as they can't stand the thought of returning to "being the person I once was."

Now, there are at least three practical reasons or arguments that should give us pause about categorically endorsing these kinds of "cognitive enhancements"—so called because they ramp up one's "normal" baseline quality of cognitive functioning as opposed to improving an injured or diseased brain's impaired functioning. The first argument concerns harm – some of these drugs can cause agitation, headaches or sleeplessness. After prolonged use, they can flatten one's affect such that some users have described themselves as "zombies" when coming off them. Some drugs can also be habit forming such that when users try to quit, they find they can no longer tolerate their previous, foggy-headed mental state or their depressingly uninteresting or withdrawn selves.

The second argument is fear of coercion. If an individual resists taking these drugs but fears being penalized because his or her performance will compare poorly to competitors who are using them, he or she might feel enormous pressure to take them. This is probably not dissimilar to the problem of steroid use in athletics.

A third argument is equal access. Even if these drugs prove relatively harmless and effective, will only certain individuals have access to them? Will we have a two-tiered society wherein one group's members are cognitively robust, vital, and high-performing, while the other is depressingly average?

Yet a fourth kind of argument that opposes cognitive enhancement was strongly advanced during George W. Bush's administration by some members of his President's Council on Bioethics. Leon Kass, the chair of Bush's first bioethics council from 2001-2005, believed that the three arguments above missed what is really at stake and said, "If there is a case to be made against these activities (i.e., cognitive enhancements)…we sense that it may have something to do with what is natural, or what is humanly dignified, or with the attitude that is properly respectful of what is naturally and dignifiedly human."

Kass argues that these "artificial" cognitive enhancements disrespect the "special gift that is our own given nature;" that they are a form of cheating in giving us abilities that are undeserved given how they were acquired; that they show disdain for the importance of discipline, hard work, and even pain and suffering in achieving superior performance; and that they render us less humble in the presence of the Creator's design of human functioning, which does not contemplate a "brain on steroids."

*"…we shouldn't be wary of [cognitive enhancing interventions and technologies] because they threaten human dignity. Indeed, they might ultimately promote it or at least better clarify what we mean by it."*

Because I have no quarrel with the first three arguments above, I want to spend the remainder of this essay discussing what we are to make of this last one. It continues to be a prominent argument among "moral conservatives" and extends to virtually all kinds of biotechnology—involving not just cognitive enhancement but research on reproduction, stem cell research, and other neurotechnologies—that might tamper with "the special gift that is our own given nature." How seriously, given the democratic, ethically pluralistic values that characterize America, should an "argument from nature and human dignity" be taken?

**Assessing the Argument from Nature and Human Dignity**

Despite this argument's appeal and popularity, many individuals such as myself find it very

flawed. First of all, "Nature"—understood as a world of unadulterated biological, physical, geological, meteorological, and cosmological phenomena—presents us with what exists, not with what *should* exist. For every item in the natural world at which we marvel and might want to recommend as a morally right and compelling example—animals caring for their young, say—there is another natural phenomenon that is horrifying and abhorrent—such as natural predators looking to feast off those animals and their offspring.

Proponents of the argument from nature know this, and so they focus on a particular manifestation of nature which, they believe, offers up compelling moral rules and prescriptions: human nature. Thus, philosophers like Kass make numerous appeals to certain characteristics and traits of human beings, especially those bearing on human dignity, that they believe embody undeniable and inviolable moral truths. For example, Kass fears that the use of cognitive enhancements will replace humility with arrogance and incline us towards what is "ignoble;" that cognitive enhancement would "undermine the highest and richest possibilities of human life"—indeed, would undermine "what it means to be a human being"—and that cognitive enhancement would dismiss the normal exercise of hard work, diligence, perseverance, and suffering in the pursuit of human excellence.

For many individuals, this kind of language has enormous intuitive appeal, and that's the problem. Different cultures might have radically different conceptions of dignity and its accompanying connotations. The idea that there is some absolute, eternally true or correct representation of dignity that is not the product of some culture seems wildly wrong. Indeed, why even insist that dignity be the primary principle or value that morally grounds and restrains cognitive enhancement research and use? Why not choose human flourishing, creativity, or efficiency as our primary goal or human purpose?

Second, while appeals to human dignity might sound ennobling, "dignity" in and by itself often fails to give us explicit moral direction. For example, does the jet-lagged sales manager impugn human dignity when he takes a Provigil to be at his best (or even better) for his sales meeting? Does the college student who opts for some Adderall rather than multiple helpings of espresso during finals similarly violate dignity? Invoking "dignity" isn't necessarily morally informative because different people, each of whom is morally respectable and decent, can disagree on what dignity demands in any given situation.

Third and somewhat related to the last point, some philosophers believe that dignity is a useless concept. What does "acting with dignity" add to the idea that we should respect one another, not harm one another, and treat one another fairly and with civility? How many of us walk into our offices thinking, "Today, I must respect everyone's dignity."? Very few, one suspects, largely because "dignity" sounds too abstract and vague, while acting courteously and respecting others' rights seems much more normatively concrete and helpful.

Last, and perhaps most obviously, objecting to cognitive enhancement on the grounds that someone or some group's idea of dignity is insulted runs afoul of the traditional rights-based conception of our moral obligations and norms. I am obliged to respect your liberties and freedoms; I cannot harm you without compelling justification; and I should treat everyone I meet with a reasonable degree of fairness and justness (although I might be even more obligated towards special individuals, such as my family or professional clients). On the other hand, denying individuals the right to cognitive enhancement because it is "ignoble," or would make them "less humble," or that it would "undermine the highest and richest possibilities" of their lives sounds hopelessly dogmatic, vague and undemocratic.

We should be careful about cognitive enhancing interventions and technologies because they might turn out to be harmful, or encourage coercion, or produce unfairness. But we shouldn't be wary of them because they threaten human dignity. Indeed, they might ultimately promote it or at least better clarify what we mean by it.

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# FURTHER AFIELD: Mind Reader v2.0

## By Lingjun Kong

Technology has advanced to a stage where the term "mind reader" is no longer mainly associated with the fortuneteller, but rather, a machine, especially in areas such as East Asia. Neuroscientists have reached the point in functional Magnetic Resonance Imaging (fMRI) technology to be able to actually read someone's mind. As ludicrous as that sounds, this indispensable tool in neurotechnology and cognitive research can determine several levels of basic thoughts. fMRI research, particularly in social cognition, personality, and emotion, have generated millions of dollars in government funding in Japan and China. The vast array of applications of a potential mind-reading machine, as well as the ethical implications that come with it, can drastically change society. However, at the current status of development, the level of "mind reading" that fMRI technology can determine is truly basic and at times inaccurate.

An fMRI scan is able to "read" minds by scanning a person's neural activity. A subject is scanned by the fMRI, during which he or she is given a stimulus, such as a question, an image or a video, causing oxygen to flow to certain parts of the brain through bloodstreams. Depending on the rate of oxygen flow, the mag-

netic properties of the oxygen-carrying hemoglobin in the blood change. The fMRI receives and interprets this information and transmits it into a running map of the areas of strong oxygen-carrying blood flow and brain activity. So, if a person responds to a stimulus in a certain way, scientists can see which part of the brain is firing, thus "reading" his or her mind.

Various studies have been undertaken to test the extent of this "mind reading" technology. Neuroscientists in China were able to identify seven years ago that the GO game player, a traditional Chinese strategy board game, indicated a stronger activation in the right parietal area of the brain, which contrasts the heavy use of the left side in similar games such as chess .One study aimed to predict a patient's intention to either add or subtract two numbers. Using fMRI scans, they were able to correctly predict his intention 71% of the time. Although showing a percentage notably higher than the fifty-fifty of an uneducated guess, this study is a clear interpretation of the early stages of fMRI applications of mind reading. Another study published in Nature presented a set of 1,750 images to patients, measuring the activity in specific areas of the visual cortex of the brain. Then, one-by-one, each image was presented to the patients, and the scientists were able to determine which image was being shown. Other studies have ventured into emotions and personality, testing patients' responses to virtual reality situations that would invoke stress or pleasure. Not only in the medical field, the possibilities of fMRI scanning at the areas of Neuromarketing, Neuroeconomics and Neuroforensics are also endless and only the tip of the iceberg has been studied.

**Neuromarketing: Coke or Pepsi?**

Several commercial businesses have been utilizing the powers of fMRI technology to gauge consumer preferences. Known as "neuromarketing," the use of neuroscience and clinical psychology for commercial gains has become a more and more popular application. To gain the powers of persuasion through advertising, neuromarketing has proven to be an influential tool. A study of the Brain Sciences Institute proposes that successful advertising does indeed cause consumers to be more emotionally engaged as well as more likely to remember the product. Another study conducted at Baylor College of Medicine suggests that neuromarketing may be part of the reason why people buy Coke when they prefer the taste of Pepsi. Even though neuromarketing can result in increased sales and better product design by matching consumer preferences, this interdisciplinary field is still young and only a few businesses have incorporated it into their advertising campaigns.

**Secrets of Weight Loss?**

In recent years, functional neuroimaging research has yielded a wealth of intriguing fodder for journalists but few scientific breakthroughs. We've learned, for instance, the nucleus accumbens brain regions light up when we fall in love, our reward centers of the brain light up more as a wine's price increases (even if the taste of the wine stays the same), and the brains of meditating monks show little change, since they exercise greater control over their frontal lobes. Functional MRI has begun to contribute to many psychological areas. For example, a study on weight loss has shown that those with greater success in weight loss programs can attribute their weight loss to greater inhibitory control in response to images of food when scanned with fMRI. At the other end of the spectrum, fMRI has been used to locate biomarkers in the brains of soldiers with posttraumatic stress disorder.

fMRI has already proven to be an extraordinary tool that few would have predicted to arrive so soon. The prospect of a machine capable of reading minds, peering into unconscious thoughts and reading a state of consciousness that is hidden even to the people themselves, will provide not only countless implementations and applications but many ethical challenges as well. The technology is still limited and as it develops, so must society. There should be no surprise that in the next decade, this "mind reader" will be used wildly in East Asia. Better tell those fortunetellers to look for new jobs.

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# Using Massive Multiplayer Online Games in Telehealth

▸ By Andrea Gaggioli et al.

Telehealth is the use of telecommunications services to deliver healthcare-related services and information, including (but not limited to) consultation, assessment, intervention, and follow-up programs to ensure maintenance of treatment effects. In past decades, the increasing diffusion of the Internet and related online tools has opened up a blend of possibilities for this approach. Medical professionals can now communicate with patients utilizing chat, e-mail and videoconference systems, in ad-

**Figure 1:** Group therapy in a MMOG.

dition to telephones. In this way, doctors can reach isolated and marginalized people such as rural, prison and military populations, as well as patients who are unable to travel due to transportation difficulties, cost or disabilities. Telehealth can help to maintain the primary care provider-patient relationship, while at the same time reducing overall costs by monitoring patients daily and preventing them from requiring emergency care and expensive re-hospitalizations. Thanks to these benefits, telehealth is rapidly becoming one of the most important ITC healthcare markets. According to a recent forecast by independent analyst Datamonitor, the global market for remote access health systems is growing rapidly and will exceed US$8 billion by 2012.

One of the most promising field of telehealth is telepsychology, the provision of psychological services in a technology-assisted environment. The advantages of this approach are similar to those offered by telehealth – patients can have direct and immediate access to geographically remote professionals and expertise, with the possibility for consistent and continuous care. A specific benefit provided by telepsychology is that clients can feel less inhibited, which foster further emotional involvement and disclosure. Individual therapy and on-line self-help groups are the most widespread applications of telepsychology. The first refers to the provision of individual therapy and consultation over the Internet. Online self-help groups refer to bulletin boards, chat rooms, news and discussion groups operated within health-related Web pages, list-servs (groups in which each individual message is copied and sent to all subscribers), and other electronic forums focused on the sharing and solving of psychological disturbances. The core principle of the on-line self-help groups approach is the sharing of experiences, strengths and hopes between members in order to solve their common problem.

Even if the available data about telepsychology programs are encouraging, this approach poses new and important challenges with respect to the anomalies of "being present" and able to meet other presences in virtual space, but with no physical body. Facial expressions, movements, tone of voice, and body gestures are commonly used by therapists to better understand the psychological status of patients and by patients to trust to the therapist, but they are at least partially missed during telehealth sessions. As a consequence, misunderstandings between a therapist and patients may arise due to the lack of these non-verbal clues. Moreover, telehealth applications do not allow multiple users to share the same mediated communication environment, that is, from a clinical point of view, the main characteristic of group therapy or self-help groups.

**The Potential of Using Massively Multiplayer Online Games in Telepsychology**

The emergence of Massively Multiplayer Online Games (MMOGs) may provide a useful approach to overcome the limits of current telepsychology applications. MMOGs are persistent social and material worlds characterized by the simultaneous presence of multiple users who can interact, through their self-created digital characters or avatars, using local chat, voice, instant messaging, and in some cases gestures and movements. One of the most popular MMOGs is Second Life, an Internet-based virtual world launched in 2003, developed by Linden Research. Users can interact with each other through motional avatars, explore, meet other residents, socialize, participate in individual and group activities, create and trade items and services from one another using a specific currency. MMOGs such Second Life have the potential to facilitate the clinical communication process by providing a more immersive and socially interactive experience for the patient, which can help to create higher levels of interpersonal trust, a fundamental requirement for establishing a successful therapeutic alliance. Results of recent studies on avatar-based social interaction provide

*"Telehealth can help to maintain the primary care provider-patient relationship, while at the same time reducing overall costs by monitoring patients daily and preventing them from requiring emergency care and expensive re-hospitalizations.."*

support for this idea. In one such study, Bente and colleagues investigated the experience of "social presence" as a relevant effect dimension of avatar-mediated net-communication. In this research, 142 participants were randomly assigned to one of five possible communication settings – text only, audio only, audio and video, audio and low fidelity avatar, audio and high fidelity avatar. Results revealed a significant difference between text and all other communication modes, indicating that audio, video and avatar systems work similarly and better than text alone in creating an experience of social presence. However, according to the authors, avatar platforms offer new possibilities to overcome many restrictions related to audio and video communication modes. In particular, they suggest that, "Virtual worlds and avatars could be seen more as a means to contextualize social interaction and to foster the salience of nonverbal information, rather than just to provide high fidelity transmission channels for visual cues. They are in this sense not just virtual equivalents of a video conferencing system but a possibility for active filtering and contingency management systems."

**Existing Applications of MMOGs in Telehealth**

The Brain Talk Industries have created a number of online communities and forums to support people affected by specific physical and mental disabilities. An example is the Brigadoon, a private island created in Second Life specifically designed for patients with Asperger's Syndrome, a form of Autism characterized by enormous difficulties in social interactions. Brigadoon is meant to serve as an ideal place for these patients to develop social abilities and interactions with other people dealing with the same problems. A similar aim has guided the creation of Live2Give, another place in Second Life dedicated to people affected by cerebral palsy. Like Brigadoon, this virtual world brings people together giving them the possibilities to help each other in their similar struggles. Similarly, a British organization called ARCI has developed a virtual environment in Second Life to help abused children learn important life skills. They enter the virtual world to learn to socialize, work as a team, and learn essential computer skills. The success of these virtual communities proves the potentiality of MMOGs in becoming very useful tools for an innovative form of telehealth.

In addition to these existing mental health programs, we can envision a possible therapeutic application scenario of MMOGs consisting of group therapy sessions performed in private areas. After a number of face-to-face sessions in which the therapist meets the patient in order to make a diagnosis and to analyze his or her needs, the therapist can decide if the patient is suitable for on-line group therapy. If this is the case, the patient will receive instructions on how to enter into the virtual space with a personal identification code. In order to guarantee privacy, only persons with a personal code will be admitted to the therapy rooms. Different therapy rooms will be created on the basis of the needs of different categories of patients and the access will be restricted only to those patients with a specific diagnosis. Various environ-



**Figure 2:** The creation of an Avatar.

**Figure 3:** The use of a MMOG in the treatment of Eating Disorders.

ments can be created for each category of patients, such as, for example, learning areas, discussion areas and experience-oriented areas. Learning areas use motivation provided by the virtual worlds to teach the users how to manage the critical aspects of their experience through slides and film presentation, both with and without teachers (Figure 1).

**Figure 4:** The typical MMOG interaction.

Discussion areas allow patients to talk about their problems and share experiences with others, with or without the supervision of an expert (see Figure 2).

Finally, experience-oriented areas will serve to practice both emotional and relational reactions, using the feeling of presence provided by the virtual experience, as well as general decision-making and problem-solving skills through the presentation of critical situations related to the different pathologies (Figure 3). Free access to an electronic library with books on specific arguments will also be provided for subjects in order to extend their theoretical knowledge at any time.

The main advantage of this MMOGs-based therapeutic scenario is to provide patients with live meaningful experiences instead of just theoretical information in a virtual environment in which they have the possibility to meet other users, socialize, participate in group activities and practice new abilities. Since MMOGs are closed worlds that do not reflect the real status of the users, during their presence in the virtual worlds patients could be instructed to use various bio and activity sensors in order to obtain real-time monitoring of their health status and feedback that can influence their own experience. At the same time, the use of biosensors allows the therapist to monitor, at distance, the outcome of the virtual experience. This approach – usually defined "interreality" and actually explored by the European funded project "Interstress" (http://www.interstress.eu) – can provide the following advantages – the outcome obtained from the virtual experience can be transferred to the real world and vice versa and the social links created in the virtual environments can be continued in the real world, even without revealing the user's identity (for example, by using SMS or e-mail to communicate or ask support from a virtual friend).

### Some Important Issues in the Use of MMMOGs in Telehealth

Although the therapeutic possibilities of online games are quite promising, the problems that could arise with such a kind of therapy should not be overlooked. In fact, if it is true that people can explore threatening aspects of reality in a "safe" environment, it also true that if the use of MMOGs becomes excessive, it could present a risk of preventing people from forming meaningful relationships in the real world. As observed by Dr. Sara E. Allison, M.D., from the Menninger Department of Psychiatry and Behavioral Sciences, Baylor College of Medicine in Houston, TX, an "increased substitution of cyberspace-based personas and relationships at the expense of face-to-face interaction may create a developmental double-edged sword. The Internet may provide a socially -anxious patient the opportunity for modified peer group interactions, yet it does little to foster the development of genuine intimacy." When exposing patients to virtual environments, therapists should consider the risk of game addiction and also encourage their patients to participate in real life social interaction as much as possible.

Regarding therapists, as for any other type of domain of practice, it is very important that they first conduct a self-assessment and then enhance their knowledge and skills in using these alternative forms of therapy, since the provision of telehealth services is not simply a click of the mouse nor is it fraught with pitfalls and malpractice suits. Most MMOGs have open access, meaning that it may be difficult to create safe therapeutic environments in which patients can interact with therapists without external interferences and with privacy protection.

In sum, the possibilities of using MMOGs as an advanced form of telehealth are quite promising as long as their limitations and dangers are taken into consideration as well. Further research is needed in order to understand the real added value of this emerging technology.

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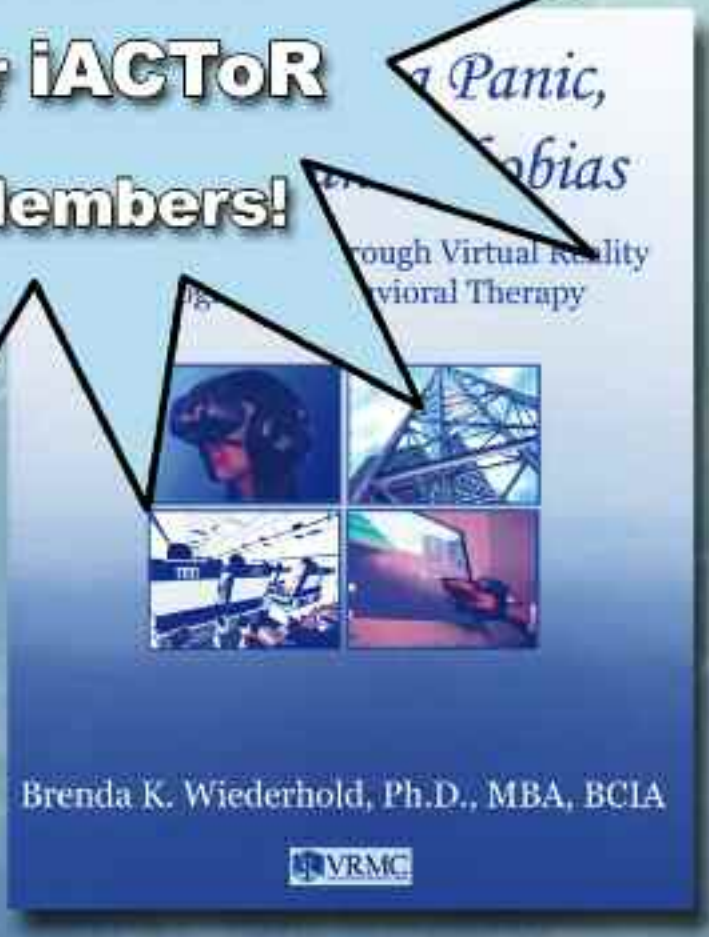


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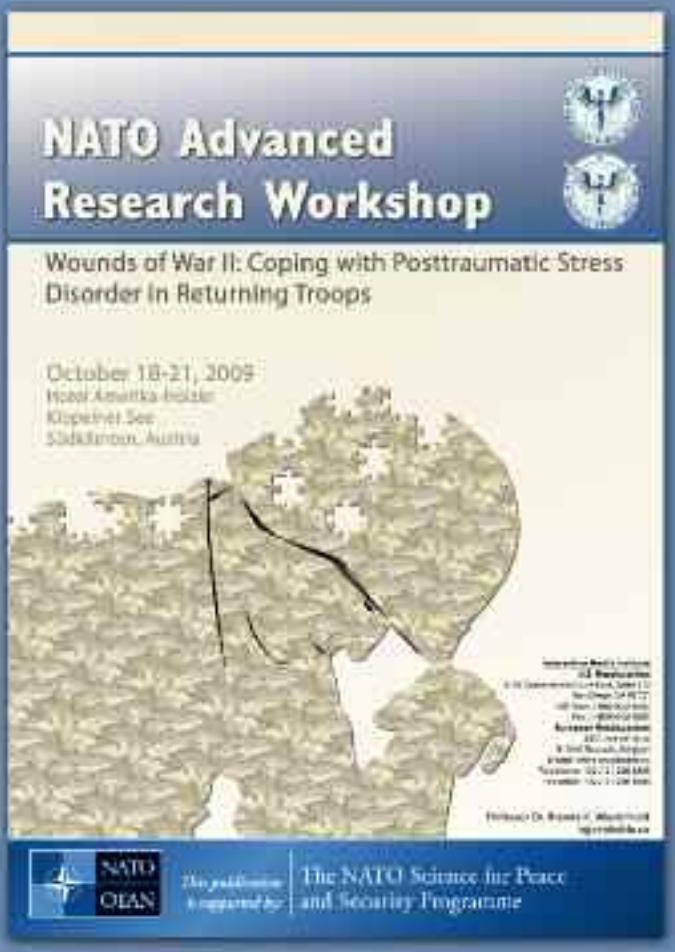
# Wounds of War II: Coping with Posttraumatic Stress Disorder in Returning Troops

**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 Klopeiner 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 Cosic and Professor Dragica Kozaric-Kovacic of Zagreb, Croatia and Colonel Carl Castro from the United States.

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> **COUNTRY** FOCUS

# C&R in Austria


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*Austria has a long, rich history of innovation in mental health, with scientists like Sigmund Freud, Alfred Adler, and Otto Rank laying the foundation for the world of psychology. Now, over half a century later, Austria remains one of the top contenders in the world of mental healthcare.*



After the disastrous events of World War II, Austrian psychologist Sigmund Freud began diving into the subconscious mind of humans in an attempt to uncover the intimate relationship between the mind and human behavior. Freud's theories of the subconscious, along with methods like psychoanalysis, quickly piqued the interest of scientists in the world of psychology.

In 1902, Freud formed the Vienna Psychoanalytic Society, inviting close colleagues Alfred Adler, Otto Rank, and a few others, to join him in discussing different ideas about psychology and neuropathology. Their theories being new areas of study, Freud's society dominated psychology until new and more promising theories surfaced, alongside medical knowledge and technology.

**A Proactive Stance on Mental Healthcare**

Mental health is becoming increasingly recognized as a global problem, and for the eight million inhabitants of Austria, mental health means more than the mere presence of mental disorders. It focuses on health promotion, the debilitating effects of mental disorders, and prevention.

Mental disorders represent about half of the leading causes of disability. Disorders related to anxiety and depression are increasingly becoming the main cause for early retirement, disability pensions, sick leave, and early onset of dementia. Until recently, care for the mentally distressed was left under the control of the national healthcare system, which was quickly crumbling under its own weight.

Now, the federal government allocates healthcare to Austria's nine provinces. Under Austria's healthcare system, 99% of the population is covered, ensuring access to healthcare without any financial burdens.

However, the fragmented arrangement of earlier years, as related to the allocation according to the provinces, resulted in a disorganized compilation of data, especially when it came to mental healthcare prevalence and practices. Up until the 1970s, Austria's psychiatric care operated under a two-tier system. The first consisted of ten large mental hospitals and three small university departments responsible for in-patient treatment, housing a total of 12,000 patients. A survey conducted in 1974 showed that 85% of these patients suffered from schizophrenia, mental retardation, or dementia, nearly 60% had been hospitalized for more than two


| | |
|---|---|
| Population (Billion) | 1.3 |
| Percentage of Urban Population | 45.4% |
| Unemployment Rate | No Official Rate |
| Life Expectancy (Years) | 71.9 |
| Fertility Rate | 12.14 |
| Mortality Rate | 7.06 |
| Psychiatrists (per 100,000 Inhabitants) | 1.26 |
| Suicide Rate (per 100,000) | 23 |
| Total Hospitals | 19,712 |
| Psychiatric Hospitals | 598 |
| Psychiatric Hospital Beds (per 100,000) | 7,175 |
| Psychiatric Hospital Inpatients Yearly | 742,905 |
| Psychiatric Hospital Patient Yearly Number of Visits | 16,305,419 |
| Extrapolated Prevalence to Schizophrenia | 1% |
| Extrapolated Prevalence to Anxiety Disorders | 5.6% |



years, and more than 90% were held involuntarily.

The second tier was made up of a few dozen "neuropsychiatrists" running solo practices, treating both neurological and psychiatric outpatients. Little communication between the two tiers was only one problem that this system faced. A new system was needed in order to keep up with the increasing number of people affected by mental disorders in the rapidly changing industrial world.

Reforms in all nine provinces were swiftly underway. Presently, they embrace a more community-based system. The prominent large hospitals were replaced by over 40 smaller psychiatric in- and day-patient facilities. Under the funding of social security, other similar services were established, such as residential facilities, day structures, and ambulatory care units. Neuropsychiatry was also divided into two different specialties, neurology and psychiatry, and new professions such as clinical psychology and psychotherapy emerged.

These changes addressed issues that were overlooked by the previous two-tier system. For example, suicide rates noticeably decreased since the adoption of this new system. This was partly due to the improved structure for the early recognition of mental disorders, as well as greater attention to problems in the workplace, attempts to anti-stigmatize mental disorders and making access to help more available.

**Technology as a Tool for Reform**

Reforming the healthcare system is not the only way that Austria has chosen to help improve mental health within their country and throughout the world.

As a global leader in biotechnology, Austria's technological advancements and biomedical research have facilitated mental health treatment.

In 1997, Austria's largest hospital, AKH of Vienna, purchased a ROBODOC Surgical Assistant System. ROBODOC is a robot that is used by orthopedic and trauma surgeons to accurately assist with surgery.

Austria has also built up a strong reputation of high quality medical care along with excellent patient care. In 2007, the European Health Consumer Index ranked Austrian healthcare at number one, and in 2008, it was listed among the top three most consumer friendly healthcare systems in Europe. To obtain such a high rank, Austria ensures short waiting times for doctor consultations and surgery wait lists, as well as direct access to doctors. Austria's dedication to pa-


tient care, and its promising medical results, has been rewarded with worldwide recognition.

**Willkommen in der Zukunft**

In 2002, the Upper Austrian Health Cluster was established as a network of various sectors, aiming to strengthen international competitiveness and promote innovative medical technology by bringing together European countries with similar fields of interest, while meeting the needs of small and medium-sized enterprises (SME). This network has had a tremendous influence on medical technology research and development. Over 216 companies are partnered with Upper Austria, 90% of which are SMEs.

G.tec, Guger Technologies, is a medical and electrical engineering company in Graz, Austria that has been working on developing systems for biosignal data acquisition and analysis, for research and healthcare applications. G.tec specializes in real-time processing systems. "One of the main application areas is the usage of EEG to control a brain-computer interface for handicapped people," says G.tec CEO, Christoph Guger. In one of their most recent projects, called Presenccia, G.tec set out to build a better Virtual Reality (VR) system, alongside 15 European partners. Improving the hardware and software components of VR systems, and looking at VR's scientific background, helps to understand the system better in order to find new ways for improvement.

For example, "It is not so important that avatars look very realistic," says Guger, "but it is important that avatars have eye contact and head motion." Guger also stresses the importance of working with other research institutions, especially since Austria is such a small country. G.tec has roughly 50 partners throughout Europe and the U.S., where research is being conducted. It sells products to more than 60 countries worldwide, and has around 20 distribution partners in the U.S., Europe, and Asia. G.tec's goal of developing software capable of real-time analysis of brain functions would open so many more windows into understanding the brain, and could potentially provide solutions to many mental disorders.

Universities are also very active in developing technology that can be used to treat psychological disorders. Dr. Andreas Schrempf from the Upper Austria University of Applied Sciences describes how the main areas of focus of the degree program are studying the biomechanics of the musculoskeletal system, and rehabilitation engineering. "The main concern is to develop medical devices for preventative care, diagnosis, therapy, and rehabilitation," says Schrempf. At the university, their labs are equipped with 3-D and real-time devices that measure muscular forces and pressure, as well as eye-movement and other variables. Their latest project was an intelligent bed that measured nightly activity and weight loss.

Intelligent furniture is one of the latest advancements in medical devices, and the university makes it a priority to develop other in-home devices that will assist with people's physical and psychological needs. Schrempf says that in the future, it will be important to research interdisciplinary fields because it allows researchers to "integrate the know-how from different fields like ICT [Information and Communication Technologies], biomedical engineering and material engineering in order to address future challenges." The Upper Austria University is working together with other universities in Europe and throughout the world to advance medical technology.

With companies like G.tec studying the brain using real-time VR systems and universities developing medical devices, Austria bridges the gap between how the brain functions and how this knowledge can be applied to everyday life activities. With a plethora of international collaborations, Austria welcomes new research from all fields of study in order to expand the scope of their knowledge. Despite its small size, Austria's status rises consistently as it continues to improve the lives of its citizens and people throughout the world.

**Sources:**

Personal communication with Christoph Guger, Ph.D. and Andreas Schrempf, Ph.D., CBS Business Network and Austrian Mental Health Reports.

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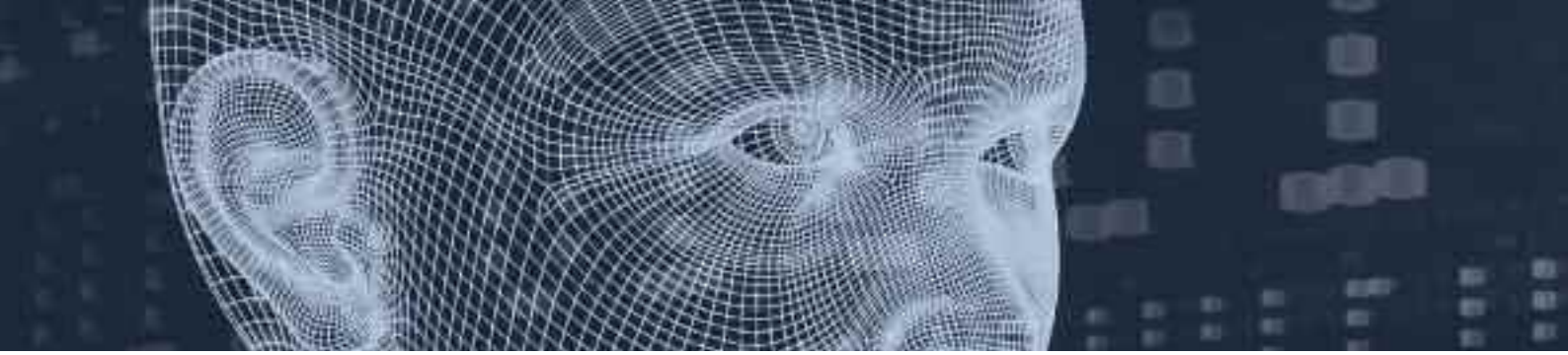

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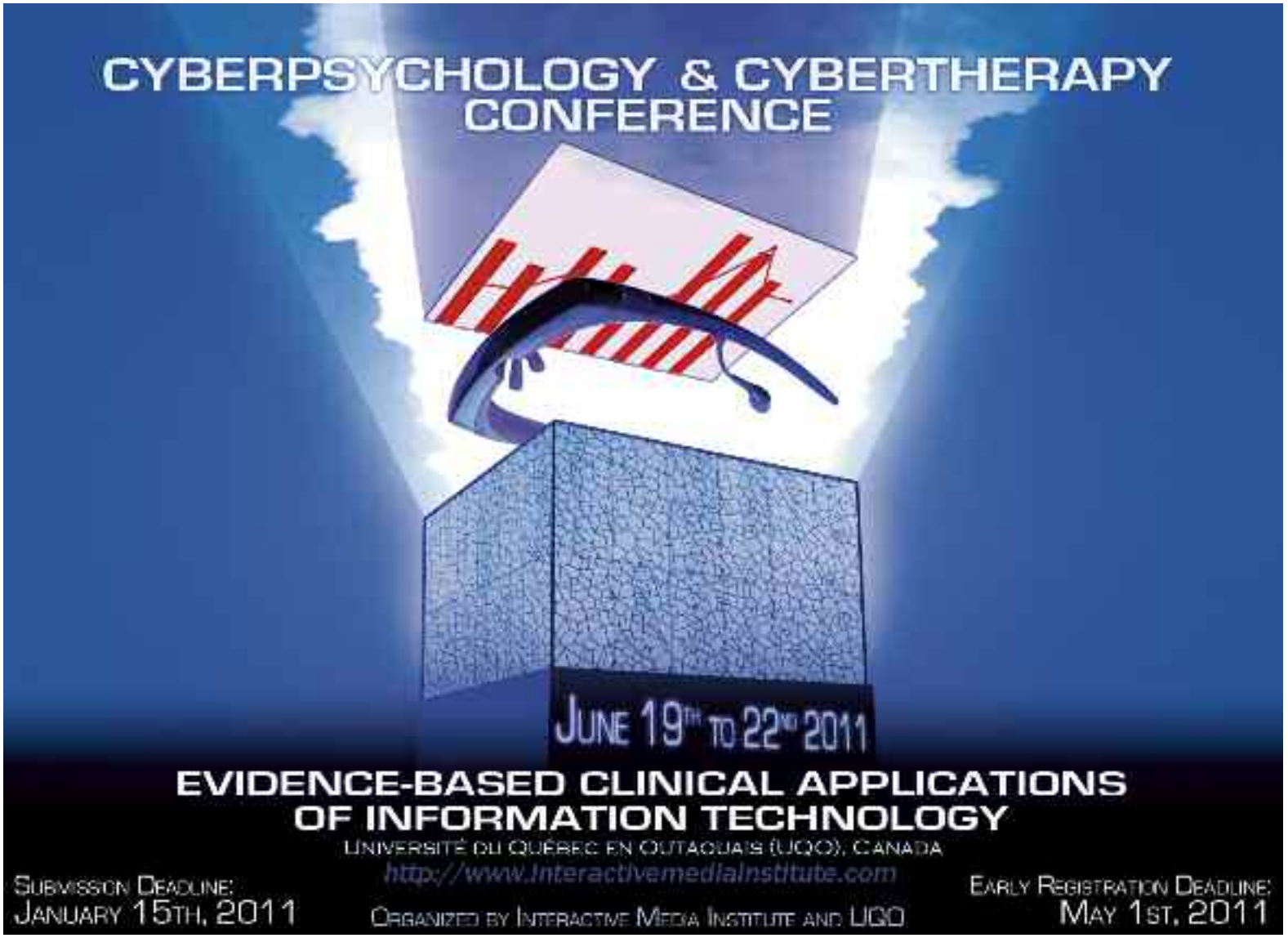
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