



JCR

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In This Issue

Abstracts from the “Beyond Brain Machine Interface: Motor, Cognitive and Virtual” Pre-Conference Workshop

Human-Machine Visual Digest

Brain-Computer Interface Research: EEG- and ECoG-Based Paradigms

A NeuroVR-Based Version of the Multiple Errands Test for the Assessment of Executive Functions: A Possible Approach

Biofeedback, VR and Mobile Phones in the Treatment of Generalized Anxiety Disorder (GAD): A Phase-2 Controlled Clinical Trial

Reliability and Validity of the Nintendo® Wii Fit™

Trapped in the Web: The Psychopathology of Cyberspace



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Journal of CyberTherapy & Rehabilitation

Winter 2009
Volume 2, Issue 4

-
- 269 **Editorial**
B. Wiederhold
- 271 **Abstracts from the “Beyond Brain Machine Interface: Motor, Cognitive,
and Virtual” Pre-Conference Workshop**
- 279 **“Human-Machine Visual Digest”**
Y. Cai, G. Milcent & R. Franco
- 289 **“Brain-Computer Interface Research: EEG- and ECoG-Based Paradigms”**
R. Scherer, F. Darvas, J. Ojemann, Y. Matsuoka & R. Raoa
- 299 **“A NeuroVR-Based Version of the Multiple Errands Test for the Assessment of
Executive Functions: A Possible Approach”**
S. Raspelli, L. Carelli, F. Morganti, G. Albani, R. Pignatti, A. Mauro, B. Poletti,
B. Corra, V. Silani & G. Riva
- 315 **“Biofeedback, VR and Mobile Phones in the Treatment of Generalized Anx-
iety Disorder (GAD): A Phase-2 Controlled Clinical Trial”**
F. Pallavicini, D. Algeri, C. Repetto, A. Gorini & G. Riva
- 329 **“Reliability and Validity of the Nintendo Wii Fit”**
L. Gras, A. Hummer & E. Hine
- 337 **“Trapped in the Web: The Psychopathology of Cyberspace”**
T. Cantelmi & M. Talli
- 351 **CyberProjects**
- 352 **CyberFocus**
-

EDITORIAL

Welcome to the Winter 2009 issue of the Journal of CyberTherapy & Rehabilitation (JCR). We are pleased to bring this special issue of our publication to readers, critics and researchers around the world. Our peer-reviewed academic journal explores the uses of advanced technologies for therapy, training, education, prevention and rehabilitation. JCR is a quarterly published academic journal, unique in the fact that it focuses on the rapidly expanding worldwide trend of applying groundbreaking technology towards the field of healthcare. Psychiatry, psychology, physical medicine and rehabilitation, neurorehabilitation, oncology, obesity, eating disorders and autism continue to be main areas of interest studied by JCR.

Since our inaugural issue, JCR has received international attention from peers, international institutions and international conferences. A common thirst for new knowledge and application of cutting-edge technologies to better the lives of others brings this diverse group of people towards a similar goal. Advanced technologies, such as robotics, adaptive displays, E-health, virtual reality (VR) and non-invasive physiological monitoring are now applied to many diverse fields of healthcare. As this body of research is added to, patients, doctors and therapists can look towards a hopeful future and new ways to treat mental and physical disorders. Within this issue of JCR, we present comprehensive review articles submitted by preeminent scholars in the field. The content is diverse, featuring such topics as VR immersions, the effects of video game playing and even online forums to treat sufferers of disease.

This special issue of JCR includes three full papers, as well as all presented abstracts, written by presenters from the "Beyond Brain Machine Interface: Motor, Cognitive and Virtual" pre-conference workshop, held September 2, 2009 in Minneapolis, Minnesota. The conference, co-organized by the Army Research Office, IEEE EMBS and the Interactive Media Institute, educated attendees on more efficient and intuitive ways of

achieving system control than manual manipulation and allowed for discourse among academics, members of the scientific community, biomedical device engineers and the clinician user community. Scientists from five different countries and ten diverse institutions gathered to discuss these technologies and developments in their fields of research, and gave formal presentations on their papers.

In this issue's first article Cai, Milcent and Franco explore the human-machine visual digest system by focusing on the relationship between gaze and object. They describe ways to better utilize network bandwidth and in turn, minimize the resulting media footprint by combining human vision and machine vision.

Next, Scherer et al. discuss brain-computer interface research using EEG and ECoG-based paradigms that are presented to the reader, along with ways to improve information transfer rates. Different BCI projects are discussed, such as an anatomically correct testbed for a human hand model.

In the following article, Raspelli et al. conduct further research on the Multiple Errands Test, applying virtual reality to assess executive functions in patients suffering from Parkinson's disease and stroke.

In the fourth manuscript, Pallavicini et al. report findings on a study to treat sufferers of Generalized Anxiety Disorder using biofeedback, virtual reality and mobile phones. The use of mobile phones allowed patients to continue treatment in an outpatient setting and addresses the classic problem associated with VR therapy—the lack of mobility for the treatment system.

Gras, Hummer and Hine, in the fifth manuscript, compare the reliability and validity of the Nintendo Wii Fit to the widely used NeuroCom EquiTest, to measure balance and help rehabilitate patients.

Lastly, Cantelmi and Talli explain the psychological

and psychopathological risks associated with overuse of the Internet, including the problems associated with defining a relevant syndrome, possible diagnostic criteria and possible therapies for treatment.

This issue of JCR will continue to explore the ways in which healthcare, in Europe and worldwide, can benefit from the applications of technology. I would like to sincerely thank the contributing authors for their inspiring work and dedication to this field of research. I also want to thank JCR's Associate Editors – Professor Botella, Professor Bouchard, Professor Gamberini and Professor Riva for their leadership and hard work, as well as our internationally renowned Editorial Board for their con-

tributions. We encourage readers and subscribers to contact us with ideas and manuscripts. Your input continues to enrich our publication. Looking to 2010, we are optimistic as this diverse field continues to grow and attract those wishing to learn more and those already supporting and implementing new technologies. With only more room to grow, we will continue to bring you news of further developments in the upcoming year.

Brenda K. Wiederhold, Ph.D., MBA, BCIA
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Abstracts from
**“Beyond Brain Machine Interface:
Motor, Cognitive, and Virtual”**

September 2, 2009
Minneapolis, Minnesota, U.S.A.

ABSTRACTS

Neurophysiological Basics for Brain-Machine Interface: Motor, Sensory, and Cognitive Rehabilitation and Limitation

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Decades of research have improved the brain-computer interface to allow people with severe disabilities to communicate their thoughts through recorded electroencephalographic signals along the scalp non-invasively. Recently, brain-machine interface based on neuroprosthetics for motor function has been inspired by successful demonstrations of controlling movement of computer cursors or even actual robots to perform meaningful tasks of feeding by control commands converted from cortical neuron activities from implanted intra-cortical electrode arrays. There are also active research efforts to pursue neuroprosthetic systems for recovery and enhancing sensory and cognitive functions.

In this lecture we will briefly review the techniques and neurophysiological basis of brain-machine interface based approaches for motor, sensory and cognitive function recovery and improvement. Finally, we will start a discussion on limitations and future directions of the field of BMI-based neuroprosthetics.

Consolidation of Prosthetic Motor Skill in Primates

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Research in Brain-Machine Interfaces (BMIs) has led to demonstrations of rodents, non-human primates and humans controlling prosthetic devices in real-time through modulation of neural signals. In particular, cortical BMI studies have shown that improvements in performance require learning and are associated with changes in neuronal tuning properties.

As these studies incorporated variable ensembles of neurons from day to day, and required daily modifications to the transform of cortical activity into motor output, little is known about long-term consolidation of prosthetic motor skill. Here we demonstrate consolidation, defined as motor skill that is retained, readily recalled and resistant to interference, in two macaque monkeys performing a center-out reaching task using a brain-controlled computer cursor under visual feedback. When a fixed transform was applied to stable recordings from an ensemble of primary motor cortex (M1) neurons across days, there was dramatic long-term consolidation of prosthetic motor skill.

This process created a directional tuning map for prosthetic function that was stable across days. Surprisingly the same set of neurons could encode a second motor map without interference with the first map. In contrast, daily modification of the transform, in a manner similar to past studies,

resulted in variable performance and an unstable motor map. Taken together, our results demonstrate that the primate brain can achieve skilled control of a neuroprosthetic device through consolidation of a motor memory.

BCI-based Robotic Rehabilitation for Stroke

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Stroke is the third leading cause of death and the leading cause of severe disabilities in the developed world. Stroke causes neurological damage to certain portions of the brain, and surviving portions of the brain are capable of altering functional activity in a vicarious manner to provide a substrate for recovery. Current research is directed at understanding how this neuroplasticity phenomenon may be modulated to develop more effective therapeutic interventions such as neurorehabilitation for stroke. Robotic neurorehabilitation is motivated by alleviating the labor-intensive aspects of physical rehabilitation by a human therapist and by enabling novel modes of exercise not currently available. Current studies have shown that robotic neurorehabilitation helps improve motor recovery of chronic stroke patients.

Brain-Computer Interface (BCI) is a communication system that directly translates brain signals into commands for controlling an external device, which bypasses the normal motor output pathways. The brain signals can be acquired by scalp-recorded electroencephalogram (EEG) non-invasively from a subject. Studies have shown that distinct mental processes such as Event-Related Desynchronization or Synchronization (ERD/ERS) are detectable from EEG measurements for both real and imagined motor movements in both healthy subjects and stroke patients. Studies have also shown that it was useful for stroke patients to perform motor imagery during their rehabilitation exercises, but direct use of motor imagery

based BCI for stroke rehabilitation was not intensively studied and tested in the clinical setting until recent years.

It is hypothesized that a motor imagery based BCI could provide an effective guide (through visual feedback) for a stroke patient while a robot provides useful sensory feedback. Hence, the synergy between BCI in the detection of motor intent from stroke patients and current robotic neurorehabilitation is promising. We started a clinical study on stroke rehabilitation with a BCI-controlled robotic system. This system enables stroke patients to make use their motor imagery to relearn motor control and improve their cognitive capacities at the same time. The clinical protocol and results will be discussed in detail.

BCIs Based on the Detection of High Gamma Oscillation in ECoG and EEG

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Brain-computer interface (BCI) technology augments the human capability to interact with the environment by directly linking the brain to artificial devices. In the recent past, BCIs provided simple 1D control in order to select targets or to trigger pre-defined motion sequences. Today, users have on-demand access to assistive robotic devices, Virtual Reality and to standard software applications such as Internet browsers or Google Earth. These accomplishments, together with technological and neuroscientific advancements have lead to more ambitious goals, e.g. the restoration of lost motor or sensory function. Such goals are within reach with invasive recording technologies. The electrocorticogram (ECoG), usually obtained from the brain surface in epilepsy patients, has high spatio-temporal resolution and higher signal-to-noise ratio compared to the non-invasive electroencephalogram (EEG). In fact, our

latest results demonstrate that contralateral and ipsilateral finger movements can be accurately classified from high gamma (70-120 Hz) ECoG oscillations recorded from a single hemisphere. These findings have important implications for neurorehabilitation, suggesting, in particular, the possibility of regaining ipsilateral movement control using signals from an intact hemisphere after damage to the other hemisphere.

The non-invasive EEG, however, still plays the most important role for practical applications. The non-stationarity and inherent variability of EEG require time consuming training and mutual adaptation of both, the human brain and the machine. Ideally we aim to achieve the fidelity of ECoG with non-invasive techniques. Inverse mapping techniques can provide some amount of spatial unmixing of EEG signals and thus produce ECoG-like signals. Using these techniques, we demonstrate that mapped EEG can provide BCI signals similar to ECoG. We identify two control parameters in the high gamma frequency range in EEG: spatially localized power increases and bihemispheric phase-locking.

Non-Invasive Brain Controlled Robots

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The idea of moving robots or prosthetic devices not by manual control, but by mere "thinking" (i.e., the brain activity of human subjects) has fascinated researchers for the last 30 years, but it is only now that first experiments have shown the possibility to do so. Such a kind of brain-computer interface (BCI) is a natural way to augment human capabilities by providing a new interaction link with the outside world and is particularly relevant as an aid for physically disabled people. Key elements for a successful BCI are real-time feedback and training, of both the subject and the classifier embedded into the BCI.

In this talk I will review our work on non-invasive asynchronous BCI, with a focus on how brainwaves can be used to directly control robots. Most of the hope for such a possibility comes from invasive approaches that provide detailed single neuron activity; however, it requires surgical implantation of microelectrodes in the brain. For humans, non-invasive systems based on electroencephalogram (EEG) signals are preferable but, until now, have been considered too poor and slow for controlling rapid and complex sequences of movements. Recently we have shown for the first time that online analysis of a few EEG channels, if used in combination with advanced robotics and machine learning techniques, is sufficient for humans to continuously control a mobile robot and a wheelchair. Finally, we discuss current research directions we are pursuing in order to improve the performance and robustness of our BCI system, especially for real-time control of brain-actuated robots. In particular, I'll mention work on recognizing cognitive states that are crucial for interaction.

Non-Invasive Brain Controlled Robots

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**Cognitive Integration of Prosthetic Devices:
Is it Feasible?**

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Technology has impacted human life in many different ways, but has followed a predictable evolutionary path characterized by the creation of artificial systems that have either been controlled explicitly by human limbs or have been made autonomous. The latest push has been characterized by the overwhelming use of digital computers and artificial intelligence/signal and pattern recognition algorithms. The research trend has progressively shifted towards autonomous platforms and has shown the difficulties of creating robust, truly intelligent behavior. In any case, machines are perceived as external and independent of our own bodies. The objective here is to revisit the human machine interface paradigm and provide broadband control of external machines directly through brain processes to capitalize both on the merits of biological information pro-

cessing/intelligence and on man-made external devices that will enhance the reaction time, force, scale, physical locality, sensing of biological sensors and actuators.

We are at the brink of a revolutionary technology stage, where machines may be “cognitively integrated” in the human experience, manipulated and controlled through direct brain processes in virtually the same way as we see, walk or grab an external object. But unlike the current generation of brain machine interfaces, this is done through a dialogue that requires only that goals between the machine and the user coincide. The vision is a new kind of implanted prosthetics that senses intentional brain processes (e.g. moving an arm) and translates the spatio-temporal neural signals into models that control external devices. Through the perception action reward cycle the brain is made aware of the machine existence and actions, which will provide the basis to be considered a body extension. Several key technological and scientific developments will be discussed to implement this vision.

**Cognitive Science and Human Factors Issues in
Non-Manual Control Devices**

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As display technologies become miniaturized (and even embedded in the human), and as more of the tasks one does become computer-based, the traditional interface technologies that lie on keyboard input is beginning to shift to non-manual control devices (NMCD). It is however difficult to argue pre ante that an interaction device that is non-manual is an automated version of control (otherwise known as automatic control devices). I mention this so as to be clear about the intent of my presentation which argues for the challenges of NMCD rather than automatic control devices.

Historically, the development of computer interfaces has been a technology-driven phenomenon. The progress to tap into the human characteristics and interaction deficiencies led to the consideration of multi-

modal-multisensory interfaces (MMI).

Current progress in MMI have considered human speech, gesture, gaze, movement patterns, and other complex natural behaviors, which involve highly automatized skills that are not under full conscious control of the human operator. These are to some extent variants of NMCD. For example, in collaborative work environments, a large display may be fixed, but users move about the room, interacting with each other with small, mobile input devices. Thus, it can be surmised that most NMCD are sensory driven. Thus, cognitive science imperatives and human factors issues must be addressed so as to realize the full benefits of NMCD during human control of actions with these devices. This is necessary since sensory modalities span across the integration of human and system-level sensors such as visual (e.g. gaze), auditory (e.g., voice), haptic (e.g., hand movements, sign languages; lip reading, and the use of head movement for pointing). Obviously (although not completely), sensory information processing tends to be a cognitive task.

This paper will give a proposition on the cognitive science and human factors foundations of NMCD. The essential roles of multimodal, multisensory information integration, including the interpretation and use of such information for control of behaviors in task space, both spatially and temporally will be discussed, as well as the properties of different sensory modalities within NMCD components and the information content they carry.

In addition, this paper describes the important role that NMCD plays in information acquisition and processing in complex battlefield information systems. Specifically, the followings are addressed:

1. Interpretation of NMCD information at the semantic, syntactic, and pragmatic levels of system abstraction.
2. Cognitive aspects of NMCD information processing and sensemaking, such as how meaning of interacting multisensory information are derived, and how the derived information leads to understanding of dynamic contexts.
3. Human factors challenges in developing performance metrics, as well as the ergonomics issues when NMCD mechanisms are embedded into the human operator.
4. Implications of NMCD to interface designs for military systems are discussed.

Non-Manual Visual Digest Networks

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Attention, understanding and abstraction are three key elements in our visual communication that we have taken for granted. These interconnected elements constitute a Visual Digest Network. Here we investigate the non-manual visual digest networks at three visual abstraction levels: gaze, object and word. The goal is to minimize the media footprint during visual communication while sustaining essential semantic data. The Attentive Video Network is designed to detect the operator's gaze and adjust the video resolution at the sensor side across the network. Our results show significant improvements in network bandwidth utilization. The Object Video Network is designed for mobile video and vehicle surveillance network applications, where faces and cars are detected. The multi-resolution profiles are configured for media according to the network footprint. The video is sent across the network with multiple resolutions and metadata; controlled by the bandwidth regulator. The results show that the video is able to be transmitted in the low-bandwidth conditions. Finally, the Word-Image two-way mapping network is designed for face reconstruction across the network. In this study, we assume the hidden layer between the facial features and referral expressive words contain 'control points' that can be articulated mathematically, visually and verbally. From our prototypes, we see the potential of the non-manual visual digest networks using gazing, talking and machine vision.

Integrating Hands-free Interface into 3D Virtual Reality Environments

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Summary

Navigating in the Virtual Reality (VR) scene^{3,4} or playing a video game often accomplished by a transformation of human control over the VR or gaming device. This transformation is usually achieved by using a joystick or other hand-held controlled Systems¹⁴. Here we present an alternative and novel approach towards hands-free interface device for VR and videogames control, i.e. a sensor shirt². It consists of 52-sensors woven inside the garment. This kind of interface with VR or other gaming devices, offers both portability and unobtrusive user movement in a VR environment.

This paper addresses the systems engineering aspects of the solution, and presents the initial results and future research directions. Participants navigated a VR scene using natural body movements that were detected by their wearable sensor shirt and then mapped to electrical control signals. The initial results are promising, and offer many opportunities for use in other applications.

Motivation

A 52-piezoresistive sensor shirt, as reported in^{2,6}, was integrated with a fully immersive 3D VR environment. The sensor shirt behaved as a hands-free input device by detecting and then translating body movements into electrical control signals. This preliminary setup can be used for applications in multimedia and animation, motion tracking, robot-aided rehabilitation¹ and video game development. The proposed system is likely to cut labor costs as discussed in³. In the area of rehabilitation, the sensor shirt is easy to deploy and affords the patient comfort whilst navigating in a VR environment. Other alternatives require specific seating positions and recalibration procedures after short intervals⁵. A great advantage of the system is related to the high number of sensors: the redundancy in the sensor set makes possible to obtain the same control pattern with different body motions and lets the user choose which is the control scheme he prefers (i.e. the body motion patterns used to perform a certain action in the VR scene). By exploiting

this concept, the control scheme will be adapted and personalized to the user.

Results

This article describes a novel method for navigating in a VR environment using smart sensing garment technologies. A wearable multi-sensor shirt that can detect upper body (wrist, elbow and shoulder) movements, was custom built to generate electrical control signals from residual movements. A combination of VR and signal processing methods were used to develop an effective body-machine interface to perform tasks. The sensor shirt was worn by a participant shows the front side of the sensor shirt), and the analogue signals originated from the shirt were converted into digital signals by a National Instruments analogue-to-digital converter. The digital output was read in Matlab Realtime Windows Target and the processed signals were sent as unified datagram protocol (UDP) packets to the VR software. Following a calibration phase and an initial training phase in the VR environment the user was capable of learning how to move in the VR scene. From an initial starting point in the VR scene, the control signals generated by the participant's movements were used to move the participant in VR. The sensor shirt was used with the VR system continuously for one hour without recalibration. Error measurements were calculated in the shoulder sensors outputs after 20 minute and 60 minute intervals. The results show the complete stability of the system (for at least an hour without recalibration), ease of deployment and comfort.

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**Virtual Reality Feedback to Target
Cortical Remapping**Eugene Tunik^{a,1} and Sergei Adamovich¹*Corresponding author:*

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Though the traditional human-computer interface (HCI) field focuses on extracting usable neural signals to control a computer device, it is equally important to understand how interacting with a computer device affects neural activity. This issue relates to a longstanding challenge in rehabilitation; that is whether and how clinicians can tailor technology to facilitate cortical reorganization in select brain regions of patients. We present data demonstrating that visual feedback illusions in Virtual Reality (VR) that are time-locked to actual movement can be a potent signal to the motor.

We asked three healthy subjects and two patients who have had a stroke more than six months ago, to perform a simple finger sequence (index-middle-ring pinky) with their dominant right hand (healthy subjects) or their unaffected hand (patients). During the task, we simultaneously acquired

brain activation using functional MRI (fMRI) and hand kinematics (using an MRI-compatible data glove).

Hand motion animated either an ipsilateral (corresponding) or contralateral (mirrored) virtual hand model. In a visual feedback control condition, the virtual hand models were replaced with nonanthropomorphic ellipsoids. To also understand if brain activation would depend on training, the patients performed this task over three sessions, with a period of intense VR-based rehabilitation between the second and third fMRI session.

In the healthy subjects, the virtual mirrored feedback led to significant activation of the motor cortex ipsilateral to the moving hand. In the patients, no significant activation was noted in motor or premotor areas in first two baseline sessions. However, increased activation in the ipsilesional motor cortex occurred in the third session, despite the absence of active involvement of the ipsilesional motor cortex in this condition.

The contralesional motor cortex was also recruited in this condition (though the activation was weaker); activation which was not attributed to the movement of the hand since the control condition which had equivalent movement was subtracted from this contrast. In summary, our data suggest that virtual mirrored visual feedback may have had a facilitatory effect, which is amplified in patients after training in VR. These findings may have important implications for the development of novel therapies in the acute phase, when paresis and the potential for neural remapping are greatest.

HUMAN-MACHINE VISUAL DIGEST

Yang Cai¹, Guillaume Milcent¹ and Rafael Franco¹

Human vision is an information digest process in which attention, understanding and abstraction are three key elements. In this paper, we present an architecture of the human-machine visual digest system at two visual abstraction levels—gaze and object. By combining human vision and machine vision, we aim to minimize the media footprint during visual communication while sustaining essential semantic data. The system is designed to detect the operator's gaze and adjust the video resolution at the sensor side across the network. Our results show significant improvements in network bandwidth utilization. The machine vision system is also designed for mobile video network applications, where faces are detected. The multi-resolution profiles are configured for media according to the network footprint. The video is sent across the network with multiple resolutions and metadata, controlled by the bandwidth regulator. The results show that the video is able to be transmitted in the low-bandwidth conditions. By combining attention detection and pattern recognition, human and machines can interact at understanding and abstraction level.

Keywords: Attention, Video, Multiple Resolutions, Bandwidth, Semantic Network

INTRODUCTION

To our eyes, information is often redundant. We only pay attention to a very small portion of the information around us (Arnham, 1969). We often omit details by using diagrams, gestures, signs, symbols, icons, thumbnails, and words to represent complex images. This abstraction process is called a “visual digest,” which enables us to communicate in minimal means. A visual digest is not the same as an image compression that is context-independent. Rather, it is based upon understanding of the context. Visual digest is abstract in order to reserve the structure, dynamics or interaction but still in a visual form. Arnham calls it representational abstraction (Cai, 2003).

Attention, understanding and abstraction are three key elements in our visual communication that we have taken for granted. These interconnected elements constitute a “visual digest network.”

Human vision is driven by attention (Allport, 1993). The center of our gaze where we are looking, called the fovea, has the highest possible visual acuity. However, in the pe-

ripheral visual field, we have surprisingly low visual acuity. We are not conscious of this because we instinctively direct our center of gaze to where we are looking. Our foveal vision is optimized for fine details, and our peripheral vision is optimized for coarser information.

Human attention is guided by purpose. Humans selectively look at objects that are interesting. Furthermore, humans anticipate objects that are familiar. Cognition psychologist Yarbus (1967) uses eye tracking systems to study the gazing path of the human visual information process. He demonstrates that the gaze pathways are different if the viewers are asked different questions about a painting. To understand the imagery data, viewers have to know the name of objects and the relationships among them.

Given a method to detect gaze and objects, how do we encode our visual information in multiple resolutions to minimize the communication load and maximize the efficiency for information retrieving? Figure 1 illustrates the architecture of a visual digest network.

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BRAIN-COMPUTER INTERFACE RESEARCH AT THE UNIVERSITY OF WASHINGTON: EEG- AND ECOG-BASED PARADIGMS

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The development of practical brain-computer interfaces (BCI) is proceeding rapidly and devices can now often provide control to select targets or to trigger pre-defined motion sequences. To move toward the eventual goals of restoring lost sensorimotor function, information transfer rates will need to increase. Information transfer can be improved at the signal and application end, and we provide several examples where our laboratory has addressed both issues.

In particular, we have implemented P300 control of an autonomous humanoid robot and EEG-based motor imagery control of the Google Earth software. An anatomically correct test bed for a human hand model provides another example where applications are specifically designed to maximize the utility of a readily available control signal. In parallel, we seek signals that can provide improved information and fidelity of signal, including signals obtained from direct recording of the human cortical surface. The high-frequency signals seen at this level show promise for practical BCI applications, such as the use of contralateral and ipsilateral movement signals from the motor cortex, and, once identified by invasive means, may actually be detectable in non-invasive EEG recordings. These combined strategies may improve BCI development.

Keywords: Brain-Computer Interface (BCI), Electroencephalogram (EEG), Electrocochicogram (ECOG), Neurobotics, Motor control

INTRODUCTION

Brain-Computer Interface (BCI) technologies enable the establishment of a direct connection between the human brain and artificial devices. Actual movements are no longer necessary to interact with the environment. Instead, actions are encoded into predefined brain patterns that the BCI can detect and translate in real-time. The motivation for the development of such direct interaction channels is to reestablish, at least to some extent, communication capabilities of physically disabled individuals. These include individuals suffering from degenerative neurological diseases such as amyotrophic lateral sclerosis (ALS), individuals with spinal cord injury or survivors of a stroke.

Until recently, typical BCIs provided simple 1D control in order to select targets on a computer screen or to trigger predefined motion sequences (Birbaumer et al., 1999, Wolpaw et al., 2003, Pfurtscheller et al., 2003, Müller-Putz et al., 2005). Today, users can use BCIs for on-demand access to assistive robotic devices, Virtual Reality (VR) and standard software applications (Galán et al., 2008, Leeb et al., 2007, Bensch et al., 2007, Scherer et al., 2007). These accomplishments, together with technological advancements in neuroscience (Moritz et al., 2008, Ganguly et al., 2009) have lead to more ambitious goals, such as the restoration of lost motor or sensory function. Currently, the information transfer rates are still low compared to manual control (generally less than 30 bits min⁻¹), but have risen to a level

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A NEURO VR-BASED VERSION OF THE MULTIPLE ERRANDS TEST FOR THE ASSESSMENT OF EXECUTIVE FUNCTIONS: A POSSIBLE APPROACH

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This paper presents a study aimed at developing a tool for the assessment of executive functions in patients with different etiologies by customizing a virtual reality (VR) version of the Multiple Errands Test (MET) (Shallice & Burgess, 1991; Fortin et al., 2003). The MET is an assessment of executive functions in daily life which consists of tasks that abide by certain rules. It is performed in an actual shopping mall-like setting where there are items to be bought and information to be obtained. The specific goal of this study was to conduct a pilot study using the virtual version of MET (VMET) with both control subjects and patients suffering from Parkinson's disease and from stroke. The task was supported by the employment of an advanced technology able to ensure an ecologically valid context for the patient. Specifically, the MET procedure, previously modified according to the requirements of the NeuroVR software system, was presented via a virtual supermarket. Subjects were requested to select and buy various products presented on shelves with the aid of a joy-pad. The procedures developed and employed during this pilot phase, results obtained for the two clinical samples and the implications for the assessment of executive functions are addressed in this paper.

Keywords: Virtual Reality, Executive Functions, Multiple Errands Test (MET), Daily Life Tasks, NeuroVR

INTRODUCTION

This paper presents a study aimed at developing a tool for the assessment of executive functions in patients with different etiologies, in particular Parkinson's disease (PD) and cognitive impairment due to acquired brain injury (including stroke), by customizing a virtual reality (VR) version of the Multiple Errands Test (MET) (Shallice & Burgess, 1991; Fortin et al., 2003). This task is supported by the use of advanced technologies capable of providing an ecologically valid context for the patient while he or she is involved in a complex planning task.

THE "DYSEXECUTIVE SYNDROME"

The term "executive functions" refers to a set of behav-

ioral competencies which include planning, sequencing, the ability to sustain attention, resistance to interference, utilization of feedback, the ability to coordinate simultaneous activity, cognitive flexibility (i.e. the ability to change set), and, more generally, the ability to deal with novelty (Crawford, 1998). The neural substrates of these competencies are considered to lie in the prefrontal cortex. These abilities play a critical part in complex social behavior, help to suppress improper actions and to focus on purposeful information.

The "dysexecutive syndrome" refers to a cluster of deficits in executive functions. Individuals who suffer from executive function impairments, including attention, planning,

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BIOFEEDBACK, VIRTUAL REALITY AND MOBILE PHONES IN THE TREATMENT OF GENERALIZED ANXIETY DISORDER (GAD): A PHASE-2 CONTROLLED CLINICAL TRIAL

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Generalized Anxiety Disorder (GAD) is a psychiatric disease characterized by long-lasting anxiety that is not focused on a specific object or situation. Within the treatment of GAD, physical (relaxation and controlled breathing), behavioral (visualization and controlled exposure) and cognitive control strategies (challenging negative thoughts) represent a key part of the treatment, even if they difficult to learn. To overcome this limitation, the EU-funded INTREPID research project (IST-2002-507464) proposes improvement of existing treatment for GAD through the use of a biofeedback-enhanced virtual reality (VR) system, used both for relaxation and controlled exposure. Furthermore, this experience is strengthened by the use of a mobile phone that allows patients to perform the virtual experience even in an outpatient setting. This approach was tested in a Phase II randomized controlled trial (NCT00602212), including three groups of four patients each, resulting in a total of 12 patients. The first group consisted of the VR and Mobile group (VRMB) including biofeedback, the second of the VR and Mobile group (VRM) without biofeedback, and the third the waiting list (WL) group.

This study provides initial evidence for better efficacy of treatment for the VRMB group. Subjects belonging to this group reported a higher decrease in some of the anxiety psychometric questionnaires after the treatment than both VRM and WL groups, even if the VRM group, too, reported some significant improvements at the end of therapy. Moreover, qualitative reports concerning outpatient use of mobile phones suggests that it can solve a classical problem of VR therapies—the impossibility of using a VR system in the real life context of the patient.

Keywords: Generalized Anxiety Disorder (GAD), Virtual Reality (VR), Biofeedback, Relaxation, Portable Devices

INTRODUCTION

Generalized anxiety disorder (GAD) is a common anxiety disorder that typically has an early age of onset, a chronic course and a high degree of comorbidity with other anxiety and mood disorders (Kessler et al., 1994). According to the DSM-IV-TR (APA, 2000) the essential feature of

GAD is at least six months of "excessive anxiety and worry" about a variety of events and situations. Anxiety and worry are often accompanied by additional symptoms like restlessness, being easily fatigued, difficulty concentrating, irritability, muscle tension and disturbed sleep. The lifetime prevalence of GAD in the general population

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RELIABILITY AND VALIDITY OF THE NINTENDO® WII FIT™

Laura Z. Gras¹, Audrey D. Hummer¹ and Elizabeth R. Hine¹

The Nintendo® Wii™ is gaining popularity with clinicians to use with their patients to simulate real world games and sports. Patients enjoy the interaction with the game while the therapist's focus is on improving the patient's function. The Wii Fit™ is being promoted to improve balance. The program begins with assessment tools to give the user an idea of how well they are balancing. This study investigated the reliability and concurrent validity of the Nintendo® Wii Fit™ compared to a known standard in measuring balance, the NeuroCom EquiTest®. The results of this study found that the Wii Fit™ is not reliable or valid in balance assessment as compared to the EquiTest®.

Keywords: Wii, EquiTest, Balance Testing, Center of Gravity, and Left-Right Symmetry

INTRODUCTION

A holistic approach to therapeutic intervention for a patient of any age should incorporate balance. This focus is integral in treatment, either to address fall risk in an older adult or to analyze the success of a training program in a young adult. A broad topic, balance has been difficult to measure and document effectively in the past, either to demonstrate improvement with therapy or to provide a means to precisely identify the source of impairment (Dickin & Clark, 2007). However, with current technology, analysis of balance has been quantified with the use of computerized dynamic posturography, an electronic system that employs a force plate equipped with sensors to detect abnormal postural sway during testing (Balance Disorders, n.d.).

Recently, with the development of virtual reality gaming systems, an interactive, three-dimensional experience to train and challenge a patient became available (Holden & Todorov, 2002). Particularly, the use of the Nintendo® Wii™ gaming system is becoming more popular and widespread in therapy for varying populations. There is a multitude of practical advantages associated with its use, including increased patient safety, decreased amount of time, space, and amount of equipment necessary, increased cost efficiency, and quantified results that allow ease of documentation (Bekter, Desai, Nett, Kapadia &

Szturm, 2007). In addition, patient experience in rehabilitation programs is improved. Two recent studies reported subjective results from participants that motivation and desire to complete therapy was increased when using the virtual gaming system (Deutsch, Borbely, Filler, Huhn & Guarrera-Bowlby, 2008; Bekter et al., 2007). It is a legitimate supplement to rehabilitation programs because it encourages patients to actively participate in simulated real-life games (Bekter et al., 2007). The activities tend to be more enjoyable to patients than traditional rehabilitation because they are both fun and motivating. Improvements in functional mobility, visual-perceptual processing, and postural control have all been observed following an 11-session training program with the Wii™ (Bekter et al., 2007).

A cost-efficient and commercially available option for the Wii™ that is focused on balance activities is the Wii Fit™. Launched by Nintendo® in 2008 to work with the Wii™ gaming system, the Wii Fit™ utilizes a thin Balance Board™ with a Body Test and Training Games to assess, then improve and track, an individual's static and dynamic balance (What is Wii Fit?, 2009). The Wii Fit™ provides results related to an individual's Body Mass Index, Center Of Gravity (COG), and left-right symmetry via the Body Test. Sensors imbedded within the board are used to directly influence an on-screen character through

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TRAPPED IN THE WEB: THE PSYCHOPATHOLOGY OF CYBERSPACE

Tonino Cantelmi¹ and Massimo Talli¹

In this review the authors, after an initial description of the “Internet phenomenon,” particularly of the psychological and psychopathological risks related to its use, propose to the reader a series of works on this theme developed during recent years. In this review many interesting aspects are discussed such as the problem of defining the syndrome and the possible diagnostic criteria, the explanatory models proposed by various authors and possible therapy options to treat the syndrome.

Keywords: Internet, Psychopathological Risks, Explanatory Models, Diagnostic Criteria, Addiction

INTRODUCTION

It was around 12 years ago when we studied so-called “internet addiction” for the first time (Cantelmi & Talli, 1998). Our interest in this unique pathology began when a woman from Northern Italy came to our department showing clear dissociative signs after a prolonged exposure to the Internet. We could not identify the precise role played by the Internet. Even though we analyzed her clinical state in detail, we could not understand if it was just an accidental coincidence or a cause of the same symptomatology.

In 1998 the pioneering studies performed by Young in Pittsburgh and other researchers (Young, 1996; Suler, 1996; Brenner, 1997, Griffith, 1997) represented all we knew about this problem until that time. In Italy, very few people could benefit from Net connection and it was not very common to talk about “strange” psychological influences. Since then, the “Queen of the Nets” has spread to a global level by becoming the best means of communication, among all the others. Its spread increased scientific knowledge related to the Net and psychopathologic aspects, and it also made it possible to have access to many kinds of information.

The technology on which the Net is based has changed. The broadband has enabled safer and faster connections, while at the same time the arrival of the telephony and dig-

ital TV has made the Internet more useful and attractive. Nevertheless, its anarchic spirit remained pleasantly integral, just like its capability to stimulate fresh mental pathways.

This review intends to examine the most important scientific contributions obtained by authors who contributed in such ways as providing definitions, diagnostic criteria, impact of disorder, theoretical patterns, motivation, net services and toxicity, means of assessment and treatment. As conventionally agreed, we will use the expression Internet Addiction (IA) in order to indicate a series of online disorders and behaviors, united by the same technology, the Internet, and from the same type of use-abuse. Moreover, we will fully discuss the new scientific contributions that our studies developed in the last few years. The contributions represent a new knowledge that we hope will enrich the previous, existing knowledge on the subject.

DEFINITIONS

The first computer addiction cases appeared during the 70's and 80's (Shotton, 1991). These kinds of problems were related to PC use-abuse and not to the Internet, since it did not exist yet.

Ivan Golberg, an American psychiatrist, was the first scholar to recognize this “illness” by defining it as Internet Addiction Disorder (1995). He helped to clarify all rela-

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