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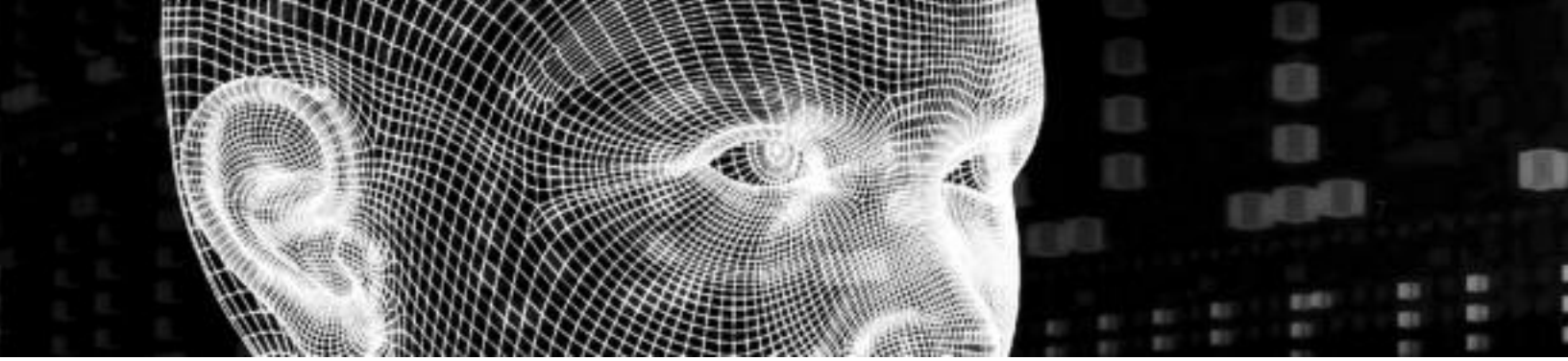

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GUEST EDITORIAL

In this special issue of the Journal of CyberTherapy and Rehabilitation, you will find several papers that were selected from the more than one hundred submissions received by the Scientific Committee for the International Symposium on Neurorehabilitation.

Seeing the need to strengthen the collaboration between technical and health related disciplines, the International Symposium on Neurorehabilitation: from Basics to Future was held in Valencia, Spain on October 15-16, 2009. The main purpose of the Symposium was to bring together engineers, researchers and health care professionals to share ideas and experiences with the aim of creating a "common language" that will help to increase the efficacy of the neurorehabilitation process and to improve the quality of life of patients. World-renowned researchers in cognitive and motor rehabilitation, virtual reality, telerehabilitation, brain-machine interfaces, patient assessment, behavioral science, neuroplasticity, neuroimaging, neuropharmacology and rehabilitation robotics updated participants on the current state of their respective research areas during the Symposium. Similarly, more than 350 delegates from around the world participated in this event and provided examples of their current work.

In the coming years, the incidence of diseases and afflictions with a neurological origin will increase to–what some have ventured to call–epidemic proportions. Among the main reasons behind this "coming epidemic" is the shift that the world's population will experience, according to several forecasts, towards an increasingly older population as a result of improvements in medicine and standards of living. According to the United Nations, more than 20 percent of the world's population will be over 60 years old by the year 2050, more than doubling the current size of this population segment. This shift towards an older population will not be limited to the developed world; most of the developing world will experience a similar population shift in the coming decades. Unfortunately, an aging population increases exponentially the risk of suffering from afflictions affecting the central nervous system, which could lead to a lower quality of life for these individuals, or even death. Among these afflictions one can find multiple sclerosis, Parkinson's disease, Alzheimer's disease, stroke, among many others. Recent advances in neurorehabilitation, the specialized and interdisciplinary treatment of individuals suffering from neurological afflictions, can prove to be extremely important to ameliorate the suffering experienced by these individuals and to help them to return to a normal life. At the same time, we are seeing the increasing importance of technology in our everyday lives. As a result, technology is also playing an important role in the improvement of neurorehabilitation, and we feel that its importance will only increase over time. Applying technology to the neurorehabilitation process can not only assist us in obtaining more precise diagnostics and in improving the flow of information between health care professionals but it can also help us to develop more effective and efficient rehabilitation-specific clinical pathways. Similarly, the increasing bandwidth capacity of our telecommunication networks could bring hope to individuals that do not have access to rehabilitation facilities by making possible the implementation of telerehabilitation-based treatments. Furthermore, the increasing importance of assistive technology and orthetics also shows how technology can have a great impact on the quality of life of our patients long after the rehabilitation process has finalized.

In this symposium, several sessions have been centered in virtual rehabilitation and related fields. Virtual Rehabilitation is a recent scientific and technological area that investigates the use of interactive graphics technologies and telecommunications to provide rehabilitation and clinical services in a more effective and efficient way. It is a multidisciplinary field that combines technologies such as virtual reality, augmented reality, bioelectronics, medical imaging, ambient intelligence, natural man-machine interfaces, all aimed at achieving better therapies for patients and more sustainable services health.

At this moment, we are experiencing the emergence of an information society increasingly based on the production and exchange of information. New information and computer technologies (ICT's) are having an impact in the field of rehabilitation of motor and cognitive functions. Over the past twenty years this progress in technology has provided clinicians with new opportunities for evaluation and treatment of cognitive disorders, which were not available with traditional methods. Several tools have been created in order to evaluate and train the

cognitive impairment that is associated with acquired or developmental cerebral damage including memory, spatial knowledge representation and planning abilities and executive function.

With virtual rehabilitation we are developing engaging virtual worlds in which patients interact while rehabilitating, environments that are capable of recognizing the patient and provide the necessary services even at home, miniaturized and low-cost tracking and monitoring systems used to enable patients to continue rehabilitation at home thus saving costs to health services and improving both the quality of care, intelligent TV screens that recognize the patient's movements and through virtual agents are leading him in the exercises, or robotic systems that assist the patient in their exercises in both the clinic and at home. In coming years, we will attend to a revolution in this field through the combined efforts of clinicians and technology, which we intend to make closer ties in scientific events like the International Symposium on Neurorehabilitation. We hope that you enjoy these papers and that you will join us in the next edition of the International Symposium on Neurorehabilitation to be held in 2011.

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ANALYSIS OF MULTITOUCH TECHNOLOGY FOR NEUROREHABILITATION

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The technology for supporting user friendly and intelligent interaction becomes very important for technology applied to rehabilitation. In this paper we review state of the art information and communication technologies (ICT) applied to cognitive and motor rehabilitation in order to discuss the advantages of multitouch technologies over other technologies. We describe a multitouch system specifically developed for use in clinical rehabilitation. The ergonomic analysis and user acceptance results are described.

A multitouch tabletop display system based on Frustrated Total Internal Reflection (FTIR) has been developed using user centered design principles in order to adapt the technology to patients with acquired TBI. We also described the classification of hand gesture commands for interacting with the system developed using the library Human-Touch. Several software applications have been developed both for usability tests and for cognitive rehabilitation tasks.

The different natural man-machine interface technologies are analyzed for their use in neurorrehabilitation and the possibilities of the multi-touch technology are analyzed. The implementation of a prototype specially adapted for its use in neurorrehabilitation is described and the ergonomic analysis and user satisfaction results are described.

Keywords: Multitouch, Cognitive Rehabilitation, Tabletop, Natural Interface, Virtual Rehabilitation

Introduction

The technology for supporting user friendly and intelligent interactions becomes important for technology applied to rehabilitation. Specifically, many researchers worldwide have focused on the input technology using hands and gestures, which are the most intuitive tools for humans. This technology becomes a core component of the information devices adopting dynamic touch interfaces. This paper will describe a hardware platform and its component technologies that are used to manipulate the contents naturally by recognizing the motion of the user's hands and the contact between the hands and display. This technology enhances the availability of next generation multimedia contents utilizing the interaction between the user and information system for rehabilitation purposes.

One of the benefits of the tabletop display is the natural direct manipulation experience they provide, as well as their potential for more complicated interactions using multiple fingers. It would be desirable to allow more than one user to access the display without affecting the work of others. The users of a tabletop display could randomly access any point on the display by simply touching the desired location. Also, physical objects could be used for augmented reality. Lastly, the expense of developing the system is not expensive. Ultimately, the system developed pursues interaction of four components–human, computer, physical objects and displayed objects. Additionally, tabletop displays can help cooperative interaction of multiusers as a medium of communication. The ability to directly touch and manipulate data on the screen without using any intermediary devices has a very strong appeal to users. In particular, novices benefit most from the directness of touch screen displays. A fast learning curve and inherent robustness, meaning it contains no movable parts, makes touch screens an ideal medium for interacting with interactive graphic based applications. While touch screen use is widespread in special purpose applications, the slow adoption of touch screens into more general computing devices has be attributed to known issues of relatively high error rates, arm fatigue, and lack of precision (Armstrong, C., 1989.) Due to technical restrictions, most commercially available touch screen devices in use today are only capable of tracking a single point on the surface

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of the device. However, during recent years there has been an increased interest towards multi-touch technology that permits detection of several fingers at the same time.

Background of multitouch technology

Multi-touch technology is a human-computer interaction technique that uses a touch screen or tablet to recognize multiple simultaneous touch points and software to interpret those simultaneous actions. This frequently includes the position and pressure or degree of each touch point independently, which allows gestures and interaction with multiple fingers or hands and can provide rich interaction through intuitive gestures. Depending largely on their size, some multi-touch devices support more than one user on the same device.

Multi-touch technologies have a history beginning in 1982, with pioneering work being done at the University of Toronto (Mehta, 1982) and Bell Labs (Akatani & Rohrlich, 1983.) Lee et al. (1985) described one of the first multi-touch prototypes that consisted of a touch tablet capable of sensing an arbitrary number of simultaneous touch inputs, reporting both location and degree of touch for each. The Digital Desk, described by Wellner (1991), used an early front projection tablet top system that used optical and acoustic techniques to sense both hands and fingers as well as certain objects, in particular, paper-based controls and data. Fitzmaurice et al. (1995) demonstrated the concept and later implemented the ability to sense the identity, location and even rotation of multiple physical devices on a digital desktop display and used them to control graphical objects. A novel and very interesting approach to this class of device was the Haptic Lens (Sinclair, 1997), a multitouch sensor that had the feel of clay; it lost its shape the harder you pushed and resumed its basic form when released. In 2006, Mitusbishi introduced the Diamond Touch system (Wu et al., 2006) that is capable of distinguishing which person's fingers and hands are which, as well as location and pressure. The first commercially available product using multi-touch technology was the Lemur Input Device, a professional multi-media controller from the French company JazzMutant (www.jazzmutant.com.) It was launched in 2005. In another paper, (Han, 2005) the author describes a very elegant implementation of a number of techniques and applications on a table format rear projection surface that used FTIR techniques for finger tracking. Some other prototype descriptions can be found in Rekimoto, 2002 and Wilson, 2004, 2005.

ICT's and cognitive rehabilitation

We are experiencing the emergence of an information society increasingly based on the production and exchange of information. New information and computer technologies (ICT's) are impacting the field of rehabilitation of cognitive functions. Over the past twenty years this progress in technology has provided clinicians with new opportunities for evaluation and treatment of cognitive disorders which were not available with traditional methods. Several tools have been created in order to evaluate and train the cognitive impairment that is associated with acquired or developmental cerebral damage including memory, spatial knowledge representation, planning abilities and executive function.

In the past few decades, computers have developed rapidly in power and sophistication. A variety of software and multimedia computer programs can be used as tools for assessment and even treatment, including applications in cognitive rehabilitation (Armstrong, 1989; Gontkovsky et al., 2002; Green et al., 1994; Johnson & Gravie, 1985; Smart, 1988.)

Applications of an advanced form of computer technology, virtual reality (VR) and evaluations of its efficacy, have appeared in studies on the assessment, treatment, and functional outcomes of patients with cognitive impairments (Christiansen et al., 1998; Elkind, 1998; Knight & Titov, 2009; Lengenfelder et al., 2002; Rizzo et al., 2000; Rose et al., 2005; Schultheis & Rizzo, 2001; Tsirlin et al., 2009.) With the introduction of VR tools, it has become possible to assess and train patients in ecologically relevant environments (Katz et al., 2005; Rizzo et al., 2006.) The use of computerized tools, in particular VR, presents specific advantages–adaptability to varying user abilities, compensation for sensory deprivation and motor impairments, a high level of engagement and motivation and repetitive training which may, in some cases, be used at home. These tools provide multi-sensorial stimulation and feedback and more realistic tasks that are safe and suitable for rehabilitation. The realism and engagement of VR tools also help the transfer of learning to the real world (Rizzo & Kim, 2005.)

The evolution of VR research made it possible to integrate video and virtual objects in real time, resulting in a mix of real and virtual or mixed reality named Augmented Reality (AR.) AR provides safer and more intuitive interaction techniques that offer the opportunity to interact with 3D objects in the real world (Azuma, 1997.) AR provides a more realistic feeling of presence and reality judgment than VR because the environment and the elements the patients use to interact with the application are real. However, few studies have developed AR systems for cognitive rehabilitation (Correa et al., 2007; Richard et al., 2007.)

Another advancement of ICT's in the field of cognitive rehabilitation is telemedicine which is the use of telecommunicating technology for diagnostic and therapeutic purposes (Lathan et al., 1999.) Specifically, telerehabilitation is the remote delivery of rehabilitation services such as teleconsulting, monitoring, and training and care of people with acute and chronic disabling disorders. This method of rehabilitation becomes useful when the patient is unable to move to a rehabilitation center so it can be applied in

Figure 1. HumanTouch prototype; right user interaction with multitouch system.

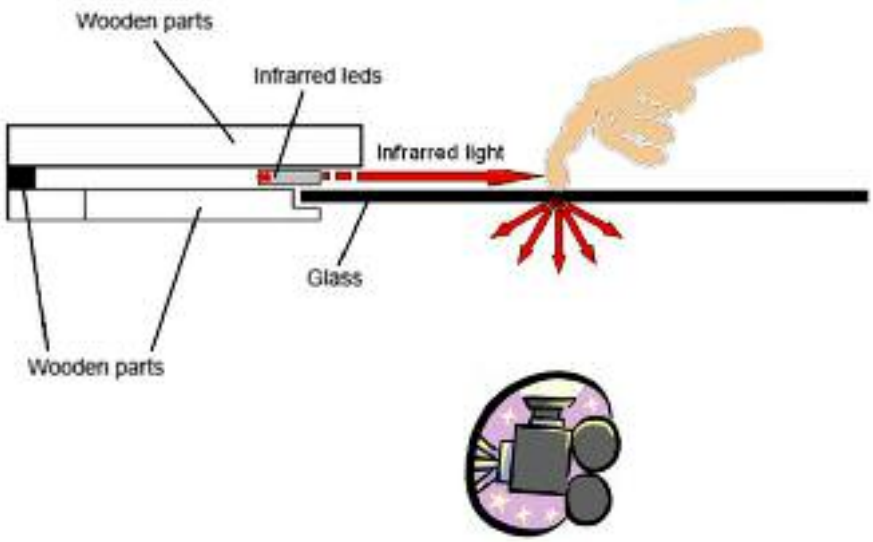

Figure 2. Touch detection in the HumanTouch system.

rural and underserved areas. Other advantages include reducing the cost of hospital visits and maintaining the improvements achieved during the process of rehabilitation in the unit. Several studies have showed telerehabilitation advantages and utilities for cognitive rehabilitation (Burdea, 2003; Caltagirone & Zannino, 2008; Currell et al., 2001; Grimes et al., 2000; Schoenberg et al., 2008.)

Description of hardware prototype

A prototype called HumanTouch was developed for testing the capabilities of multi-touch technology on cognitive rehabilitation. In figure 1 some images of the prototype are shown.

The HumanTouch system uses a projector to transfer the image onto a mirror. It is then reflected onto a board surface which is made up of a translucent glass screen.

The interface works by reading an image through the screen which is generated by the infrared reflections on the fingers' skin.

Hardware configuration

The system consists of four main components–an image projector, an infrared LED illuminant block, a camera with an infrared pass filter and a special table made with a retroprojector system.

The advantages of this approach compared to other configurations like hanging the projector on the roof, or projecting from

the back are the following:
– Difficult and dangerous overhead installation of the projector is avoided.
– The system does not need to be calibrated often. If the camera and illuminant is rigidly mounted to the retroprojector structure, there is no need to re-calibrate the camera and projection to the surface when the unit is moved. Similarly, since the distance of the camera and projector to the surface is constant, there are no problems related to adjusting focal length of either the camera or projector when the unit is moved.
– With the retroprojection, occlusion problems typical of front-projected or oblique-projected systems are eliminated. For example, it is possible for the user to stand over the prototype without their head or their hands occluding the projected image.
– By controlling the projection surface, the image projection quality can be guaranteed.

The second device used was an infrared illuminator. To illuminate the surface, the most common infrared LED's could be used, mounted in line arrays around the screen. In order to obtain a consistent illumination, the arrays were installed in a chassis nine centimeters from the screen perimeter. The position of the illuminator was adjusted during the building phase in order to obtain the optimum performance. These LED's should be mounted in a simple electronic circuit.

Regarding the camera, any conventional camera with an infrared pass filter that fits the requirements in frequency and resolution could be used. Also, a black and white camera could be used because in this case color information is not needed. It is also important that it has good resolution and a wide-angle lens. The resolution should be at least 640x480 since the camera is set at the side of the projector, in front of the user and the effective resolution decreases with the distance to the camera. Therefore, in the edge where the user is sitting, the resolution will be the worst. The angle is important to cover the whole table and an angular lens could be used for that purpose.

The imaging source used was The ImagingSource DBK 21BU04, a USB Bayer camera with a 1/4"Sony CCD which captures visible and the near infrared light. A B/W camera with a resolution of 640x480 VGA output and refreshing rate is 60 fps was used. Several other lenses can be used to widen the angle.

Finally, the last device used with the prototype was a retroprojection structure. The most important features are the surface area used similarly to a touch screen and the mirror system to project the image from the projector.

It is important that the surface where the system is going to be placed reflects the infrared light because in the detection algorithms the reflected light needs to separate the fingers and shapes from the background (they reflect the IR light through the screen and the camera, placed under the surface, captures the image.) For this reason, for example, a black board could not be used. On the other hand, that surface must not be transparent because the image to be projected. The solution in the study was to use a semitransparent surface to show the projection image and the light reflected. Most surfaces accomplish this.

The mirror system was quite simply constructed. Only a sturdy table with a hole as the touch screen was needed. That hole was covered by the semitransparent surface and a mirror was placed under it at a 45-degree angle. The image was projected onto the mirror which reflected it onto the surface. On the other hand, the IR light, which came from the finger and shapes through the touch screen, was also reflected by the mirror to the camera which was placed near the projector.

Software to detect and track fingers

Like other vision-based interaction systems, the difficult part is to design robust algorithms that reliably detect the interaction of the user and are fast enough to work in real time. This system does both.

There is a main distortion in the image–there is a barrel distortion since the lens is wide angle. This kind of distortion is stronger as long as the focal length is shorter.

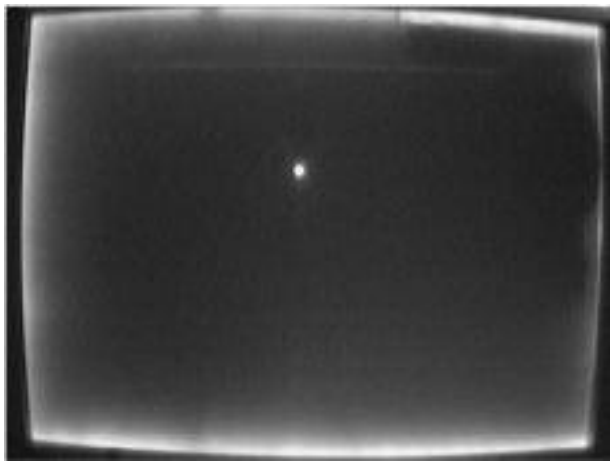

Figure 3. Image captured by the camera with a finger touching the surface.

The correction of this distortion was achieved through a standard camera calibration procedure.

After correcting the distortion, the next step was the segmentation of the contacted fingertips. An appropriate threshold value was applied and contacting elements were isolated. To determine the threshold value an adaptative threshold algorithm was used. The value was determined by considering the histogram of the image. Once the adaptative threshold algorithm was applied, a simple mathematical morphology (opening and closing) was used for eliminating noise. Later, the resulting figures were processed, being classified as isolated blobs that appear like fingers. Finally, additional tracking algorithm was necessary to establish a temporal coherence for finger position. The most common model for the tracking problem is the generative model, which is the basis of popular solutions such as the Kalman and particle filters.

HumanTouch and cognitive rehabilitation

In relation to multitouch technology application in the health field, LabHuman is working on several prototypes for cognitive evaluation and rehabilitation of patients with brain damage. Specifically, an application for Unilateral Spatial Neglect (USN) disorder has been developed and another for training activities of daily living (ADLs) within the framework of Occupational Therapy.

The USN prototype transfers multitouch technology to several standardized pen-and-paper tests used for detecting visual neglect and measuring its severity. The hypothesis in this study is that multitouch technology could be very useful in order to motivate USN patients to carry out the conventional sub-tests of the Behavioral Inattention Test (BIT, Wilson et al., 1985), such as line crossing, letter cancellation, star cancellation, figure and shape copying, line bisection and representational drawing. This would facilitate the patients' performance and also measure the USN severity by tracking the screen location when patients performing the tasks touch the screen with their fingers. This would make possible an estimation of the extent of the observer's spatial exploration deficit. From the therapist's point of view, the computerized control of a system with these features could be very useful to provide patients with tests and tasks in an automated way. Other advantages are the adaptability to varying user abilities and the facilitation of real time feedback concurrent with task performance together with the obtained scores. In figure 4 some tasks developed for the system are shown.

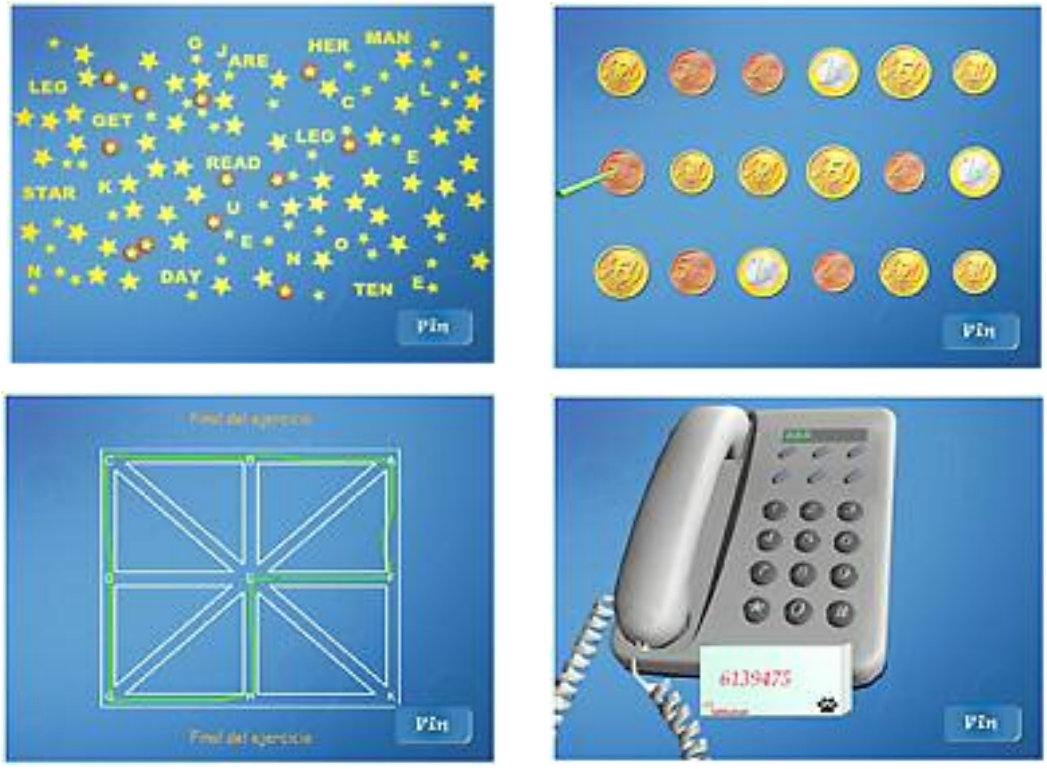

Figure 4. Dumpscreens of the USN prototype developed for HumanTouch interface.

Specifically, the multitouch USN prototype offers the patient a virtual environment from every sub-test mentioned previously and a multitouch interface based on the HumanTouch prototype.

In relation to occupational therapy, and in a similar way to the prototype described before, the study shows it would be possible to transfer multitouch technology to conventional tasks used for developing, recovering, or maintaining daily living and work skills in patients with brain damage. This prototype is a first attempt to rehabilitate cognitive disabilities in these kind of patients. Basically, this prototype offers a virtual environment that shows several decks of cards, each associated with a daily living task. The patient then selects one of these decks and the screen displays all the cards included in it (each card is associated with a necessary sub-task to carry out the complete task correctly) in random order. Then, the patient has to put all the cards in order, obtaining the correct sequence of cards which completes the daily living task properly. During the task, the virtual environment displays real time feedback about the patient's performance. In figure 5 some parts of the occupational therapy module are shown.

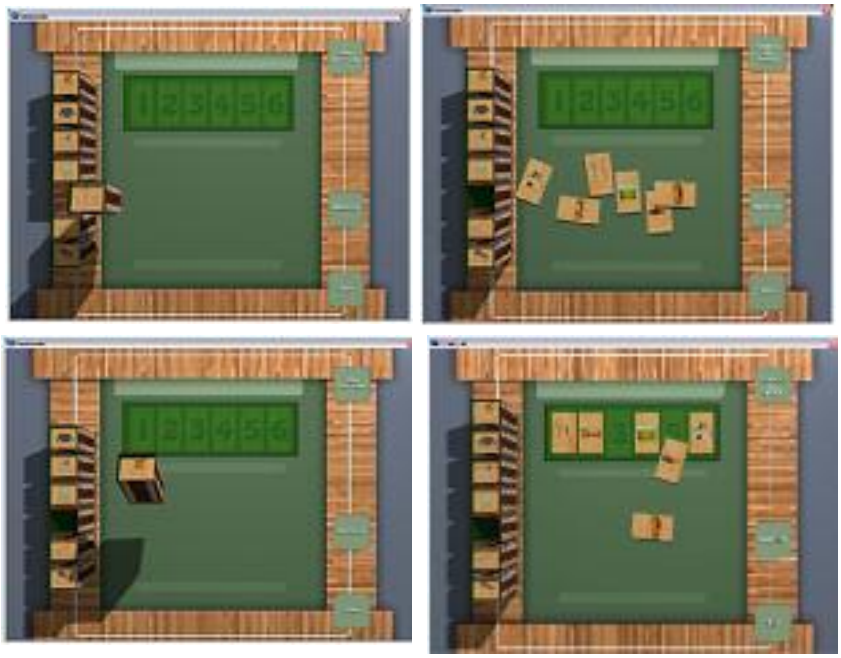

Figure 5. Dumpscreens of the USN prototype developed for HumanTouch interface.

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IMPROVING GAIT AFTER STROKE – TREADMILL OR WALKING; QUANTITY OR QUALITY

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The main aim of the present study was to evaluate treadmill training versus walking outdoors in order to improve quality aspects like step length, step width, cadence and quantitative aspects like endurance, walking speed and distance in walking. A secondary aim was to evaluate factors that might be influential in retrieving walking capacity.

The results indicate that treadmill walking achieved improved function, such as an increase in walking speed and distance, in less time than walking outdoors and in regard to bilateral step length with higher degree of symmetrical use. This observation supports the notion that walking exercises on a treadmill are an effective and important tool in rehabilitation. The patients studied were well past the acute period of time after stroke. The fact that both treadmill walking and walking outdoors did improve functional activities supports the importance of "booster doses" of rehabilitation in order to maintain physical function levels.

Keywords: Physiotherapy, Rehabilitation, Stroke, Treadmill, Walking

Introduction

Walking capacity is an important aspect of stroke rehabilitation regarding endurance, functional activities like ADL and as a primary goal expressed by the patient (Globas, Macko & Luft, 2009.) Different approaches are used in the rehabilitation of stroke patients in order to enhance and improve walking capacity and there are different options depending on which aspect of walking is being considered (States, Pappas & Salem, 2009, Tang et al., 2009, Moseley, Stark, Cameron & Pollock, 2005.) In order to enhance walking in the acute stage, the therapist often focuses on stability, balance and quality of movement. In the chronic stage functional aspects, such as endurance and quantity and how long and how fast walking is possible, become more important during rehabilitation (Peurala, Airaksinen, Jäkälä , Tarkka & Sivenius, 2007, van de Port, Kwakkel & Lindeman 2008.)

There are very few studies on walking exercises outdoors compared to walking indoors despite the advantages considering that fact that most patients suffering from the complications related to stroke return home. One of the options for an independent living and domestic life is that you can walk indoors and outdoors. Task-oriented training is recommended in the acute rehabilitation to gain skills for patients with stroke (Langhammer & Stanghelle 2000, Pollock, Bær, Pomeroy & Langhorne 2007.) It is safe to assume that walking outdoors is beneficial training for a patient who wanted to improve this skill. Walking outdoors is not a goal in itself but rather improvement in rehabilitation. If the patient's goal is to walk to the grocery store two kilometers down the road or to walk quickly across a street, there is probably a need for endurance, power and strength. On the other hand, reducing pain or economizing walking because of asymmetry calls for another approach. Walking parameters like bilateral stride length, step width and cadence are part of a qualitative aspect of gait where one would assume a symmetrical stride length, narrow step width and a reasonably low cadence would indicate a better performance.

Treadmill walking has been shown to be a valuable therapeutic tool for improving walking patterns post-stroke (Ada, Dean, Hall, Bampton & Crompton, 2003.) It is also effective in enhancing endurance (Macko et al., 2005.) Although treadmill training does not seem to enhance performance more than ordinary walking exercises in the acute stage (Nilsson et al.,2001, Moseley, Stark, Cameron & Pollock, 2005, Dickstein, 2008), it might be beneficial in improving gait in the chronic stage. A question posed, then, is will exercise gain transfer from a treadmill to walking over ground?

The main aim of the present study was to evaluate treadmill training versus walking outdoor in order to improve quality aspects

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like step length, step width, cadence and quantitative aspects like endurance, walking speed and distance in walking. A secondary aim was to evaluate factors that might be influential in retrieving walking capacity.

Methods

A single blind randomized controlled trial was set up. Patients were tested within the first day after arriving, and were randomly assigned to one of two groups directly after the test by a person not involved in the study. One group performed treadmill exercises and the other group performed outdoor walking exercises. Participants were informed about the study and participation was voluntary. The study was approved by the Regional Committee of Medical Research Ethics.

Inclusion criteria were neurological impairment and age above 50 years. Exclusion criteria were objections to taking part in a physical rehabilitation program, insufficient language, an unstable cardiac status, neurosurgery and a pre-morbid history of orthopedic problems or any problems that would prevent patients from walking.

Tests

The Motor Assessment Scale, item 3 was chosen to evaluate balance as the participants entered the program. Item scores in the test range from 0 to 6, and the total scores range between zero and 48 (Carr & Shepherd, 1985.)

During The 6-Minute Walk Test length and gait speed were recorded (Guyatt et al., 1985.) The participants were asked to walk as quickly as they could for six minutes. The 6-Minute Walk Test was also used to assess exercise tolerance (Larsen, Aarsland, Kristiansen, Haugland & Dickstein, 2001), thus measuring functional exercise capacity.

A 10-meter walk test was performed by walking 10 meters, with markers on the heels on both the affected and the unaffected foot, to measure quality of walking. The walkway was 14 meters long, with two meters for warming up and two meters for slowing down, as also used in other studies (Ada, Dean, Hall, Bampton & Crompton, 2003.) The participants were instructed to walk as fast and as safely as they could. Gait speed was measured with a stop-watch.
The patients were tested on arrival at the clinic (test 1) and at the end of the intervention period (test 2.) The participants were permitted to use assistive devices and take a rest during the tests. An experienced investigator, familiar with the tests and blinded to group allocation, performed all tests in a separate section of the recreational center.

Intervention

The group performing the treadmill exercises completed walking exercises five days a week during the testing period. The participants walked on the treadmill. The exercises were carried out with the treadmill in a flat position and the participants could use support if needed. The working load was determined in co-operation with the participants to a level they felt comfortable with and they felt no insecurity in balance or discomfort otherwise.

The group assigned to outdoor walking also exercised five days a week at a comfortable speed and with the use of ordinary assistive devices when necessary. The walk was performed regardless of weather conditions, and the intention was a 30- minute continuous walk.

The other activities in the physiotherapy department were the same in the two groups.

Statistical analysis

Descriptive statistics are presented as mean and standard deviation (SD.) An independent t-test was used to assess baseline differences. First, a multiple regression analysis was performed where 6 -MWT distance, 10 m walking speed and step variables was entered as dependent variables separately and all other variables were entered as independent variables in order to find the significantly correlated variables. Final models were then analyzed with the same dependent variables but now with the significantly correlated variables time after stroke, time exercising, group assignment and gender-independent variables (Tabachnick & Fidell, 2001.) Preliminary graphical analysis determined that all applicable variables met the assumption of normality and that no significant outliers existed. Statistical significance was set at $p<0.05$.

Results

A total of 39 patients were initially included in the study with baseline tests. Five participants dropped out, three in the treadmill group and two in the walking outdoor group. Four participants, two in each group, were returned to the hospital because of acute symptoms, and one in the treadmill group, discontinued the stay for personal reasons. There were no baseline differences between the groups, and the length of stay was equal in the two groups with a mean of 2.5 weeks (see Table 1.) Group activities and exercises were carried out five days a week and during weekends only self - training was performed. The mean treadmill speed during exercise was 0.5 m/s, with a range of 0.4 to 1.1 m/s and a flat surface. The mean time per session for treadmill walking was 12 minutes, and the total exercising time was 107 minutes. The outdoor walks were carried out at a comfortable walking speed. The time spent exercising depended on the weather conditions, but was on average 29 minutes per session. The total mean time for outdoor walking was 316 minutes. Thus, significantly less time was spent on the treadmill than on walking exercise outdoors ($p=0.02$.) The groups were supervised by physiotherapists and compliance to their respective programs was performed at 100 percent.

Table 1
Demographic data for patients included in the different groups and significance levels at p< 0.05 for differences between the two groups

Walking:	Treadmill, n=21	Outdoor, n=18	p-value
Men (n)	10	6	0.4
Women (n)	11	12	
Age (years, mean, SD)	74 (13.3)	75 (10.4)	0.8
First time ever stroke (n)	17	16	0.5
Right/left hemisphere (n)	15/6	13/5	0.9
Time after stroke (days)	419, 1034	349, 820	0.8
Height (cm; mean, SD)	172 (9.2)	167 (11.6)	0.2
Weight (kg; mean, SD)	75 (15.0)	67 (17.3)	0.1
MAS 3 score	5.4	5.3	07
Assistive device arrival (n)	7	9	0.73
Assistive device departure (n)	5	6	0.53
Reduced sensation (n)	7	6	0.9
Length of stay (days; mean, SD)	15.9 (5.3)	16.9 (5.4)	0.6

A multiple regression analysis including all independent variables explained 57 percent of walked distance in the 6-Minute Walk test (F = 4.5, p=0.002.) Model 1 displays significantly correlated independent variables–group assignment, time spent exercising, gender and time after stroke and explained 51 percent of the 6-Minute Walking Test (F=7.0, p=0.001) (Table 2), 43 percent of 10m walking speed (F=5.1, p=0.003) (Table 3), 39 percent of right stride length (F=4.3, p=0.008) (Table 4), 41 percent of left stride length (F=4.8, p=0.005) (Table 5), 15 percent of step width (F=1.2, p=0.33) (Table 6) and 29 percent of cadence (F=2.7, p=0.05) (Table 7.) A final model 2 with independent variables group assignment and time exercising explained 28 percent of 6-Minute Walking Test (F=5.6, p=0.009), 28 percent of 10m walking speed (F=5.6, p=0.009), 21 percent of right stride length (F=3.9, p=0.03), 19 percent of left stride length (F=3.4, p=0.04), 15 percent of step width (F=2.5, p=0.09) and 22 percent of cadence (F=4.2, p=0.03.)

There were no differences in use of assistive aids between the groups on arrival at the clinic or at departure.

Table 2
Regression analysis showing the association between the 6-Minute Walk Test and independent variables group assignment, gender and time exercising (model 1) and group assignment and time exercising (model 2)

Variables	**Beta**	**SE**	**p-values**	**R square**
Model 1				
Group	-0.28	53.0	0.1	0.51
Gender	0.4	43.5	0.008	
Time exercising	0.5	0.13	0.006	
Time after stroke	-0.35	0.02	0.02	
Model 2				
Group	-0.4	59.5	0.04	0.28
Time exercising	0.6	0.2	0.02	

Table 3
Regression analysis showing the association between the 10m walking speed and independent variables group assignment, gender and time exercising (model 1) and group assignment and time exercising (model 2)

Variables	**Beta**	**SE**	**p-values**	**R square**
Model 1				
Group	-0.3	0.15	0.11	0.43
Gender	0.31	0.13	0.04	
Time exercising	0.5	0.0	0.001	
Time after stroke	-0.33	0	0.04	
Model 2				
Group	-0.41	0.16	0.04	0.28
Time exercising	0.64	0	0.002	

Table 4
Regression analysis showing the association between the dependent variable stride length right leg and independent variables group assignment, gender and time exercising (model 1) and group assignment and time exercising (model 2)

Variables	**Beta**	**SE**	**p-values**	**R square**
Model 1				
Group	-0.38	0.13	0.04	0.39
Gender	0.26	0.11	0.11	
Time exercising	0.39	0.0	0.04	
Time after stroke	-0.38	0	0.02	
Model 2				
Group	-0.48	0.14	0.02	0.21
Time exercising	0.51	0	0.02	

Table 5
Regression analysis showing the association between the dependent variable stride length left leg and independent variables group assignment, gender and time exercising (model 1) and group assignment and time exercising (model 2)

Variables	**Beta**	**SE**	**p-values**	**R square**
Model 1				
Group	-0.41	0.12	0.03	0.41
Gender	0.26	0.10	0.09	
Time exercising	0.26	0.0	0.17	
Time after stroke	-0.45	0	0.006	
Model 2				
Group	-0.51	0.14	0.02	0.19
Time exercising	0.39	0	0.06	

Table 6
Regression analysis showing the association between step width and independent variables group assignment, gender and time exercising (model 1) and group assignment and time exercising (model 2)

Variables	**Beta**	**SE**	**p-values**	**R square**
Model 1				
Group	-0.42	2.5	0.06	0.15
Gender	0.14	2.1	0.9	
Time exercising	-0.07	0.006	0.8	
Time after stroke	-0.035	0.001	0.8	
Model 2				
Group	0.42	2.3	0.05	0.15
Time exercising	-0.06	0.006	0.8	

Table 7
Regression analysis showing the association between cadence and independent variables group assignment, gender and time exercising (model 1) and group assignment and time exercising (model 2)

Variables	**Beta**	**SE**	**p-values**	**R square**
Model 1				
Group	-0.07	11.9	0.7	0.29
Gender	0.19	9.9	0.3	
Time exercising	0.46	0.006	0.03	
Time after stroke	-0.19	0.005	0.3	
Model 2				
Group	-0.12	11.6	0.5	0.22
Time exercising	0.53	0.03	0.01	

Discussion

The main results of this study indicate that performing exercises on a treadmill walking improves walking speed, distance and stride length bilaterally in less time than outdoor walking. Treadmill walking has been reported by others to be an effective tool in the rehabilitation of stroke patients but the shorter duration of exercise in combination with both qualitative and quantitative improvements in walking patterns have not, to our knowledge, been shown before (Ada, Dean, Hall, Bampton & Crompton, 2003, Macko et al., 2005.) It can be expected that task-oriented exercises like walking outdoors would improve walking capacity resulting in increased distance and endurance and perhaps also increase in speed, but there are no studies concerning stroke patients on this subject. Studies concerning outdoor walking are mainly focused on older populations and the results from these studies show that older peple going outdoors to exercise are less functionally impaired, score less for depression and are more socially active than victims of stroke. Walking difficulty and fear of falls are, in those studies associated with going outdoors less (Rantakokko M et al., 2009.)

Time passed since a stroke is a variable that often have has negative influence on performance (Mayo et al., 1999.) Despite the fact that the patients were in the chronic phase of their stroke, the participants in both groups showed improvements in walking speed, distance and stride length (see tables.) The result indicates that intensive exercises are important in order to maintain walking capacities in the chronic stages of stroke as well (Langhammer, Lindmark & Stanghelle, 2007.) Exercise programs for chronic stroke survivors are scarce and few studies are focused on improving and maintaining function past the acute period of three months after stroke (Langhammer, Lindmark & Stanghelle 2007, Askim, Mørkved &, Indredavvik 2006.) Our study indicates that improving walking capacity by using a treadmill can transfer into increased endurance, walking capacity and better performance so that both quantity and quality of the walking motion is maintained.

The stay in a rehabilitation center incorporated several activities, all proving to be very beneficial for improving physical function and supporting an empowering process. The results of this study must therefore be seen in the light of the participants´ total amount of activity, which was equal in the two groups. However, the difference in the exercise protocols was in the methods of walking exercise. We believe, therefore, that this difference must probably be the main explanatory factor for the improvement in the treadmill exercise group. The benefit of treadmill walking as an addition to rehabilitation programs has also been shown in other studies (Ada, Dean, Hall, Bampton & Crompton, 2003, Kuys, Brauer, Ada & Russel, 2008, Chen, Patten, Kothari & Zajac, 2005.)

The gender differences influenced performance so that women walked more slowly, with shorter distance and with shorter stride length and higher cadence. These differences have also been established among healthy elderly people (Morio et al., 1997, Langhammer & Lindmark 2007.)

A weakness of this study is the relatively small group and the limited period of follow-up. The results, therefore, must be interpreted with caution.

Conclusion

This study aimed to evaluate treadmill training versus walking outdoor regarding qualities in gait–bilateral step length, step width, cadence, walking speed and walking distance. Treadmill walking achieved improved function in less time and regarding bilateral step length with higher degree of symmetrical use. The treadmill group increased in walking speed and distance, equally long and longer step length bilaterally in less time than the outdoor walking class. This supports the notion that walking exercises on a treadmill are an effective and important tool in rehabilitation. The patients were well past the acute period of time after stroke. The fact that both treadmill exercises and walking outdoors improved functional activities in patients supports the importance of "booster doses" of rehabilitation in order to maintain physical function levels.

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PRELIMINARY VALIDATION OF ECOTRAIN-COGNITIVE: A VIRTUAL ENVIRONMENT TASK FOR SAFE STREET CROSSING IN ACQUIRED BRAIN INJURY PATIENTS WITH AND WITHOUT UNILATERAL SPATIAL NEGLECT

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The objective of the study was to determine the clinical utility and the convergent validity of a computer desktop-based virtual reality (VR) street crossing task.

Twenty patients who had sustained either a right (n = 13) or a left (n = 7) hemispheric brain lesion due to an acquired brain injury participated in this study. All subjects were assessed with a neuropsychological battery including measures of attention (Color Trail-making Test, CPT) and measures of unilateral spatial neglect (Behavioral Inattention Test.) A standard VR street crossing test was performed within a week after completion of a neuropsycological assessment. Variables measured in the VR task included number of times the participant looked to the left, the total time it took to complete the task and the number of accidents. A Feedback Questionnaire was used to obtain information about the subjective responses of the participants to the VR experience.

The results were as follows–four patients in the study showed signs of persistent unilateral spatial neglect (USN =BIT cut-off store < 129.) Two of the four patients with USN and only one of the 16 without USN were unable to complete the task due to four or more accidents (Fisher's exact test, $p = 0.08$.) The number of accidents and the time taken to complete the virtual task were significantly correlated to the BIT score ($r = -0.5$, $p < 0.05$) and time to complete the Color Trail Making Test part A and B ($r = 0.7$ and $r = 0.8$ respectively, $p < 0.01$.) The participants' overall feedback on the VR experience was positive. In conclusion, the results achieved by this VR street crossing intervention correlate with those achieved by conventional neuropsychological tests measuring USN and attentional resources. Further studies should address its clinical validity as an effective instrument for training individuals who suffer from USN.

Keywords: Ecotrain, Brain Injury, Neglect, Cognitive Rehabilitation, Virtual Reality

Introduction

Unilateral Spatial Neglect (USN) is a disorder frequently observed after unilateral brain damage. It is defined as the inability to respond to or to orient toward stimuli located in the hemispace contralateral to the lesion of one of the cerebral hemispheres (usually the right), and which is not attributable to primary sensory or motor deficits (Heilman et al., 1987.) So, USN is an attentional or representational deficit, not a visual field deficit. This disabling condition is found in almost 50 percent of people with right-hemisphere stroke, and the presence of left USN in these patients has a well-established negative impact on functional recovery (Buxbaum et al., 2004.) Behaviorally, USN patients display a wide range of functional spatial deficits, such as bumping into objects when walking, shaving only one side of their face and eating food from only one side of the plate.

The complexity of USN makes it a difficult condition to diagnose and treat. While many rehabilitation methods have been proposed and applied with various degrees of success (Chokron et al., 2007), there is still a great need for effective treatment. Diagnostic techniques could also be improved and extended. In the last decade, promising new methods using virtual reality (VR) technologies have emerged (Tsirlin et al., 2009.)

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Virtual reality (VR) is a new technology based on computerized simulation and real-time visual, auditory and, in some cases, haptic (relating to the sense of touch) feedback (Rizzo et al., 2002.) VR technology may provide an extremely powerful tool to evaluate and treat patients who suffer from USN due to its unique combination of attributes. First and foremost, VR has inherent ecological validity, enabling a therapist to present intervention within contexts that are both realistic and more meaningful to the user which provide the individual with a sense of presence in the environment (Schultheis & Rizzo, 2001.) VR also provides opportunities for experiential, active learning which encourage and motivate the participant (Mantovani & Castelnuovo, 2003.) Performance within virtual environments can be measured objectively and the level of difficulty can be graded to provide stimuli that are achievable yet challenging (Rizzo et al., 2004.) VR also offers the capacity to individualize treatment needs, while providing increased standardization of assessment and re-training protocols, provides the opportunity for repeated learning trials and offers the capacity to gradually increase the complexity of tasks while decreasing the support and feedback provided by the therapist (Schultheis & Rizzo, 2001.) Furthermore, activity within the environment is safe and strict experimental control may be maintained over stimulus delivery and measurement (Rizzo et al., 1997.) In our specific application, the safety issue is paramount, as training an individual suffering from unilateral spatial neglect in a real street may be dangerous.

Street crossing is one example of a training environment using VR that can re-create the living environment of the patient with USN, which will lead to better generalization of the therapy to everyday life. Effectiveness of VR for teaching pedestrian safety and transfer to real world behavior was studied by McComas et al. (2002) for children. Results showed that children in the VR group learned safe street crossing skills as demonstrated by their scores on pre and follow up trials whereas the control did not. To train stroke patients with USN to cross a street safely, Weiss et al. (2003) design and testing a PC-based 3D, non-immersive VR system. 12 subjects, 6 had sustained a right hemisphere stroke (4 of these patients showed left neglect) and 6 healthy age-matched controls, participated in the initial feasibility and suitability study. The results showed that this VE was suitable in both its cognitive and motor demands for the targeted population. More recently, this group (Katz et al., 2005) examined the efficiency of the same virtual street crossing application for training patients with USN to cross the street (experimental group; n=11) in comparison with standard computer-based visual scanning training (control group; n=8.) After nine hours of training, distributed over 4 weeks, both control and experimental groups of participants with USN improved on standard USN measures. The experimental group also showed significant improvement on the VR street crossing test, while the control group did not. On real street crossing, the experimental group looked more to the left than they did before the VR training, while the control group showed no change. These results are important, since even such a simple system, located on the lower end of the immersion spectrum, equaled and in some cases surpassed the conventional method in its rehabilitative abilities. Such ecologically valid rehabilitation can be of great value to patients.

The objective of this initial study was to determine the suitability and feasibility of using VR technology to train neglect patients to safely perform dangerous activities of daily living (ADL), such as crossing streets.

Materials and Methods

Subjects

Twenty patients, 10 men and 10 women, aged 52 (SD: 13.2) years, with a mean chronicity of 568.4 (SD:327.4) days, participated in this study. All patients had sustained either a right (n=13) or a left (n=7) hemispheric brain lesion, due to an acquired brain damage (stroke: n=9, intracranial hemorrhage: n=8, brain tumor: n=3.) Four of the thirteen patients with a right-hemispheric lesion presented persistent left USN according to BIT (Behavioral Inattention Test, Wilson et al., 1985) cut-off score (less than 126.) All participants had a MMSE (Mini-Mental State Examination, Folstein et al., 1975) greater than or equal to 23 and a MASTc (Mississipi Aphasia Screening Test, Nakase-Thompson et al., 2005) greater than or equal to 45. So, they did not show important cognitive deficits and had a good comprehension.

VR street crossing test

VR street is a virtual environment for the rehabilitation of patients with neglect that simulates several streets next to a supermarket. The patient's objective is to go to the supermarket via the streets, crossing all crosswalks, paying attention to the cars (coming from both directions) and the traffic lights, and trying not to get run over.

In order to obtain this objective in a progressive way the virtual environment is configured with the option of several difficulty levels. In this way the therapist can define if the virtual environment will include traffic cars–even to define the traffic flow–or the traffic lights. Also, it is possible to define the inclusion of distraction components, that is, different audio or visual stimuli that could distract the patient while he/she is focusing his/her attention in the neglect side. On the other hand, in order to help and to motivate the patient to obtain this objective the virtual environment offers real time audiovisual feedback about what he/she must to carry out and how he/she is confronting it.

In order to visualize this virtual environment, in an immersive and non-invasive way, the patient uses a panoramic 47" LCD

monitor. The navigation and interaction is performed by means of a conventional joystick. On the other hand, the virtual environment makes use of an optical tracker system to track patient's head movements using a cap with reflecting marks. Head tracking is used in order to provide a 180º panoramic view of the virtual environments without the use of a head mounted display. In order to do so, movements of the patient's head are magnified in the virtual environments.

Figure 1. Screen and overview of the VR street crosing system.

Procedure

The study took place in a quiet room free from potential attentional distractors. The patient was comfortably seated in front of a 47-inch LCD monitor and experienced the virtual environment from a first person perspective. A neuropsychologist, trained in the virtual program, controlled the entire process and gave precise instructions about the assessment task and the software use. Once the program started, the participant was asked to pay attention to a divide road with vehicles approaching from both sides. The main objective of the task was to cross two divided roads in order to arrive at a destination point, in this case a supermarket, and then return to the start point as quickly and safely as possible. The street crossing was performed on two divided roads so the participants had to cross the lanes where vehicles were approaching from the left to reach a central island. Then, they continued to the other side where cars came from the right. The position and speed of movements in the environment were controlled by a joystick. The virtual task was considered finished once two routes–arriving at the supermarket and getting back to the starting point–were completed, or after four accidents had occurred.

After instructions, the head tracking system was adjusted to each patient and a preliminary session was administered for learning software and hardware use. In this training session, the patient was asked to navigate though the virtual environment and try to complete one single route in the absence of traffic, or any other audiovisual distractor. Once the patient was used to the system, the main objective of the task was remarked again and an assessment session was performed. Although the software allowed the presence of verbal cues, such as "look to your left", visual cues like traffic lights or visual distractors like obstacles in the road, the assessment session was performed without any of these elements, and only an emotionally-intense audiovisual feedback was allowed in case of an accident. If this happened, the therapist encouraged the patient to carefully look at both sides of the road before crossing and the program was automatically restarted from the initial point, without discounting the time already used. Variables measured during the assessment session included the number of times the participant looked to the left and to the right, the total time to complete the task and the number of accidents.

Once the assessment session was finished, the patient completed the Short Feedback Questionnaire with the help of the therapist when required.

Short Feedback Questionnaire

A Spanish adaptation of the Short Feedback Questionnaire (SFQ) (Kizony et al., 2003) was used to obtain information about the subjective responses of the participants to the VR experience in the VE. The SFQ is an eight-item questionnaire which queried the user's sense of presence, perceived difficulty of the task, and any discomfort that users may have felt during the experience.

The first six items of the questionnaire were formulated as an abbreviated alternative to the longer Presence Questionnaire developed by Witmer & Singer (1998.) These items assessed the participant's sense of enjoyment, sense of being in the environment, perception of the success, perception of control, perception of the environment as being realistic and comprehension of computer feedback. The seventh item, composed by four sub-items, explores the comfort during the experience and possible side effects–dizziness and sickness, eye pain or "molestias en los ojos" and disorientation. The eighth item, composed by two sub-items, explores difficulty–perception of difficulty while performing the task and perception of difficulty using interface devices. Responses to the first seven items were rated on a 5-point Likert scale, where 1 = not at all and 5 = very much. Responses to the eighth item were also rated on a 5-point Likert scale, where 1 = very easy and 5 = very difficult. Negatively keyed items (7 and 8) were inverted for data analysis. So, in results, item seven scores mean 1 = very much and 5 = not at all, while item 8 scores mean 1 = very difficult and 5 = very easy.

Data Analysis

Many dependent variables (SFQ items) were non normally distributed (Kolmogorov-Smirnov test was <0.05) and sample sizes were small so non parametric tests were used. Kruskall – Wallis test and a subsequent Mann-Whitney U test for independent samples were used in order to search possible SFQ score differences between those with left USN (n=4), those with right-hemispheric brain lesion without USN according to BIT cut-off score (n=9) and those with left-hemispheric brain lesion (n=7.) The Spearman test was used searching possible correlations between items of the SFQ.

Results

Our purpose at this preliminary stage is to examine the patients' responses to a one-time experience in the VR street crossing task. None of the participants felt any side effects during their performance in the virtual environment. According to SFQ scores all patients (n=20) described the experience as enjoyable (mean: 3.95; SD: 1.31), they felt a marked sense of presence during their VR experiences (mean: 4.05; SD: 1.31) and perceived the virtual environment as being realistic (mean: 4.39; SD: 1.29.) Moreover, the participants showed a good comprehension of computer feedback (mean: 4.56; SD: 0.78) and a good control of the situation (mean: 3.74; SD: 1.24.) In general, they described their performance on the virtual task as a success (mean: 3.74; SD: 1.00) and did not perceive great difficulties while performing the task (mean: 4.37; SD: 0.95) or using interface devices (mean: 4.53; SD: 1.07.) In fact, two of the four patients with USN and only one of the 16 without USN were unable to complete the task due to four or more accidents. For that reason we examined possible differences between groups in all of these variables using Kruskall-Wallis test.

As the statistical test (Kruskall-Wallis) showed differences between the three groups of patients studied regarding the perception of the success ($p = 0.02$) and the comprehension of computer feedback ($p = 0.07$), the Mann – Whitney U test was performed to study where were those differences. Patients with left USN showed the lowest mean scores in both perception of the success and comprehension of computer feedback. However, only significant statistical differences were found for comprehension of computer feedback ($p = 0.01$) between patients with left USN and patients with left-hemispheric brain damage. Regarding perception of the success, significant statistical differences ($p = 0.01$) were found between patients with left USN and patients with right-hemispheric brain lesion without USN.

On the one hand, correlational analysis of SFQ variables revealed an obvious significant relationship between sense of presence and the perception of the environment as being realistic ($p = 0.04$.) On the other hand, presence or sense of being in the environment, was related to both difficulty sub-items ($p = 0.04$.) Patients who felt less sense of presence in the virtual environment showed more difficulties performing the task and using interface devices. In addition, a strong correlation was found between the sub-item difficulties using interfaces and feeling disoriented ($p = 0.006$.) In other words, patients who felt more disoriented thought they had more difficulties using interfaces, but no association was found between disorientation and difficulties performing the virtual task.

Discussion

The obtained results indicate that the use of virtual environments that simulate dangerous activities of daily living (ADL), such as crossing streets, is an adequate training tool for neglect patients. The developed virtual environment permits the customization for simulating ADL and presents a low cost and non-invasive interface for interaction.

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INAPPROPRIATE SEXUAL BEHAVIOR AND AGGRESSION OBSERVED WITHIN A NEUROBEHAVIORAL REHABILITATION SERVICE: SASBA AND OAS-MNR OUTCOMES OVER A THREE-MONTH PERIOD

Nick Alderman[1], Caroline Knight[1] and Louise Birkett-Swan[1]

The St Andrew's Sexual Behavior Assessment (SASBA) scale has recently been proposed as providing a valid, reliable means of recording inappropriate sexual behavior (ISB) exhibited by people with acquired or progressive neurological impairment. ISB amongst these populations has not previously been studied in detail, consequently, little is known about its prevalence or characteristics. In this study, SASBA data collected over a three-month period in a neurobehavioral service was examined to begin ascertaining the extent of ISB amongst people with acquired brain injury (ABI.) Overall, 699 incidents were recorded among 91 patients–most were verbal comments of a sexual nature. Comparable measures of aggression made over the same period suggested ISB was relatively infrequent, accounting for seven percent of all events. Aggression was characteristic of most patients, whereas ISB was exhibited by less than half. Two patients accounted for nearly half the SASBA recordings. Data suggested aggression primarily served an escape or avoidance function while ISB was mostly concerned with social distance reduction. Benefits of encouraging services to utilize the SASBA to ascertain prevalence and characteristics of ISB in other ABI contexts and suggestions for future research are discussed.

Keywords: SASBA, ISB, Neurobehavioral Rehabilitation, Outcome, Aggression, OAS-MNR

Introduction

A recent review by Johnson and colleagues (Johnson, Knight and Alderman, 2006) highlighted that in comparison to other behavioral consequences of acquired and progressive neurological impairment, inappropriate sexual behavior (ISB) has been relatively neglected in the literature. For example, increasingly more is known about the characteristics and causes of aggressive behavior secondary to acquired brain injury (ABI) and its management (Miller, 1994; Alderman, Knight and Henman, 2002; Tateno, Jage and Robinson, 2003; Alderman, 2003; Baguley, Cooper and Felmingham, 2006; Alderman, 2007.) However, a compatible level of knowledge about ISB has yet to evolve.

Johnson and colleagues (2006) suggested that one reason ISB has not been investigated thoroughly reflected uncertainty regarding what this comprises. They presented evidence that suggested there was no single accepted conceptual understanding or description of ISB. Accounts of ISB were frequently ill-defined, leading to variance and inconsistencies between studies regarding measurement of behaviors, and as a consequence, disagreement amongst investigators regarding its prevalence. The point was made that availability and acceptance of clear operational definitions of ISB would facilitate creation of standardized, structured assessment tools which would increase understanding of these behaviors.

More recently, Knight, Alderman, Johnson, Green, Birkett-Swan and Yorston (2008) proposed ISB might occur infrequently among people with acquired or progressive neurological impairment. This may be why it has received less attention in literature from researchers. For example, a retrospective file review of ABI inpatient and outpatient rehabilitation services identified 6.5 percent of clients as having committed some form of sexual offense, such as touching, exhibitionism or overt sexual aggression (Simpson, Tate, Ferry, Hodgkinson and Blaszczynski, 2001.) However, while this study suggests the prevalence of ISB is low, other investigations contradict this finding. For instance, in a staff survey among traumatic brain injury rehabilitation professionals, it was found that 70 percent of clinicians reported that ABI patients frequently en-

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gaged in touch of a sexual nature, and 20 percent reported that use of "sexual force" occurred on numerous occasions (Bezeau, Bogod and Mateer, 2004.)

Building on the earlier review of Johnson et al (2006), Knight and her colleagues (2008) pointed out that the apparently contradictory findings between those few studies that had examined prevalence of ISB might be attributable to methodological and other inconsistencies. Standardized assessment tools had not been used, and there was variability regarding definition, terminology, differences in scope and the populations that had been investigated.

The OAS-MNR

In many ways the challenges to obtaining reliable, valid information regarding ISB parallels those described over a decade ago by Alderman, Knight and Morgan (1997) regarding aggression as a behavioral sequelae of ABI. At that time information about the prevalence of aggressive behavior was noted to vary considerably between different studies which was attributed to use of inconsistent terminology and lack of appropriate recording tools. Consequently, these investigators developed the "Overt Aggression Scale – Modified for Neurorehabilitation" (OAS-MNR) to introduce a standardized method of describing and reporting aggression exhibited by patients primarily participating in residential neurorehabilitation programs. This was a modification of the "Overt Aggression Scale" (OAS) that had been proposed by Yudofsky and colleagues (Yudofsky, Silver, Jackson, Endicott and Williams, 1986.) The principal modifications made to the OAS to produce the OAS-MNR were to make the instrument more relevant to use within neurorehabilitation settings by adding setting events and antecedents, increasing the range of interventions used to manage behavior and develop the documentation required to support it. Psychometric properties for the scale were also determined.

The OAS-MNR enables detailed records to be made concerning the frequency of four categories of aggressive behavior–"verbal aggression"" (VA), "physical aggression against objects" (PO), "physical self harm" (PS), and "physical aggression against other people" (PP.) Each category of aggression is rated on a four-point scale regarding severity ranging from "1" (mild) to "4" (very severe.) Ratings of severity are defined using written criteria to further facilitate objective recording. For example, mild verbal aggression (rated 1) is described as "makes loud noises, shouts angrily, is not person-directed" and very severe physical aggression against people (rated 4) is "causes severe physical injury (broken bones, internal injury) to person aggression directed at."

As well as type and severity of aggression, the OAS-MNR builds on the OAS by including information regarding various environmental and other variables. This information provides formulations regarding why patients engage in aggressive behavior. Two sets of events that precede aggression are recorded. First, one of three possible "setting events," that is, environmental factors which may not directly elicit aggression themselves, but which influence the probability that this will follow an immediate antecedent (Wahler and Fox, 1981; McGill, Teer, Rye and Hughes, 2003.) These are numbered from 1-3 with "1" representing aggression took place within a structured activity, for example, a formal rehabilitation session, "2" the environment was judged to have been noisy at the time of the incident and "3" seizure activity had taken place 24 hours or less beforehand. Second, the immediate antecedent observed to directly precede aggressive behavior is recorded. Fifteen are defined within the OAS-MNR numbered "11" to "25." For example, "11" is "given direct verbal prompt to comply with instruction." If no obvious antecedent was observed then "24" is recorded. If any antecedent that is not defined within the scale is observed "25" is used and a brief description of the action that occurred is recorded by the observer. The final recording to be made concerns the intervention used to manage aggression. Fourteen are described in the scale, each being designated by a letter of the alphabet from A-N. In addition to the eleven interventions described in the original OAS by Yudofsky et al (1986), three more were added to include strategies used in neurobehavioral rehabilitation. Thirteen of the intervention strategies describe discrete action taken by staff in order to manage an aggressive incident, for example, "seclusion." The remaining category is that of "other." If an intervention is employed that is not described in the OAS-MNR, then the letter for "other" (N) is recorded on the scale and a brief written description of action taken.

Using the tool, a set of codes can be used as a shorthand means of capturing objective detail regarding potentially complex sequences of behavior. For example, "1, 11, VA3, A" reflects the presence of a possible setting event (1 – "structured activity,") that the immediate antecedent was that the patient had been "given a direct verbal prompt to comply with an instruction" (11), which had resulted in verbal aggression rated as severe (VA3 – "swearing, moderate threats clearly person directed at others or self,") that had been managed using an intervention that minimized the likelihood of reinforcing that behavior (A – "behavior ignored or 'played down' completely.")

In addition to recording information about aggression, Alderman and his colleagues (1997) proposed a means of quantifying the intrusiveness of interventions. These were produced by asking a group of 20 clinicians to independently rate 12 of the interventions in rank order of intrusiveness. The mean ranking was then assigned to each of these as an indicator of how invasive it is, using a conceptual framework that advocated behavior should be managed using the least restrictive or intrusive means possible. As a result, the least intrusive method is "behavior ignored or 'played down' completely" which is assigned a rating of 1, while the most

invasive means of managing aggression is that of "immediate medication given by injection" which is rated 12. Alderman et al (1997) also advocated adopting the method described in relation to the OAS by Kay, Wolkenfield and Murrill (1988) which further differentiates between the different types of aggressive behavior by weighting severity. Using this scheme, verbal aggression ratings remain unchanged (1-4) as this category is seen as the least severe. However, severity ratings for other types are multiplied by two, three or four for physical aggression against objects, self and others, respectively. Quantifying the intrusiveness of interventions and weighting severity of aggression by distinguishing between the different types creates further outputs from the scale that can be studied. For example, with regard to clinical outcome, reduction in intervention intrusiveness and weighted severity scores over time can also be used along with a decrease in the frequency of aggression as markers of progress.

All of the codes and descriptors for the components of the OAS-MNR are defined on one side of A4 paper. A separate recording sheet enables these to be systematically documented, as in the preceding example (contact the corresponding author for the most recent versions of these.) Staff should receive training in the use of the scale. In our service it is routinely employed with the expectation that all behavior observed that fits the written descriptions of aggression is recorded, irrespective of staff beliefs regarding the intent of the patient in deliberately engaging in that act.

Alderman and colleagues (1997) demonstrated that the OAS-MNR had good inter-rater reliability with weighted Kappa values in excess of .90 (see also Giles and Mohr, 2007) and good convergent validity as evidenced through moderate correlations between weighted severity and intrusiveness intervention.

The OAS-MNR has been widely used and successfully employed in clinical work, research, outcome measurement and service evaluation (Alderman, Davies, Jones and McDonnell, 1999; Alderman, Bentley and Dawson, 1999; Watson, Rutterford, Shortland, Williamson and Alderman, 2001; Alderman, 2003.)

The SASBA

Because the conceptual and practical issues surrounding the definition and measurement of ISB mirrored those regarding aggression that led to the development of the OAS-MNR, Knight and her colleagues proposed a new behavior observation tool–the St Andrew's Sexual Behavior Assessment (SASBA: Knight et al, 2008) scale to measure ISB in inpatient settings for people with ABI or progressive neurological conditions. The SASBA was developed directly from, and designed to work together with, the OAS-MNR. It parallels the OAS-MNR in enabling information about four categories of ISB to be captured. These were evolved from the conceptual framework proposed by Johnson and her colleagues (2006), together with clinicians accounts of behavior they had encountered of this type. The first category of ISB is "verbal comments" (VC) which includes remarks about intimate body parts and sexual acts. The second encompasses a range of "non-contact" (NC) behaviors, such as making obscene gestures. The third category is "exposure" (E) in which genitals or female breasts are exposed, or the individual is observed to masturbate in public. The final class of ISB captured by the SASBA is that of "touching others" (TO) which includes kissing or stroking other people. As with the OAS-MNR, each category of ISB is rated regarding severity on a four-point scale ranging from "1" (mild) to "4" (very severe) using written criteria to facilitate accuracy and inter-rater reliability. For example, mild "verbal comments" of a sexual nature (rated 1) are described as "intimate personal comments of mild severity such as 'Have you got a girlfriend?', 'I love you,' 'You're gorgeous.'" Similarly, the most severe form that "touching others" takes as defined on the SASBA (rated 4) is "touching others groin, female breasts, or rubbing own genitals or female's breast against another person."

All the additional information embedded in the OAS-MNR, including setting events, antecedents and interventions, are also included in the SASBA. Similarly to aggression, a set of codes can be used as a shorthand means of capturing detailed information regarding ISB. For example, "2, 14, TO2, B" mirrors that the behavior ("kissing another person" – TO2) may be associated with a potential setting event (2 – "noisy environment"), that it occurred as a direct response to another patients verbal behavior (14), and that it had been managed through verbal prompting (B – "talking to patient including prompts.")

The necessary documentation to enable the scale to be used was also developed and a program to train staff in its use was implemented. Again, there was an expectation that all behavior embraced by the SASBA, irrespective of staff beliefs regarding intent, was recorded.

The same methods for weighting the intrusiveness of interventions used to manage aggression and severity of behavior were also employed. Clinicians were asked to rank in order the four categories of ISB from least to most severe, and the mean rankings were used for the purpose of further weighting severity. Verbal comments were seen as the mildest class of behavior; consequently, the ratings from 1-4 remain unchanged. However, severity ratings for non-contact behaviors are multiplied by two and those for exposure by three. Touching others was ranked as the most severe form of ISB captured by the SASBA and as a consequence severity ratings are multiplied by four in order to convey this.

The SASBA has good convergent validity as determined through consistency in staff rankings of the perceived relative severity of

the various ISB categories and the verbal descriptors of severity within each of these. It also has good face and content validity reflected in staff ratings regarding how well it reflects behaviors encountered in clinical settings, the likelihood they would use it and a concerns vs. benefits analysis. Inter-rater reliability for the various components of the SASBA was evaluated using weighted Kappa and the intraclass correlation coefficient and found to range from "acceptable" to "almost perfect." Repeat rating of the same 12 video enactments of ISB after four weeks by three observers using the SASBA also showed that test-retest reliability was satisfactory with very little difference between weighted Kappa and intraclass correlation coefficients evident.

Knight and her colleagues concluded that they had succeeded in their aim of developing a standardized recording instrument which has good psychometric properties that is suitable for the measurement and assessment of ISB in people with PNC and ABI within inpatient settings. They also anticipated that while the SASBA had been primarily evolved for use with these populations that it would be applicable to other clinical groups where it can be employed to meaningfully contribute to formulations regarding ISB, intervention design and outcome measurement. Finally, Knight and her team proposed that the SASBA has the potential to mirror what has been achieved using the OAS-MNR to date regarding aggression in clinical work, audit, service evaluation and research within ABI inpatient settings. Furthermore, they suggested that future investigations using the SASBA will help determine its usefulness within an area that has been relatively neglected, but which continues to challenge rehabilitation services.

Some limited SASBA data was reported by Knight and colleagues as part of the validation work undertaken regarding this tool (2008.) It included ten weeks of recordings collected from an inpatient neurobehavioral unit of 14 beds. Six of the 14 ABI patients exhibited ISB, with 85 incidents recorded in total. All four categories of behavior defined by the scale were observed. "Verbal comments" were observed most frequently.

In this paper, analysis of SASBA data from a larger group over a longer period of time will be described in order to further explore the usefulness of the tool and to begin the process of establishing the principal characteristics of ISB among people with ABI. Compatible studies examining prevalence and characteristics of aggression have been previously reported (Alderman et al 2002; Alderman, 2007.) People admitted into neurobehavioral services typically exhibit levels of challenging behavior that exclude them from other rehabilitation settings and the community. These investigations provided detailed insight for the first time regarding the nature of aggressive behavior exhibited by this very challenging group of ABI survivors. It is proposed to employ the SASBA to undertake a similar survey with regard to ISB which has not been reported to date in the literature. Data collected from both the OAS-MNR and SASBA will also be compared to begin to ascertain if ISB is as prevalent as aggression amongst people admitted into neurobehavioral services.

Data harvested from clinical records over a three-month period will be examined in order to try and answer three questions that will enable the issues highlighted above to be explored. First, how useful is the SASBA? Second, what are the characteristics of ISB amongst people with ABI admitted into neurobehavioral rehabilitation services? Finally, is ISB as prevalent as aggressive behavior? In addition, further information resulting from the analysis of data regarding the validity and reliability of both the SASBA and OAS-MNR will be described.

Method

The National Brain Injury Centre, based in the Kemsley Unit at St Andrew's Healthcare, Northampton, UK, has pioneered the development of neurobehavioral rehabilitation services since 1979. Admissions typically present exhibit behavior severe enough to impede progress within neurorehabilitation services or maintenance in the community. There are separate gender care pathways for men and women who require intensive neurobehavioral rehabilitation, and services for those with longer-term needs, both in hospital and community settings. The neurobehavioral treatment program developed within the service over the past 30 years has been comprehensively described in the literature (Alderman, 2001; Wood, 1987; Eames and Wood, 1985.)

Recordings regarding patients' behavior are routinely collected from the point of admission onwards using the OAS-MNR and SASBA. These scales are used to facilitate identification of challenging behaviors that require intervention, formulation, program design, outcome measurement and service evaluation. All staff within the service are trained to use both tools.

For the purpose of this study, a survey of all OAS-MNR and SASBA recordings made over a randomly allotted three-month period was explored. Recordings were compiled into an anonymous database and investigated using SPSS v16.

Participants

Ninety one patients with acquired brain injury, aged between 18-64, were resident within the service. Most were male–69 patients, comprising 75.8 percent total–and the majority presented with severe closed head injury as classified using either duration of post-traumatic amnesia or the Glasgow Coma Scale.

Results

Frequency, classification and severity of ISB observed. Over three months, 699 recordings were made on the SASBA. Only three

were attributable to females. Table 1 shows the frequency and mean weighted severity of each category of behavior. Recordings clearly show they were not observed to occur with similar frequency (chi-square = 253.2, p<.001.) "Verbal comments" were most prevalent accounting for nearly half the incidents, while "exposure" was least numerous, amounting to just five percent of the total.

Table 1
Frequency and weighted severity of inappropriate sexual behavior by type

	Frequency	Percentage	Mean weighted severity	SD
Verbal comments	333	47.6	1.64	1.26
Non-contact	167	23.9	2.25	0.85
Exposure	37	5.3	7.81	3.76
Touching others	162	23.3	7.12	3.82

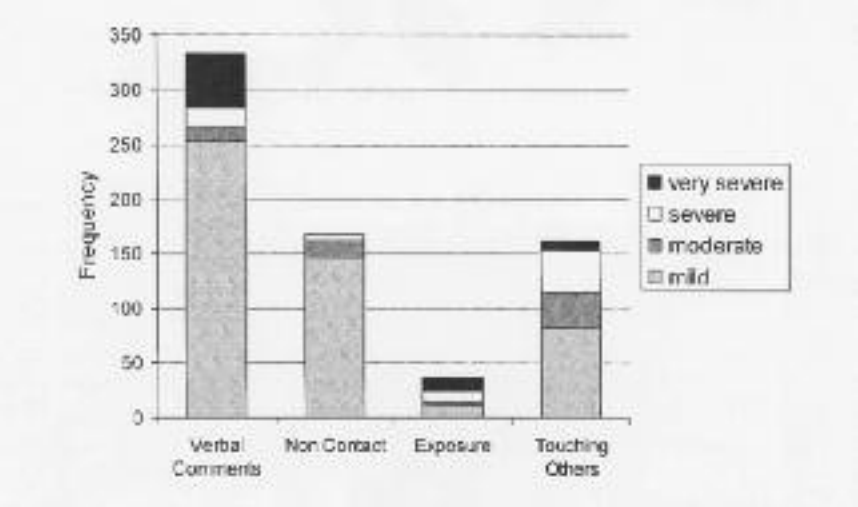

Figure 1. *Type and severity of ISB.*

Figure 1 shows that within each category of ISB most behaviors were recorded as "mild" in severity. However, Table 1 demonstrates that "touching others" and "exposure" were rated overall as more severe than both "verbal comments" and "non contact" behaviors (mean weighted severity = 7.12, 7.81 vs.1.64, 2.25 respectively.)

Setting Events and Antecedents to ISB

Table 2 suggests that only one of the three potential setting events may contribute to ISB. Little of this behavior was observed when the environment was noisy, or within 24 hours of seizure activity. In contrast, nearly three-quarters of behavior recorded occurred when patients were not engaged in formal rehabilitation sessions. A greater proportion of ISB took place at these times (chi-square = 143.1, p<.001.) This also proved to be the case for each of the four categories of ISB.

Table 2
Contributing factos and immediate antecedents to ISB

	Frequency	Percentage
Contributing factors		
Structured activity	191	27.4
Noisy environment	17	2.4
Epileptic fit in last 24 hours	1	0.1
Immediate antecedants		
No obvious antecedants	446	64.3
Other verbal interaction	125	18.0
Direct verbal promt to comply with instruction	37	5.3
Other	37	5.3
Given verbal/visual feedback	15	2.2
Agitated/distressed	11	1.6
Verbal guidance/advice	7	1.0
Purposeful behavior ignored or "played down"	7	1.0
Request denied	4	0.6
Physical guidance/facilitation	3	0.4
Given item	2	0.3

Immediate antecedents to behavior are also shown in Table 2. While 11 of the 15 available were observed, the majority of the 699 events–82.3 percent–were associated with only two. Eighteen percent of the incidents were preceded by staff verbally engaging patients that did not include prompting to comply with an instruction, being given specific feedback, advice, or denying requests. These were also associated with onset of ISB, but to a much smaller extent, making up nine percent of the total. "Other verbal interaction" thus captures communication that is characteristic of more general social exchanges. However, Table 2 clearly shows the majority of ISB did not have any obvious antecedent at all, accounting for well over half of all behavior captured (64.3 percent.)

Table 2 suggests that time spent in less-structured activities may constitute a setting event that increases the likelihood that immediate antecedents play a role in the function of ISB. In order to investigate how different levels of expectation influence behavior, the frequency of the four ISB categories, both in and out of rehabilitation sessions, was examined. Table 3 shows the principal antecedents and interventions recorded. These were chosen since they accounted for 10 percent or more of the total recordings made for each category of behavior.

Table 3
Effect of expectations (participating in formal rehabilitation sessions vs. other times) on the frequency of ISB, antecedents and interventions (10 percent or more)

Rehabilitation Sessions							
	%	Yes	No	Observed ratio	Chi-square	p	Expectations
Verbal comments		86	247		77.84	<.001	other times
Antecedents							
none	53.5	31	146	1:4.71	8.69	.003	other times
other verbal interaction	25.4	30	54	1:1.80	2.92	ns	–
Interventions							
ignored, played down	75.8	60	187	1:3.12	1.12	ns	–
talked to patient	15.6	18	33	1:1.83	1.60	ns	–
Non-contact		48	119		30.19	<.001	other times
Antecedents							
none	82.5	35	102	1:2.91	0.24	ns	–
Interventions							
ignored, played down	80.5	39	93	1:2.38	0.31	ns	–
talked to patient	14.0	8	15	1:1.88	0.63	ns	–

Table 3 continued

Exposure		9	27		9.00	.003	other times
Antecedents							
none	72.2	7	102	1:2.71	0.00	ns	–
Interventions							
ignored, played down	52.8	3	93	1:5.33	1.29	ns	–
talked to patient	47.2	6	15	1:8.33	0.53	ns	–
	%	Yes	No	Observed ratio	Chi-square	p	Expectations
Touching others		48	114		26.89	<.001	other times
Antecedents							
none	65.4	21	85	1:4.05	3.07	ns	–
other verbal interaction	17.9	10	19	1:0.90	0.72	ns	–
Interventions							
ignored, played down	59.1	27	67	1:2.48	0.08	ns	–
talked to patient	35.8	18	39	1:2.17	0.50	ns	–

The chi-square test was used to determine whether antecedents were more or less likely to be associated with ISB, in or out of rehabilitation sessions. Because ISB was less frequent in sessions, an expected value of 1:2.65 (the actual ratio of behavior that was observed in rehabilitation vs. other times) was used for the calculation. Table 3 shows the observed ratio of ISB for each antecedent within the four behavior categories. While all these were more prevalent at times other than in rehabilitation, only one antecedent was found to have a specific effect. Paradoxically, this was "no identifiable antecedent." Sexually inappropriate "verbal comments" occurred most often outside the context of rehabilitation sessions and in the absence of any immediate observable event. ISB taking place in the absence of any overt antecedent was also characteristic of the other three categories of behavior too, but unlike "verbal comments" there was no particular relationship with expectations.

Interventions used to manage ISB

Those interventions employed in the management of ISB and their frequency are shown in Table 4.

Table 4
Interventions used to manage ISB

	Frequency	Percentage	Intrusiveness (1-11)
Ignored, played down	492	70.4	1
Talked to patient	148	21.2	3
Special program	40	5.7	4
Other	16	2.3	–
Physical distraction	2	0.3	5
Physical restraint	1	0.1	7

Six of the 14 interventions from the SASBA were recorded. The most frequent was ignoring or "playing down" ISB, which accounted for nearly three-quarters of all events. This response is also ranked as the least intrusive strategy available to manage behavior. The second most frequently employed method was that of talking to patients, accounting for over 21 percent of recordings. Responses to the remaining eight percent of events comprised a mixture of low-intrusive methods, such as distraction. The most invasive strategy used was that of physical restraint (ranked 7/11) which was employed on one occasion to manage an incident of "touching others," the most distressing SASBA category, that was rated as "severe." Table 5 shows the main interventions used to manage each category of ISB. For clarity, only those accounting for 10 percent or more of recordings are shown. For each behavior category the same two methods were utilized. Ignoring or playing down ISB was most frequent, and talking to patients second most frequent. A notable finding, however, was that downplaying ISB was employed less frequently with the more severe categories of ISB. A direct verbal response to behavior was used more often in the management of "exposure" (47 percent) and "touching others" (36 percent) than proved necessary regarding "verbal comments" (16 percent) and "non-contact" behaviors (14 percent.) Furthermore, there was a significant correlation between severity of ISB and the intrusiveness of interventions required to manage them (.86, $p<.001$.) However, Figure 1 suggests this high correlation may be an evidence of the fact that most ISB is relatively benign. While a few events were rated as "severe" (10.2 percent) and "very severe" (9.9 percent,) the majority were classified as "mild" (71 percent.) The magnitude of the correlation reflects that generally low levels of severity of behavior were managed using proportionately appropriate interventions.

Finally, with regard to any contribution of expectations on either severity or management of ISB, Table 3 suggests that interventions were not determined by whether behaviors occurred within rehabilitation sessions or at other times. In addition, the intrusiveness of interventions used for any of the four categories of ISB did not differ regardless of the context in which behavior occurred. The only finding of note was that "exposure" was rated as more severe when this took place in rehabilitation sessions ($U = 54.5$, $Z = -2.57$, $p = .012$.) However, this should be interpreted with caution as it occurred relatively infrequently compared to the other ISB categories (37.)

ISB and Aggression

OAS-MNR recordings were also made throughout the same three-month period. This data enabled a comparison to be made regarding the relative frequency and characteristics of ISB and aggression.

Table 5
Interventions used with 10 percent or more of recordings made within each of the four ISB categories

Category ISB	Intervention	Percentage	Intrusiveness (1-11)
Verbal comments	Ignored, played down	75.8	1
	Talked to patient	15.6	3
Non-contact	Ignored, played down	80.5	1
	Talked to patient	14.0	3
Exposure	Ignored, played down	52.8	1
	Talked to patient	47.2	3
Touching others	Ignored, played down	59.1	1
	Talked to patient	35.8	3

OAS-MNR outputs broadly mirrored those reported previously (Alderman, Knight and Henman, 2002; Alderman, 2007.) Aggression was frequent with a total of 9,804 events recorded. Consistent with previous studies, most incidents were labelled as verbal aggression (62.9 percent) and a significant minority consisted of physical assaults against other people (2,040 incidents, 20.8 percent of total.) A greater range of antecedents were noted to precede aggressive behavior than ISB (15 vs. 11) which included being given a verbal prompt (19.2 percent events) and being agitated and distressed (21.9 percent.) As was the case with ISB, "no antecedent" was most prevalent but the proportion of events this accounted for was far lower for aggression (28.8 percent vs. 64.3 percent respectively.) A wider array of interventions was deployed to manage aggressive behavior (13 vs. 6.) The least intrusive means of responding, ignoring or downplaying behavior, was the principal method used for both aggression (71.8 percent) and ISB (70.4 percent.) Physical restraint was used more frequently in the management of physical assaults on other people (10 percent.)

In contrast to ISB and consistent with previous reported findings, expectations were found to have a more causal role regarding aggressive behavior. For example, there was an association between verbal prompts and increased prevalence of all categories of aggression in rehabilitation sessions. Similarly, agitation or distress was a characteristic precursor of aggressive behavior observed when expectations were lower. Expectations also appeared to more widely influence other aspects of aggression than was found with ISB. For example, physical assaults against others were rated as more severe when these occurred outside the context of rehabilitation sessions, and also required more intrusive means of management.

With regard to gender, it will be recalled that only a very small number of ISB were attributed to females (3: 0.4 percent of the total.) In contrast, a higher proportion of behaviors were recorded for aggression in females (1165: 11.9 percent of the total.) Interestingly, when the ratio of males to females was taken into account, aggression was more frequent amongst the latter. However, males engaged in more severe aggressive behavior that required more intrusive means of management.

Both this study and previous studies consistently report aggressive behavior is both frequent and characteristic of admissions into a neurobehavioral rehabilitation service. A direct comparison of SASBA and OAS-MNR data will help determine whether ISB is also likely to be routinely encountered within such services.

Table 6
Distribution of aggressive behaviors and ISB amongst 91 patients

Percent of Patients				Summary Statistics			
Type	No episodes	<10 episodes	10 or more	Mean	Median	SD	Range
Aggression	17.6	8.8	73.6	106.0	35	194.5	0-1043
ISB	58.2	25.3	16.5	7.6	0	25.9	0-210
Verbal aggression	24.2	16.5	59.3	66.2	19	126.8	0-633
Aggression against objects	45.1	26.4	28.5	13.3	1	33.8	0-270
Aggression against self	70.3	16.5	13.2	4.2	0	13.2	0-102
Agression against people	31.9	37.3	30.8	22.3	3	49.8	0-249
Verbal commens	67.0	23.1	9.9	3.7	0	11.9	0-93
Non contact behaviors	81.3	14.3	4.4	1.8	0	9.1	0-83
Exposure	86.8	13.2	0	0.4	0	1.2	0-6
Touching others	70.3	26.4	3.3	1.8	0	6.6	0-52

Table 6 shows the prevalence of recordings made using both measures. Over 82 percent of the patients exhibited aggressive behavior; most (73.6 percent of the total) had been aggressive ten or more times. In contrast, ISB was evident in less than 42 percent of patients and most of these had engaged in this behavior less than ten times over three months. While the majority had been aggressive 10 times or more, only a small minority had engaged in ISB to a similar extent (16.5 percent of the total.)

With regard to the various categories of aggressive behavior and ISB, Table 6 shows that verbal aggression, aggression against objects and assaults on other people were characteristic of most pa-

Table 7
Percentage of patients whose behavior was and was not recorded on the OAS-MNR and SASBA

	Categories of Behavior Recorded				
	None	**1**	**2**	**3**	**4**
Aggression	17.6	9.9	19.8	31.8	20.9
ISB	58.2	13.2	13.2	6.6	7.3

tients. Over half displayed verbal aggression on 10 or more occasions, and a third had been physically aggressive towards objects or other people to the same extent. In contrast, Table 6 shows the prevalence of the different types of ISB was low. Verbal comments were most frequent with recordings being made for 33 percent of patients, however, this was a comparatively low-frequency behavior as most engaged in this less than 10 times over the three-month period sampled. Similarly, non-contact behaviors and exposure were prevalent in less than twenty percent. The most severe category of ISB – touching others – was observed in nearly 30 percent of the group, but this was also occasional, not widespread. Only three patients had engaged in this behavior on more than ten occasions, although for two, the frequency was relatively high (33 and 52.)

Table 7 gives some information regarding the frequency in which patients engaged in one or more of the four categories of behavior captured by both scales. This provides further evidence that aggression may be characteristic of people admitted into neurobehavioral rehabilitation services, as over half exhibited three or all categories of aggression defined on the OAS-MNR. The finding that ISB is neither characteristic or prevalent amongst patients sampled here is also confirmed in Table 7–less than half showed any ISB, and most that did exhibited only one or two of the four principal SASBA behavior categories. However, whilst these behaviors are generally uncharacteristic of patients on this occasion, it is notable that a small number did exhibit three (six patients) or all (seven patients) of the four categories of ISB.

Figure 2 further builds on the information presented in Table 6. The point that most patients did not demonstrate ISB, and for those that did this was a low-frequency behavior, is restated in Figure 2. However, it also makes clear that whilst ISB cannot be claimed to be characteristic of the group as a whole, it was a frequent event for a very small number. Two patients accounted for nearly half the total SASBA record-

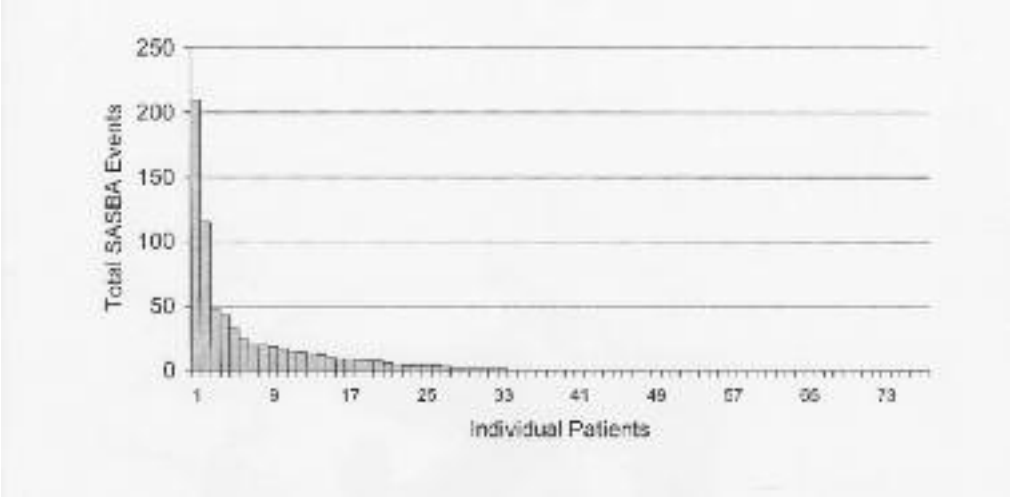

Figure 2. Frequency ISB by individual patient.

ings, logging 115 and 210 incidents respectively (46 percent of the total.)

Finally, data was explored to ascertain whether there was any linear association between aggression and ISB. There was only a modest correlation regarding frequency (.38) which suggested that not all patients who had been aggressive had also engaged in ISB, or vice-versa. Examination of data for individual patients confirmed this was the case. For example, the person with the most frequent SASBA recordings (210) had been aggressive less often (96.) In contrast, some patients who displayed very high levels of aggression demonstrated little ISB (1033 vs. 48; 1043 vs. 6; 680 vs. 0.)

Discussion

In this paper, two observational rating scales were used to capture standardized information regarding challenging behavior over a 12-week period among 91 patients resident in an inpatient neurobehavioral rehabilitation facility. One of these was a new tool, the SASBA, which builds on the psychometric properties of the OAS-MNR to provide an objective means of describing ISB.

Three specific questions were raised at the beginning of the study. First, how useful is the SASBA? Second, what are the characteristics of ISB amongst people with ABI admitted into neurobehavioral rehabilitation services? Finally, is ISB as prevalent as aggressive behavior in patients with ABI?

The first objective was to determine if the SASBA is a useful measure to employ in neurorehabilitation services. ISB had not previously been the subject of detailed investigation and there was considerable variability between outputs from investigations that have been reported. Inconsistency was attributed in part to different theoretical frameworks being employed to conceptualize ISB and a lack of an appropriate means of validly and reliably capturing information about behavior. One of the original goals in creating the SASBA was to reduce sources of investigator-induced variance by creating a tool using an operant conceptual framework of ISB which has good psychometric properties. For example, some variance in recordings can be attributable to individual clinicians making a judgement that behavior was or was not sexually motivated, however, not all clinicians will necessarily perceive the intent of patients identically, leading to inconsistent datasets (Knight et al, 2008.) The question of whether or not "intent" drives ISB is removed since recordings do not rely on clinicians making this judgement at the time of an incident. Instead, a decision on whether behavior was sexually motivated or not is made later by the clinical team reviewing SASBA data within a wider context that includes knowledge of the individual's history and other relevant information. In this regard, generating SASBA data in this survey was useful since behaviors shown by patients have been validly and reliably captured, and not influenced by perceptions of intent. What cannot be confirmed by examining group data, however, is whether all, some or no behaviors were actually sexually motivated, for example, the proportion of "exposure" events that were accidental versus intentional. However, data does provide an objective means of describing behavior within a service which has clear "usefulness" for a range of operational outputs. One might include the preparation of new members of staff by highlighting what behaviors they might encounter during their employment so they may be better able to understand and manage them effectively.

The SASBA has proved useful here in enabling a detailed snapshot to be taken for the first time regarding the characteristics of ISB within a neurobehavioral rehabilitation service. It is anticipated that future work will demonstrate its wider applicability in the way that the OAS-MNR had done at the different levels of clinical work, service evaluation and research (Alderman, 2007, 2003; Alderman, Knight and Henman, 2002; Swan and Alderman, 2004; Watson, Rutterford, Shortland, Williamson and Alderman, 2001; Alderman, Davies, Jones and McDonnell, 1999.) Group data of the kind presented here does not show the benefits of collecting information using the SASBA for clinical work with individual patients, particularly with regard to formulation and treatment outcome evaluation (Alderman, 2008.)

The second question concerned the characteristics of ISB. SASBA data from this survey has enabled a detailed, valid and reliable profile of these behaviors to be compiled for the first time.

It was found that all four categories of ISB captured by the SASBA were evident over three months. "Verbal comments" were most frequent, but conversely rated by staff as the least severe group of ISB. "Exposure" occurred infrequently but along with "touching others," received the highest severity ratings. ISB was most prevalent when patients were not engaged in rehabilitation sessions and no overt antecedent preceded the majority of incidents. As most ISB took place at times when expectations were lower, findings may reflect a tendency that these behaviors did not generally fulfil an escape or avoidance function, unlike aggression (Alderman 2007.) Instead, ISB may provide a means by which some patients initiate contact with staff at times when reduced opportunities for social engagement increase the likelihood of expression of sexual needs. Most ISB was downplayed, but a minority elicited a verbal response which may have inter-

mittently reinforced it. This highlights the need for staff to review and discuss what form the intervention "talked to patient" meant, as this encompasses a variety of reactions, including admonishment, redirection or distraction. Discriminating between different levels of verbal response is crucial to an accurate formulation regarding ISB and its subsequent management.

Of course, it remains to be seen whether the ISB captured in this survey is generally characteristic of people with ABI. Data was captured within the context of a neurobehavioral rehabilitation service to which people with severe challenging behavior are referred, so it might be a reasonable expectation that ISB may be more frequent and severe amongst this population than among other groups of people with ABI. This seems to be the case with aggression. A recent study that followed up people with ABI six, 24 and 60 months post-injury in the community found that 25 percent at any one time had demonstrated significant levels of aggression. While this statistic is disquieting, it nevertheless suggests that aggressive behavior is not the norm amongst most people with ABI in the community. In contrast, data from this study and other studies (Alderman, 2007; Alderman, Knight and Henman, 2002) suggests that aggression is the norm among people referred to neurobehavioral rehabilitation services. The prevalence and characteristics of ISB within community and other settings can now be measured using methodologies that utilize the SASBA and compared to data captured within specialized services.

The last question to be considered is whether or not ISB is as prevalent as aggressive behavior. In light of the comments above, the comparison can only be made regarding people with ABI in this study. Nearly 700 events were recorded over three months, so on the basis of that figure alone, it would seem reasonable to conclude that ISB is both frequent and characteristic of people admitted to neurobehavioral services.

However, two points undermine the generality in this conclusion. First, the OAS-MNR recordings showed aggression was much more evident, with ISB only accounting for less than seven percent of the total behavior captured by the two scales. Second, whilst aggression was characteristic of most patients, ISB was not, with just two patients accounting for nearly half the SASBA data. There was also only a modest correlation between ISB and aggression. This finding suggests that at a broad level, the two categories of behavior have different aetiologies, such as a pre-existing forensic disorder or varying locations of brain lesion sites. Alternatively, using an operant framework of explanation, lack of association between ISB and aggression, and differences in antecedents and interventions, may imply they serve different functions – aggressive behavior that of avoidance and escape, whilst ISB may primarily fulfill a social distance reduction function. Whilst these are generalities, SASBA data can make a significant and valid contribution to a formulation regarding ISB at the level of the individual patient (Alderman, 2008)

Finally, while this sample suggests ISB may be a more idiosyncratic outcome of ABI than aggression, the adverse impact it can nevertheless have on families and carers should not be overlooked. For example, it can contribute to high staff turnover in care settings and increase the risk of sexual abuse of vulnerable patients (Kettl, 2008.) Consequently, it is important to reduce anxiety, distress and risk associated with these behaviors through education and effective management of ISB. The SASBA can play an important role in both these, and other, activities.

Future Research

In the SASBA, a standardized, reliable and valid means of measuring ISB within acquired and progressive neurological impairment populations is now available. As was the case with the OAS-MNR when it was published more than a decade ago, availability of the SASBA has drawn attention to the need to encourage rehabilitation and long-term care facilities to utilize one measure to record ISB so that data can be meaningfully compared between different services. In addition, services also need to be encouraged to define the sample characteristics of populations for whom SASBA data is being reported to further validate comparisons, especially with regard to the applicability of different treatment approaches.

To better understand the prevalence and characteristics of ISB amongst people with ABI, the SASBA needs to be utilized within a wider range of settings and contexts, and the outputs from these applications reported in the literature.

Finally, in addition to SASBA data which highlights the influence of the environment to behavior, the possible contribution of other variables to ISB should be explored. For example, using the OAS-MNR Alderman (2007) found that physical assaults on other people was primarily the product of complex interactions between the environment and individual factors, particularly poor language function and the presence of other behavioral symptoms of neurobehavioral disability. Clinical accounts regarding use of the SASBA at the level of the individual patient are also encouraged. Increased knowledge and enhanced understanding of what drives ISB will undoubtedly lead to better formulations and interventions to help reduce prevalence, severity, distress and increased risk associated with these behaviors.

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EFFECTS OF VIRTUAL AVATAR CHARACTERISTICS ON PERFORMANCE OF HEALTHY SUBJECTS' TRAINING TASKS

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In the application of training for virtual rehabilitation, virtual avatars are used to help subjects performing exercises in a virtual environment. Effectively, the representative characteristics of virtual avatars have a strong impact on subjects when performing their exercises. Therefore, the selection of a suitable avatar is important. Our work aims to analyze the effects of virtual avatar representative characteristics on the performance of a training task done by healthy subjects. The system used consisted of a Cave Automatic Virtual Environment, a motion capture system and an avatar rendering library called Cal3D. The developed system also captures the gesture of subjects, renders it by virtual avatars and supports a simple game of "Ball Reaching." By changing the representative characteristics of virtual avatars, our scenarios enable the experimentation of two approaches. The first analyzes the effects of virtual avatar representative characteristics on the performances of the subject playing the game "Ball Reaching." The second measures the effect of virtual avatar representative characteristics on the performance of the subject replicating a motion which is represented by a virtual avatar. Based on our proposed real-time weighted Longest Common Sub-Sequence algorithm, the effect measured here is the similarity between represented motion of a virtual avatar and motion replicated by the subject. Our experiment shows that, for doing simple tasks, performance deviation of healthy subjects between the different types of representative avatars isn't considerable. However, when the tasks are complicated, types of representative avatars have a strong impact on the performance of tasks performed by healthy subjects.

Keywords: Virtual human, Third-person View Virtual Environment, Motion Evaluation, Motor Rehabilitation, Virtual Rehabilitation

Introduction

Many current and potential applications for human activities are developed through virtual reality (VR) systems involving virtual humans or virtual avatars (VA.) Several popular applications include computer games, simulation-based training and learning, surgery and plastic surgery performed on virtual patients and virtual psychotherapies. Effectively, the use of VA not only increases the natural interaction within a virtual environment but also increases the sense of presence. The user experiences a more natural perception of autonomous actors, increases their sense of being together and thus enhances the overall sense of shared presence in the environment (Thalmann, 1999.) Training applications for virtual rehabilitation using virtual avatars are increasingly being used. Actually, the purpose of using a VA in a functional rehabilitation application is to better guide patients performing therapeutic training tasks. In this way, the considered tasks are physical activities aiming to rescue dysfunctional muscle. For example, video games are played and human gestures are replicated and represented by a virtual avatar. Effectively, the representative characteristics of avatars, such as a skeleton, 2D virtual avatar, 3D virtual avatar, viewpoint of the represented avatar (face to face or face to back with the subject) have a strong impact on the performance of those tasks. In this paper, the aim is to analyze those effects in choosing the most suitable avatar. It is assumed that a VA performing well with healthy subjects will perform well with rehabilitated subjects as well. Hence, the experimentation could be performed with healthy subjects.

The remainder of this paper is organized as follows. Section 2 gives an overall configuration of the training-based system, materials used as well as approached method. Section 3 de-

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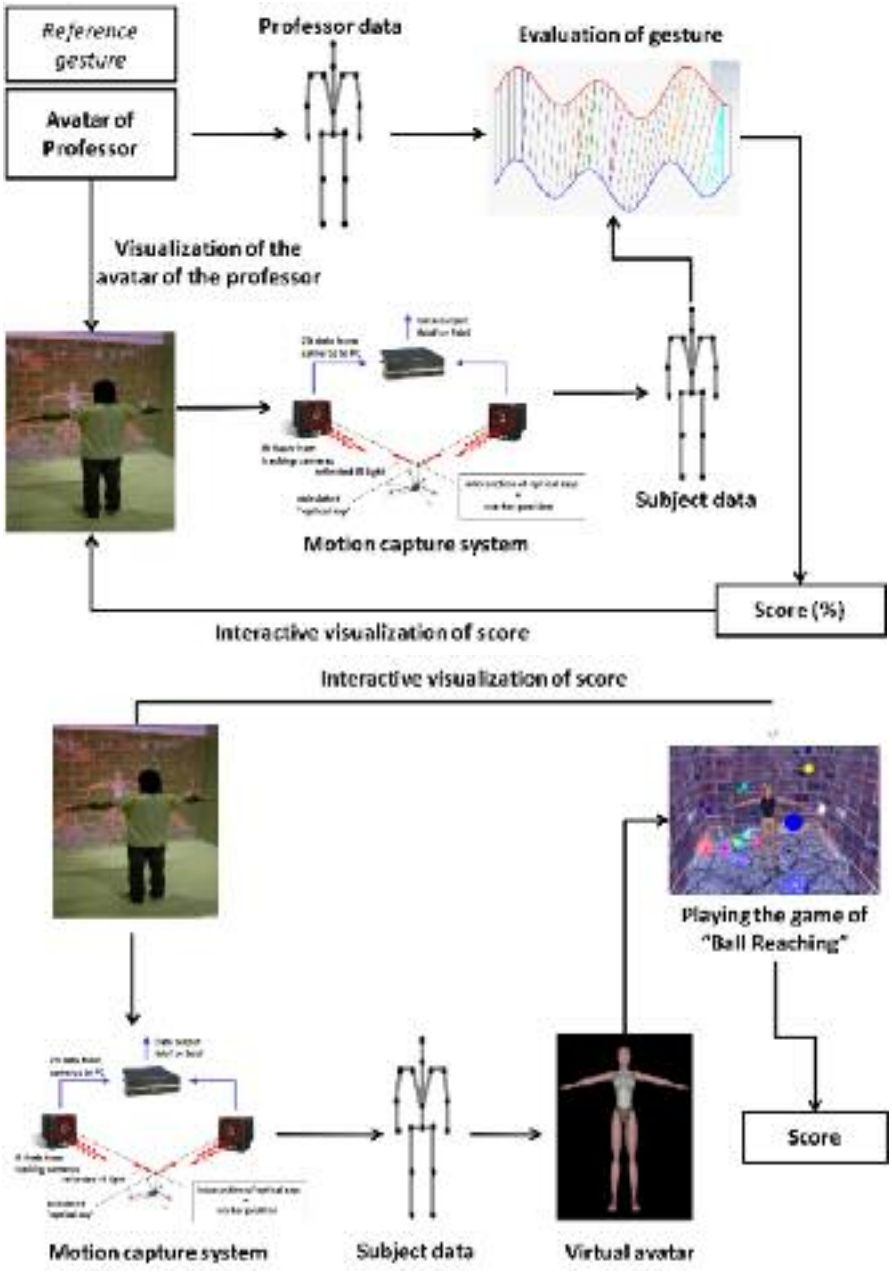
scribes the proposed real-time weighted Longest Common Sub-Sequence (rwLCSS) technique for measuring the performance of replication the human gesture. Section 4 details the protocol of experimentation of the case study. In Section 5, the result of experimentation and discussion will be presented. Finally, Section 5 concludes with a brief discussion of the case study.

Overall training-based system

The system architecture is illustrated in figure 1 below.



Game-based training system

Figure 1. Overall training-based system for functional rehabilitation. Top system illustrates for human gesture learning and bottom illustrates for "Ball reaching" game learning.

The system illustrated in figure 1 consists of two parts. The first part represents the human gesture training objective while the second part describes the purpose of the game. Our system uses a 6DOF infrared motion capture (MoCap) system (A.R.Tracking) and a Cave Automatic Virtual Environment (CAVE) in which the users are attached by markers and their motions are captured by an A.R.Tracking system. In the studied prototype, four attached markers in the arms captured upper-limb motion of users.

In the game playing system, the captured motion of the subject is rendered by a virtual avatar, shown at the bottom of figure 1. The mission of the game is for the subject to control the avatar in order to reach the multicolored balls generated by the system. The score of the game is the quantitative score, calculated by the total length of reached balls. Further details concerning the game scenario will be described in the Section 4 – Protocol of case study.

In the human gesture training system, shown at the top of figure 1, the virtual avatar is used to render the reference motion which is recorded and stored in a database volume. The task of the subject here is to see the avatar's motion and to reproduce it simultaneously. Motion of subject is captured by A.R.Tracking and taken into account to compare the subject motion with the reference motion in real-time. The goal of performing this task is the similarity shown between the avatar's motion and the subject's motion. In this case, the reference motion database is based on Tai-Chi motions which are recorded by A.R.Tracking system and are interpolated to reach the frequency of 60Hz. Tai-Chi motions have been shown promote many health benefits and are increasingly used for therapeutic purposes.

To render the avatar, the Cal3D library was used, which works on the basic of H-ANIM 1.1 (Aristidou et al., 2008) human skeleton standard. H-ANIM 1.1 defines the human body as a number of segments such as the forearm, hand and foot connected to each other by joints such as the elbow, wrist and ankle. Each joint in the body is represented by a joint node used to define the relationship of each body segment to its immediate parent. In this case, a joint is represented by an axis-angle as: P(x, y, z, w) or P(w1, w2, w3, 1) in a more compact representation, where w1 = x.w, w2 = y.w, w3 = z.w. For measuring the similarity between two motions, a needed distance between two joints represented in axis-angles is defined as follows (Cardle, 2004):

$$d(P_1,P_2)=\sum_{i=1}^{3}(w^1{}_i-w^2{}_i)^2$$

Effectively, each type of joint has a different influence on the human animation. Definition for the weights for each joint was done manually after calculating the distance between them. Because of more influence, parent joints are more weighted than child joints in general. This problem will be recalled in the section of explaining the real-time wLCSS.

Having defined the joint representation, it is then possible to define the motion or animation in the case as follows. An animation is a sequence of key-frames and a key-frame is defined as a set of position and orientation values of human skeleton joints. A general formula of animation Q which includes m key-frames of D-joints can be described as follows:

$$Q=\{(q^1{}_0,q^2{}_0,...,q^D{}_0\},(q^1{}_1,q^2{}_1,...,q^D{}_1),...,(q^1{}_m,q^2{}_m,...,q^D{}_m)\}$$

In our case, the number of joints D = 4 (number of attached markers in user's upper-limbs) and m is temporal length or dimension of animation.

As described above, the goal of the subject to reproduce the reference motion rendered by virtual avatar. The captured motion of subject in represented in real-time. In reality, because the frequency of training progress can be different from 60Hz (the standard frequency of reference motion), there is a need to synchronize the frame of reference motion with the frame of subject motion. To do that, there was a need to calculate the time to render a virtual scene and then use it to indicate correct key-frame of reference motion which is rendered in the virtual scene. Besides, in real-time training, motion of the subject always starts later than the motion of the avatar. Accordingly, the evaluation progress is finished when the temporal length of the trainee's motion is equal to the temporal length of the virtual avatar. Similarity between the two motions is rendered by an indication of the percentage of similarity. More detail about this similarity will be explained in the next section.

Real-time weighted Longest Common Sub-Sequence (rwLCSS)

The proposed rwLCSS algorithm is based on the wLCSS technique which is widely used to solve the time-series data matching problem. Therefore, it is important to review the related works for time-series data matching techniques to explain the reason the LCSS-based technique was used. Time-series data matching is a part of data mining in very large database (VLDB) domain. To solve the time-series data matching problem, there are many proposed methods divided by two main approaches– the Model-based approach such as Hidden Markov Model (HMM), Neural Network (NN), Support Vector Machine (SVM), Bayesian Network (BN) and Distance function-based approach which is discriminated in two sub-approaches, in which the first one is called the Metric functions such as Euclidean distance, Manhattan distance or Normal distance and the second one is called the non-met-

ric functions such as weighted Dynamic Time Wrapping (qDTW), wLCSS, Edit distance with Real Penalty (ERP), Edit Distance on Real sequence (EDR) and Spatial Assembling Distance (SpADe.) Recalled in this case is the result of the experimental work done by Keogh et al., 2002, which aimed to compare performances between two approaches– the model-based algorithm and the distance function based algorithm. This work has shown that the performance of the second approach is much better than with the first one, for both accuracy and computational cost. Moreover, work of Ding et al., 2008, performs a comparison of the major techniques of distance function-based approaches by testing their effectiveness on 38 time series data sets from a wide variety of application domains (Ding et al., 2008.) Experimental results obtained show that, in over a dozen distance measures of similarity among time series data in the literature, weighted Longest Common Sub- Sequence (wLCSS) (M. Vlachos et al., 2002; André-Jonsson et al., 1997; Vlachos et al., 2006) and weighted Dynamic Time Wrapping (wDTW) (Keogh et al., 2002;Keogh et al., 2005) are slightly better than the others methods for obtaining accurate measurements. Moreover, on large data sets, the computation cost of LCSS and DTW is very close to the Euclidean distance algorithm.

In reality, wLCSS and wDTW are the most popular techniques used in time-series data matching applications. However, in this case, work was done with motion capture (MoCap) data which is a type of time-series data. MoCap data is captured by recording the positions of the markers during the motion. Unlike other types of time-series data, such as stock and weather, MoCap data usually has many outliers and noises mainly due to sensor failures, disturbance signals or errors in detection technique. By their characteristics, MoCap data consists of different sampling rates of tracking and recording devices combined with different speeds of moving objects. Therefore, a distance function that can address the following issues is used (Vlachos et al., 2002):

– Different sampling rates or different speed
– Different data lengths
– Capability of ignoring the outliers
– Robustness to noise

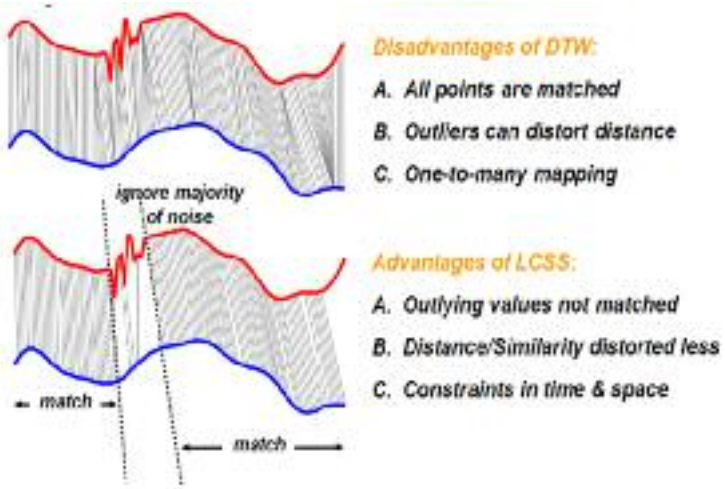


Figure 2. A comparison between wDTW and wLCSS techniques (Vlachos, et al., 2002.)

Practically, the wDTW technique performs on all items of a MoCap data sequence so wDTW is not capable of ignoring outliers. Furthermore, this technique is sensitive to noise. The LCSS technique has already been applied to address these problems (Vlachos, 2006.) Effectively, some works have shown that LCSS is more robust and appropriate when comparing distance measure for MoCap data than DTW (Croitoru et al., 2005.) The figure 2 shown above displays a comparison between wDTW and wLCSS techniques. Accordingly, wLCSS is the basic distance to propose a real-time function which is used in the system and the proposed method is noted real-time wLCSS or rwLCSS in reduction.

The standard of LCSS (Cardle, 2004) over two multi-dimensional time-series motions Q (query or reference motion) and C (candidate or replicated motion) with temporal length of n and m, respectively, is defined recursively as follows:

$$LCSS_{\delta,\varepsilon}(Q,C)=\begin{cases}0 & \text{if } Q \text{ or } C \text{ is empty}\\ LCSS_{\delta,\varepsilon}(Head(Q),C) & \text{if } m<n\\ 1+LCSS_{\delta,\varepsilon}(Head(Q),Head(C)) & \text{if } \forall d\in D\left|q_{d,n}-c_{d,t}\right|<\varepsilon_{d,t} \text{ and } 0\le m-n\le\delta_n\\ max(LCSS_{\delta,\varepsilon}(Head(Q),C),LCSS_{\delta,\varepsilon}(Q,Head(C))) & \text{if } \forall d\in D\left|q_{d,n}-c_{d,t}\right|>\varepsilon_{d,t} \text{ and } 0\le m-n\le\delta_n\end{cases}$$

Where $\delta \in \Re^{+}$ is temporal threshold,

$\varepsilon \in \Re^{+D}$ is the spatial threshold

D is the total number of dimensions to match over.

The temporal and spatial complexity of the LCSS model are in the order of O(d (n+m)) with a constant matching window d and O(max(m,n)), respectively (Cardle, 2004; André-Jonsson et al., 1997; Vlachos et al.,2006.)

In this case of motion matching, each key-frame is a multi-dimensional time-series in which D is the number of joints to match over. Due to the weight or the priority of joints discussed above, instead of using LCSS, wLCSS was used. Practically, wLCSS is the LCSS case when the definition is a different spatial threshold e for each joint. The more weighted joints will be defined with less value of e and vice-versa. Hence, the assignment of weights for each joint is equivalent to assign the spatial threshold in LCSS model. The final similarity between two time-series motions is defined as:

$$D_{\delta,\varepsilon}(Q,C)=1-S_{\delta,\varepsilon}(Q,C) \text{ with } S_{\delta,\varepsilon}(Q,C)=\frac{LCSS_{\delta,\varepsilon}(Q,C)}{\min(n,m)}$$

Based on wLCSS, a real-time rwLCSS model was proposed. Qt is the subsequence of reference motion from begin to time instant t, ct is key-frame of trainee's motion at time instant t and rwLCSS(Qt, ct) is a function of the longest common subsequence between Qt and ct. The rwLCSS(Qt, ct) is defined recursively as follows:

$$wrLCSS(Q_t,c_t)=\begin{cases}0 & \text{if } Q_t \text{ or } c_t \text{ is empty}\\ 1+wrLCSS(Head(Q_t),c_{t-1}) & \text{if } \forall d\in D,\left|q_{d,n}-c_{d,t}\right|<\varepsilon_d\\ max(wrLCSS(Head(Q_t),c_t),wrLCSS(Head(Q_t),c_{t-1})) & \text{otherwise}\end{cases}$$

Shown here, n is the temporal length of Q at time instant t. Effectively, the temporal and spatial complexity of rwLCSS model are in the order of O(d) with a constant matching window d and O(n) with the dimension of reference motion n, respectively. Accordingly, the real-time similarity between Qt and ct is defined as follows:

$$D_{\delta,\varepsilon}(Q_t,c_t)=1-S_{\delta,\varepsilon}(Q_t,c_t) \text{ with } S_{\delta,\varepsilon}(Q_t,c_t)=\frac{LCSS_{\delta,\varepsilon}(Q_t,c_t)}{n}$$

Protocol of Case Study

The case study consisted of two parts–one for the game-based experiment and the other for a human gesture learning based experiment. In this section, the experimental protocol of the case study is explained in detail.

As described in the introduction section above, both the game-based experiment and the human gesture training based experiment are performed with a set of five representative characteristics of virtual avatars. These are shown by three types of represented avatars and two of types of avatars from representation viewpoints. It is considered the skeleton avatar is the same for both of the viewpoints. The following table illustrates the different conditions used for the experiments. The (L-R) notation in the image illustrates Face-to-Face mode while (R-L) notation illustrates Face-to-Back mode between the virtual avatar and the trainee.

Table 1
Five combinations of representative virtual avatar considered to study

Participants

Nine participants aged from 22-43 years old (mean 30.4 ÷ 6.9) participated in the case study. The participants were made up of a sample of healthy staffs member at the Institute. All participants were familiar with virtual reality technology and all tests were carried out at the MOVE system of the Institute. Effectively, each participant performed 40 tests of human gesture training and six tests of game-based learning.

"Ball Reaching" game playing experiment

The size of the MOVE system used was a height of 300 cm, a width of 300 cm and 300 cm deep. The normalization resolution of the front screen was a 150 * 150 unit called graphical point (GP.) Due to the equivalence between the size of real room and the size of the virtual room where the virtual avatar was rendered, the size of virtual room here is defined as150 * 150 * 150 GP in which 150 GP is equivalent with 300cm. The MOVE structure and coordinate system are shown in figure 3 as below.

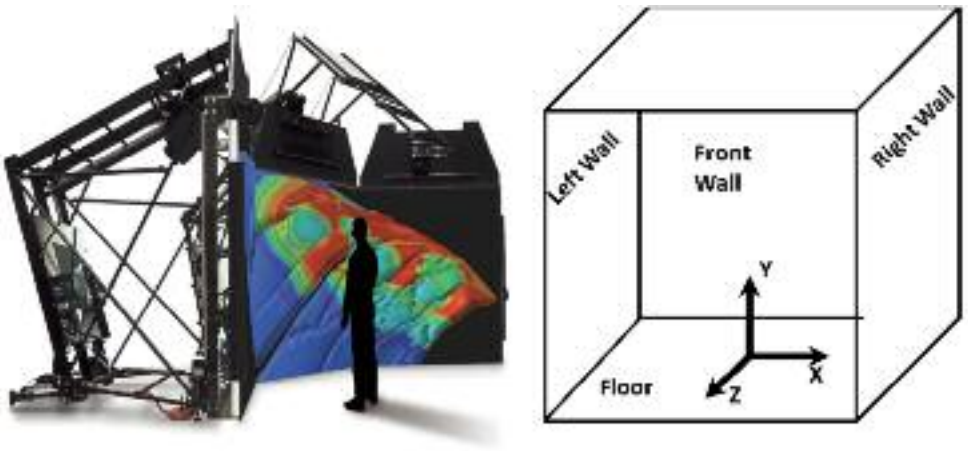


Figure 3. MOVE structure (left image) and coordinate system (right image) of our approached system.

In the exercise performed, the participant had to reach 48 multi-colored, multi-radius (r) and multi-velocity (v) balls divided uniformly by four levels of complexity–group of slow-moving, large balls ($10 < r < 15$ GP, $20 < v < 70$ GP/s) – level 1, group of slow-moving, small balls ($5 < r < 10$ GP, $20 < v < 70$ GP/s) – level 2, group of fast-moving, large balls ($10 < r < 15$ GP, $70 < v < 150$ GP/s) – level 3 and group of fast-moving, small balls ($5 < r < 10$ GP, $70 < v < 150$ GP/s) – level 4.

The complexity of divided levels here is only our intuitiveness. Practically, forty-eight balls are launched in random order for each time the trainee plays the game.

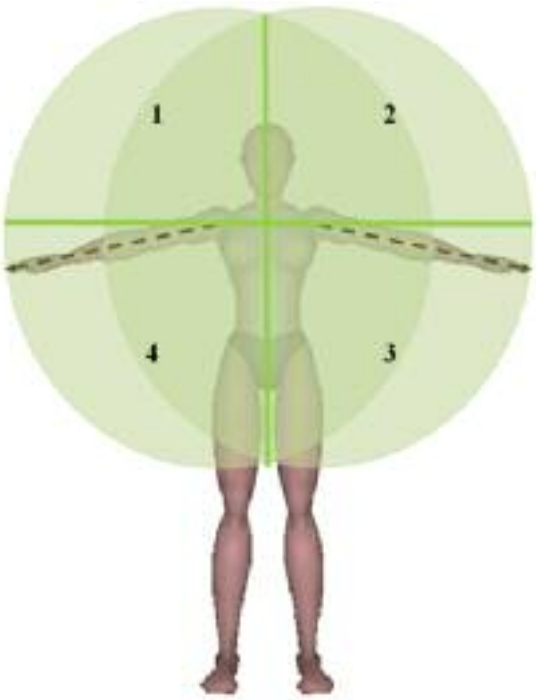


Figure 4. Limited zone to generate the reachable balls and uniform distribution of generated balls.

The scenario of the game is described as follows. At any instant, the system generates one ball from the initial position on the virtual front wall with radius of R and velocity vector $V(0,0,z > 0)$r. Due to the initial parameters of V, it is known that the ball will move along the Z axis with the initial state from the front wall to the back wall in the virtual room. During the motion, if the ball comes into contact with the front or back wall, it will continue in the opposite direction. The purpose of the trainee is to control the upper-limbs of the chosen avatar in order to reach the ball. The next ball is only generated when the previous one is reached. The quantitative score is calculated by the length the balls have traveled when they are reached with an accuracy of 1GP. Upper-limbs only were studied, therefore, to ensure that all the balls are reachable, balls were only generated in a limited zone composed by two circles made by the upper-limbs. Figure 4 shown above illustrates the limited zone in a light green color. In addition, to allow right-handed and left-handed players successfully reach the balls, the generated balls were distributed uniformly in all four sub-zones noted in figure 4. Hence, each sub-zone contained 12 balls at four levels of complexity.

Tai-Chi gesture training experiment

Most Tai-Chi motions consist of eight gestures divided intuitively into two mains groups–the slow and simple gestures and the faster, more complex gesture group. The simple Tai-Chi group includes five motions while the more complicated group includes three motions. Several examples of Tai-Chi gestures are shown in figure 5 and figure 6 below.

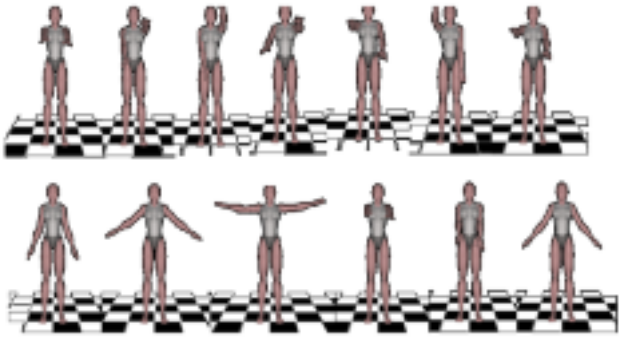


Figure 5. Example of slow and simple Tai-Chi motions in 3D human avatar representation.

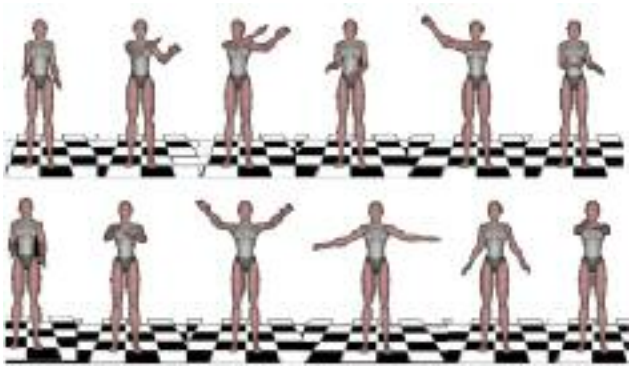


Figure 6. Example of more complex Tai-Chi motions in high velocity in 3D human avatar representation.

Five avatar representations and eight Tai-Chi motions result in 40 pairs of avatar types and motion samples. Hence, the trainee performed the experiment in a random order consisting of this set of 40 pairs. Effectively, the task of the participants was to view the avatar's motion, which was rendered in the CAVE room, and to reproduce it simultaneously. The task was accomplished when the reference motion finished. The percentage of similarity between the two motions was measured by rwLCSS in which the spatial thresholds of 10 degrees and 20 degrees for upper-arm joints and lower-arm joints, respectively, were chosen manually. Practically, the performance of doing this task was updated and illustrated on the front screen of MOVE in real-time. To analyze the results, the final performance of the training test was taken into account.

Result & Discussion

Performance of playing the game of "Ball Reaching"

Using the obtained length each ball was driven, we summed the totals of 48 balls, resulting in a classification in four different levels of complexity, which each ball can fit into. Thus, these values are considered to illustrate the performance of each representation avatar in the ball-reaching task with a lower performance correlating to a longer length. Figures 7, 8, 9 and 10, shown below, illustrate the performances reaching the balls in graphs illustrating the four levels of complexity. Level 1 (slow and big ball) and level 2 (slow and small ball) are shown in figures 7 and 8, respectively, while level 3 (fast and big ball) and level 4 (fast and small ball) are shown in figures 9 and 10, respectively. Five of the representative avatars (Skeleton, Face-to-Face 2D human avatar, Face-to-Back 2D Human Avatar, Face-to-Face 3D Human Avatar and Face-to-Back 3D Human Avatar) are numbered from 1 to 5, respectively. In each graph, the left part illustrates the curves of performance of nine subjects for five types of representative avatars and the right part of the graph illustrates the vertical line of performance of five types of avatars for nine subjects.

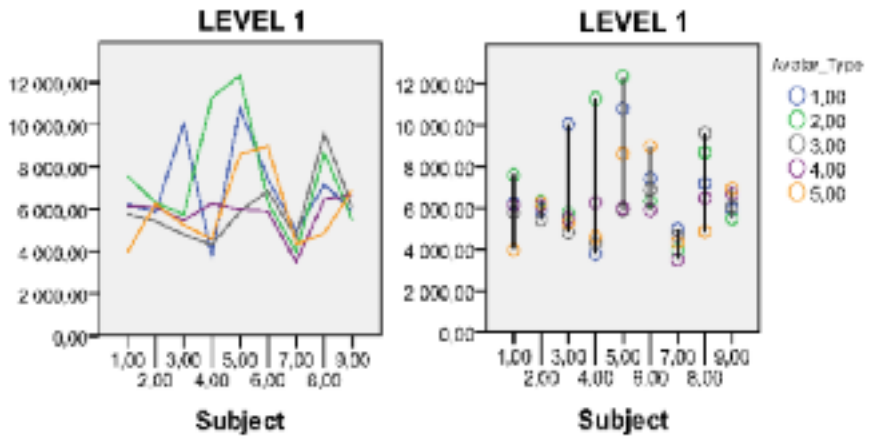


Figure 7. Reaching ball task performance graph of level 1.

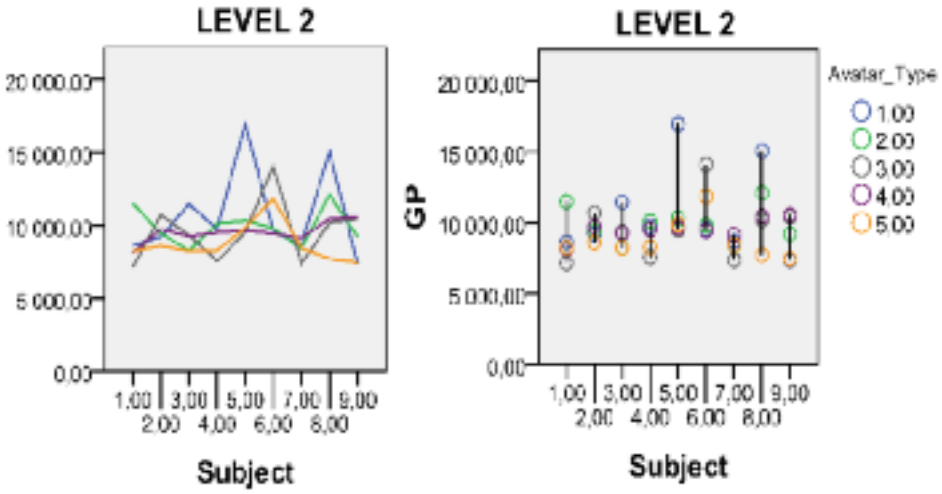


Figure 8. Reaching ball task performance graph of level 2.

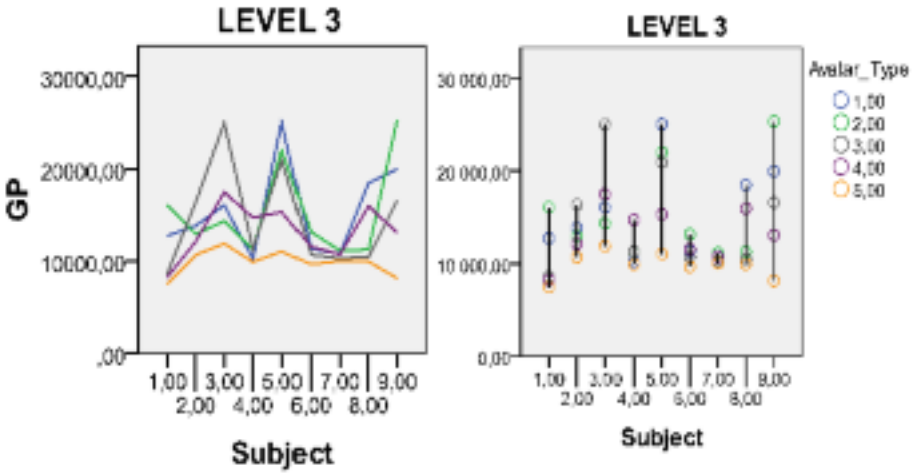


Figure 9. Reaching ball task performance graph of level 3.

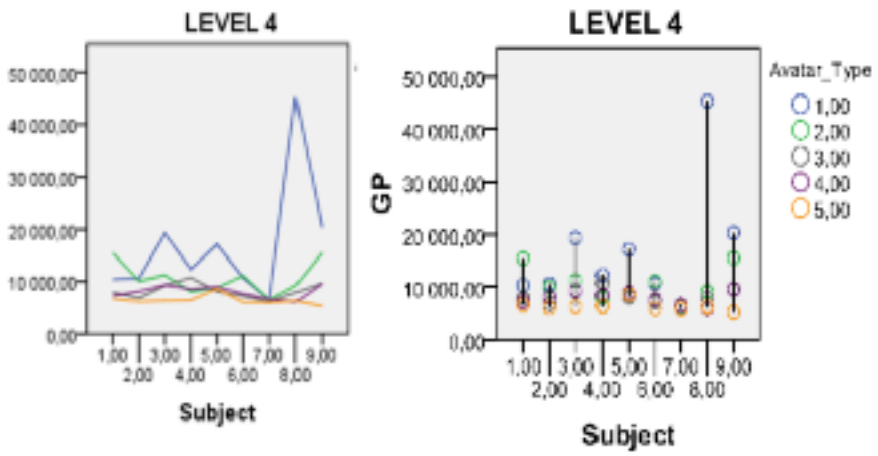


Figure 10. Reaching ball task performance graph of level 4.

From the figures, it is shown that in the cases of levels 1 and 2 containing easy-to-reach balls, the differences among performance of the five representative avatars didn't have much meaning. Indeed, in level 1, while subject 1 obtained the best result using the Face-to-Back 3D virtual avatar, subject number 3 obtained the best result using the Face-to-Back 2D virtual avatar. In level 2, while subject number 6 obtained the best result using the Face-to-Face 3D virtual avatar, subject number 1 obtained the best result using the skeleton avatar. However, in cases of level 3 and 4, containing more difficult-to-reach balls, there were significant deviations observed using different representative avatars. In both cases, the Face-to-Back 3D virtual human resulted in the best performance, in which the hardest-to-reach balls in level 4 showed a quite plain classification among the five representative avatars and the skeleton avatar resulted in the worst performance.

Performance of reproducing the Tai-Chi motions:
From the final results obtained from 40 tests done using nine subjects, an average was calculated using the performances for five representative avatars in two levels of motions. Figures 11 and 12 shown below illustrate the performance graphs for five types of avatars in two groups of complexity of Tai-Chi motions–easy motions and complicated ones.

From those figures, we can see that, in both complexities of motions, the fourth type of avatar representation (Face-to-Face 3D virtual human) obtained the best performance. Concerning the easy motions, the differences between the curves are quite small thus, the avatar representations did not result in a significant difference in performance. In relation to the more complicated motions, the classification is quite clear–the fourth type of representative avatar shows the best performance while the third type (Face-to-Back 2D virtual avatar) resulted in the worst performance in general. In order to perform a more significant assessment, a one-way analysis of variances (ANOVA) on those performance curves of complicated motion was performed with multiple comparisons between the representative avatars by using the Tukey Honest Significant Difference (Tukey HSD) method. The result is described in table 2 shown below.

Shown in the significant values of table 2, the difference in performance between the fourth type of representative avatar and the other types is very significant. The significant values between the fourth-type with the first, the second, the third and the fifth one are 0.004; 0.031; 0.000; 0.010 and 0.047. All values are less than $p = 0.05$ and their mean differences are in their 95 percent confidence interval. Hence, the Face-to-Face 3D virtual human has the best performance for reproducing the Tai-Chi motions task.

Through two experiments conducted during the case study, it was observed that the high quality 3D virtual avatar resulted in the best performance during both the "Reaching Ball" game task and reproduction of the Tai-Chi motions in real-time task. While the Face-to-Back viewpoint of the avatar representation resulted in a better performance in the first task of playing the game, the Face-to-Face viewpoint of the avatar representation resulted in a better performance in the second task.

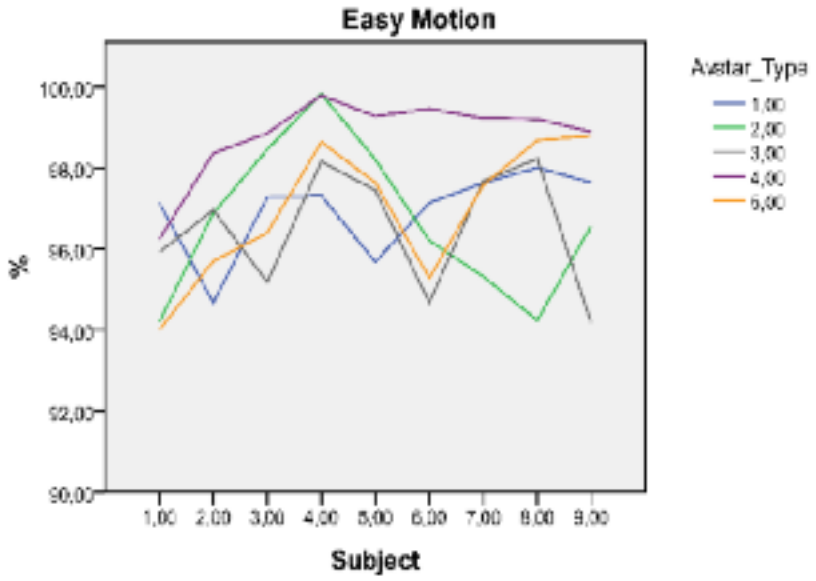


Figure 11. Curves of performance of reproducing the Tai-Chi motions in real-time of easy motions.

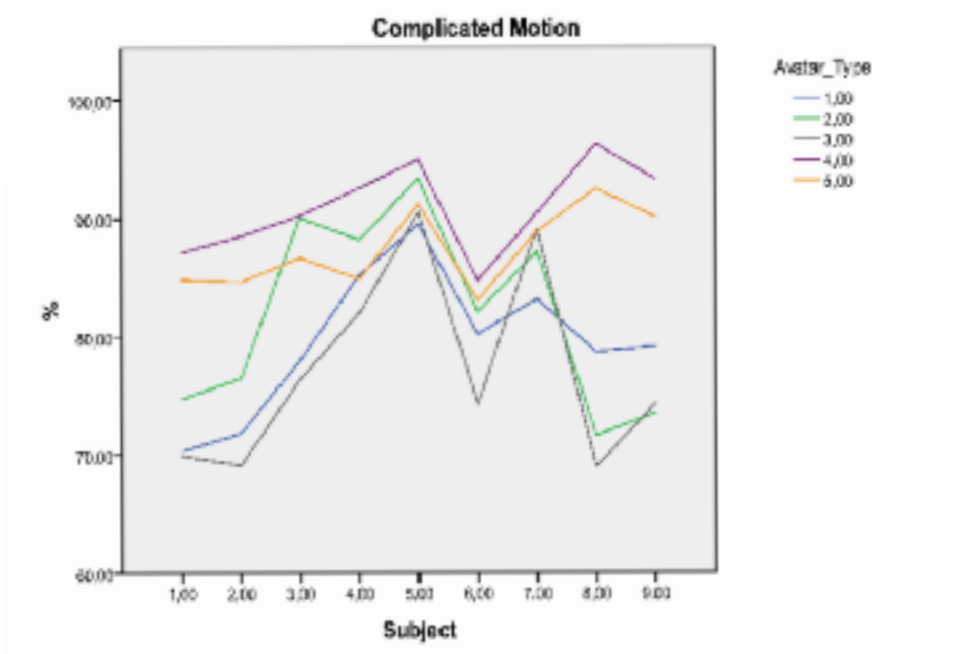


Figure 12. Curves of performance of reproducing the Tai-Chi motions in real-time of complicated motions.

Table 2

Using one-way ANOVA for the performance of reproducing the complicated motions

(I) Avatar_ Type	(J) Avatar_ Type	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
1,00	2,00	-2,35667	2,94083	,929	-10,7560	6,0426
	3,00	2,38556	2,94083	,926	-6,0137	10,7848
	4,00	***-11,34389****	***2,94083***	***,004***	***-19,7432***	***-2,9446***
	5,00	-7,85956	2,94083	,076	-16,2588	,5397
2,00	1,00	2,35667	2,94083	,929	-6,0426	10,7560
	3,00	4,74222	2,94083	,498	-3,6571	13,1415
	4,00	***-8,98722****	***2,94083***	***,031***	***-17,3865***	***-,5879***
	5,00	-5,50289	2,94083	,349	-13,9022	2,8964
3,00	1,00	-2,38556	2,94083	,926	-10,7848	6,0137
	2,00	-4,74222	2,94083	,498	-13,1415	3,6571
	4,00	***-13,72944****	***2,94083***	***,000***	***-22,1287***	***-5,3302***
	5,00	-10,24511*	2,94083	,010	-18,6444	-1,8458
4,00	***1,00***	***11,34389****	***2,94083***	***,004***	***2,9446***	***19,7432***
	2,00	***8,98722****	***2,94083***	***,031***	***,5879***	***17,3865***
	3,00	***13,72944****	***2,94083***	***,000***	***5,3302***	***22,1287***
	5,00	***3,48433***	***2,94083***	***,047***	***-4,9150***	***11,8836***
5,00	1,00	7,85956	2,94083	,076	-,5397	16,2588
	2,00	5,50289	2,94083	,349	-2,8964	13,9022
	3,00	10,24511*	2,94083	,010	1,8458	18,6444
	4,00	***-3,48433***	***2,94083***	***,047***	***-11,8836***	***4,9150***

Note. The mean difference is significant at the 0.05 level.

Effectively, for performing simple tasks, performance deviation of healthy subjects between the different types of representative avatars isn't considerable. But when the tasks are complicated, types of representative avatars have a strong impact on the performance subjects performing the tasks.

Conclusion

In this paper, a novel approach was proposed to analyze the effects of virtual avatar characteristics on the performance of training tasks executed by participants. Measurable training tasks were defined and a technique to measure the performance of doing those tasks was implemented. Hence, the experimental results shown here are quantitative. Furthermore, the ANOVA technique to analyze the results was used, thus, the assessment is significant. Therefore, the effective representative virtual avatars studied should be considered in relation to third-person view training-based and game-based virtual rehabilitation framework, in which the trainees are the patients.

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ELECTRONIC PDA DIETARY AND PHYSICAL ACTIVITY REGISTERS IN A WEIGHT LOSS TREATMENT PROGRAM FOR CHILDREN: A DESCRIPTION OF THE ETIOBE PERSONAL DIGITAL ASSISTANT SYSTEM

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Childhood obesity is a significant health problem in western societies. Self-monitoring techniques, such as the use of dietary and physical activity registers, are considered to be central to cognitive-behavioral weight control programs. Traditionally, these conventional diaries have been created using pen and paper, however, this technique has several limitations. The objective of this paper is to describe an electronic Personal Digital Assistant (PDA) system for recording food and physical activity for the treatment of childhood obesity. The authors review the benefits and limitations of such electronic diaries.

Keywords: Personal Digital Assistant, Ecological Momentary Assessment, Obesity, Self-report, E-Health

Introduction

Children suffering from weight-control issues and obesity are increasingly common public health problems, and are the most common childhood disorders in Europe (European Association for the Study of Obesity, EASO; 2002.) According to a report from the International Obesity Task Force (IOTF) published in March 2005, this problem is rapidly worsening in some European countries, particularly in recent years. The treatment of childhood obesity must be multidisciplinary, taking both medical and psychological factors into account. As for psychological interventions, Cognitive-Behavioral Treatments (CBT) are currently considered the treatment of choice (Gilles et al. 2008.) CBT programs for obesity are based on the theory that instead of forcing a patient to follow a diet forever–a therapeutic target that is very difficult to achieve–it is more effective to attempt to change the user's habits, such as learning how to achieve balance in consumption. To this end, CBT programs designed to treat obesity include components designed to promote changes in behavioral, cognitive and emotional patterns that contribute to obesity (Sarwer, Foster, & Wadden, 2004.) These programs focus on modifying patients' eating habits and physical activity levels (Wilson & Brownell, 2002.) The guidelines that have proven to be the most useful from this point of view are the following–the use of self-register for self-evaluation and self-control (recording information about eating and physical activity), stimulus control, psychoeducation, cognitive techniques for changing thoughts and dysfunctional attitudes, interpersonal relationships and relapse prevention.

Self-register techniques are considered necessary for both assessment and treatment phases. The goal is to evaluate behaviors in a natural setting such as home or school. The patient is given a paper which explains the behavior to be recorded and the conditions under which it must be done. It is important that the behavior is recorded immediately, in order to minimize memory bias (Beasley, Riley, Davis & Singh, 2008.) The information obtained allows the clinic to identify the behavior cues and the thoughts and emotions associated with the behavior. A more accurate evaluation can therefore be made, and the treatment effects and the patient's evolution can be assessed.

For obesity, the most important targets to be self-monitored are: information about diet and physical activity. As assessment tool, a fundamental benefit of diary methods is that they permit the ex-

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amination of events and experiences in their natural, spontaneous contexts (Solhan & Trull, 2007); furthermore they allow patients to see the positive changes they are making, and to observe their progress..

As a therapeutic technique, self-monitoring is central to CBT weight control programs; some authors (Boutelle & Kirschenbaum, 1998) believe it to be the most effective technique for helping people lose weight and maintain a healthy weight (Perri, Nezu, & Viegener, 1993.) The use of diaries promotes self-awareness, thus increasing the capacity for self-control and self-regulation and enhancing patient motivation and readiness for change. Cooper, Fairburn & Hawker (2003) noted several useful functions of the self-register technique in weight loss treatments; for example, it helps patients make positive change by increasing their awareness of their behavior, enhances control over eating, helps them identify which behavior and patterns of thinking need to be addressed, and helps the therapist and patient examine patients' behavior, thoughts and emotions as well as cues that elicit the behaviors (Wilson & Vitousek, 1999.)

The frequency of dietary self-monitoring during weight loss treatments is a reliable predictor of success (Streit, Stevens, Stevens & Rossner, 1991.) Data suggest that adult subjects lose more weight during the weeks when they self-monitor (Helsel, Jakicic & Otto, 2007.) In a weight loss treatment for children, Kirschenbaum, Germann and Rich (2005) found no differences between low and high self-monitoring groups during the treatment; however, they found significant differences in weight change over three and six months of treatment.

Traditionally, the use of these conventional dietary and physical activity registers have been created using pen and paper; however, they have several limitations including the inconvenience, and the difficulties to record information in real time (Burke et al, 2008.) Another important limitation is poor rates of adherence to the treatment (Baker & Kirschenbaum, 1993; Germann, Kirschenbaum, & Rich, 2007), which worsen over time (Burke et al, 2005.)

It is necessary to design more efficient methods to simplify the process of self-monitoring and to improve the consistency and completeness of self-reports (Helsel, Jakicic & Otto, 2007.) Information and Communication Technologies (ICT) can help achieve this goal. In recent years, new mobile technologies such as personal digital assistants (PDAs) and mobile phones have become more readily available, thus generating new interest in developing systems adapted for these tools.

Research has indicated that the use of a PDA improves dietary self-monitoring frequency (Stone, Shiffman, Schwartz, Broderick & Hufford, 2002; Yon, Johnson, Harvey-Berino, Gold & Howard, 2007; Lee & Bakken, 2007.) Research also shows that electronic diaries improve adherence to treatments (Beasley et al. (2008) and levels of acceptability (Fowles & Gentry, 2008) over paper diary systems. Another benefit of electronic registers for dietary information is that nutritional feedback can be provided to the user in real time and can be compared with daily targets for these values; this helps shape dietary behavior (Beasley, Riley & Jean-Mary, 2005), provides a direct measure of compliance (Bolger et al, 2003), and improves responsiveness to users' questions. Thus, the system can adapt to the real time characteristics of the time, location and mood of the user.

In order to adapt electronic diaries for weight loss treatments for children, certain factors need to be considered. For example, the language and the interface must be adapted for children in order to ensure good usability of the system; additionally, a reinforcement system must be used. The objective of this paper is to describe a PDA application of an electronic diet and physical activity register. This electronic dietary assistant is one component of a larger e-health platform called ETIOBE that was developed as a weight loss treatment for children. The ETIOBE platform is an intelligent e-therapy system (eTI) for the treatment of obesity; its objective is to improve treatment adherence and promote the mechanisms of self-control in patients, to obtain the maintenance of achievements (reduced body weight) and to prevent relapses through establishing healthy habits.

The "intelligent" aspect of ETIOBE includes sensors that allow the clinician to obtain relevant information about the patient (contextual, physiological and psychological.) The system also includes various communication and information applications for transferring, managing, and storing such information and for interpreting and reacting to it. Furthermore, the applications can be personalized and adapted in accordance with the patient's answers and characteristics. Technically, ETIOBE comprises three different applications. Clinical support system (CSS) is an Internet tool that allows the clinician to design an adapted guidelines intervention, with the ability to adapt it according to the patient's progress. This platform is connected to the other platforms, which allows the clinician to be aware of the patient's progress in real time. Home support system (HSS) is a website where the child finds the tasks the clinician has selected (including self-reports, dietary registers, and physical activity registers.) The website also features a nutritional and healthy lifestyle knowledge component, with the support of several "serious games" which help the children absorb the information. Mobile support system (MSS) is comprised of a dietary and physical activity self-register based on PDA technology, sensorization and physiological information recruitment that is connected in real time to the CSS. The objective of this paper is to describe this electronic self-monitoring application.

ETIOBE Personal Digital Assistant System for Registering Dietary and Physical Activity Information

Because the application will run on PDAs using the Windows Mobile operating system, it was developed using .net technology based on Compact Framework 3.5 for mobile devices. The Microsoft .NET Compact Framework (.NET CF) is a version of the .NET Framework that is designed to run on Windows CE-based mobile/embedded devices such as PDAs, mobile phones, factory controllers, set-top boxes, etc. The .NET Compact Framework uses some of the same class libraries as the full .NET Framework as well as a few libraries designed specifically for mobile devices such as Windows CE InputPanel. However, the libraries are not exact copies of the .NET Framework. The ones in the .NET Compact Framework are scaled down to use less memory. The Microsoft .NET Compact Framework 3.5 Redistributable contains the common language runtime and class libraries built for the .NET Compact Framework. In addition to version 3.5 support, it also supports applications developed for version 1.0 and 2.0.

The .NET Compact Framework supports various programming languages such as C#, visual Basic.NET, and C++. Our application was written in C#.

Figure 1. Main screen.

Figure 2. Login screen.

This application allows the patient to enter personal information into the system. In this version the patient can create two types of registers, for diet and activity.

The application starts automatically when the PDA is turned on; this increases ease of use for children. First, the main screen appears, which includes the logo of the ETIOBE system and a button with the tag "self-records" (Figure 1.) The application always remains open; therefore, if the PDA is set to "standby/energy saver" mode, the main screen with the ETIOBE logo automatically appears when the active mode is resumed.

When users want to fill in a record, they must press the "self-records" button. The login screen then appears, and after completing login the user presses the exit button and returns to the main screen of the application (Figure 2.)

Dietary Register (see Figure 3)

- **Screen A:** The date and the time when food was ingested is entered in this screen. By default, the current time is entered, but can be modified.
- **Screen B:** Food eaten by the user is entered in this screen. For each type of food eaten, the amount (a piece, a glass, a dish, etc.) and order should be entered. All of this information is stored in a table, in which each row shows the type of food ingested (with the amount and order.) Thus, in the same self-record entry, patients can enter more than one food eaten; for example, the first row could be a dish of pasta and second row could be an apple. It is possible to add and delete rows as needed.
- **Screen C:** The social situation at the time of ingestion is selected in this screen. The different possibilities are presented as images accompanied by a short title. There are three possible situations: alone, with friends, and with parents.
- **Screen D:** In this screen The place where the user ate the meal is selected in this screen. As in the previous screen, the choices are presented as images with a short title identifying each. In this case there are five possibilities: home, kiosk, bakery, bar, and school.
- **Screen E:** The event preceding the meal or snack, and the user's thoughts prior to ingestion are entered in this screen. These two elements are entered as text.
- **Screen F:** The emotion experienced by the user prior to eating is selected in this screen. The different choices are presented as images accompanied by a short title. The five choices are: happy, angry, greedy, sad, and calm.

After entering the data, a message indicating that everything has been stored correctly is shown; if there is any problem, a message indicating the mistake appears. Next, a screen with a virtual agent or avatar appears with a message of encouragement. (The avatar is configured by the user using a different application, called Home Support System.) Finally the login screen again appears so that the user can fill out a new self-record or close the application.

Figure 3. Food dietary screens.

Physical Activity Register (see Figure 4)
- Screen A: This screen is the same as in the case of the dietary self-record. It contains the date and time when the activity occurred. By default, the current time is entered, but can be modified.
- Screen B: The activity completed and its duration are entered in this screen. The activity is entered as text and the time can be increased in increments of five minutes.

As in the dietary self-record, after entering the data a message indicating that everything has been stored correctly is shown; if there is any problem, a message indicating the mistake appears. Next, a screen with a virtual agent or avatar appears with a message of encouragement. Finally the login screen again appears so that the user can fill out a new self-record or close the application.

Screen A Screen B

Figure 4. Physical activity.

Discussion

This paper describes a PDA system designed for registering Dietary and Physical Activity information for the treatment of childhood obesity; it is an important component of the ETIOBE system. The use of self-records is fundamental in evaluating and treating obesity. However, traditional self-recording systems have significant limitations. Situational constraints, lapses of motivation and memory can result in missing reports in diary protocols (Piasecki, Hufford, Solhan & Trull, 2007.) The use of electronic PDA diaries offer important advantages and may enhance weigh loss treatments and assessment of nutrition and physical activity habits in children. They are portable and can be easily carried by participants, allowing for immediate entry of food intake; this aspect is critical for children who need to have higher levels of activity. Furthermore, the system is flexible and can be adapted to the specific conditions of each particular user. Additionally, such programs enable direct communication between therapists and patients through the internet, which facilitates real time monitoring. Moreover, the date and time of the self-record is accessible at all times, which offers therapists current information on the nutritional or lifestyle habits and progress of patients.

Another important benefit of the PDA system is that researchers can set an alarm within the PDA to remind participants that they should record their food intake. Alarms could reduce measurement errors that could occur when recording food intake at the end of a day. This alarm system can also alert the clinician if patients drastically reduce the number of their registers. It can be added an encouragement message system when the registering is correctly done. The software can give feedback to the patient if daily objectives have been met or not met.

Another advantage is that child participants may enjoy using a PDA to record dietary information, and may thus be more likely to keep accurate dietary records. Although the use of new technologies can be a barrier for older populations, the opposite is true for children and adolescents; the use of new technologies helps motivate them. Another advantage is that the digital information entered into the PDA system is easier for clinicians and researchers to share between different databases than information written manually. Furthermore, since participants enter their responses directly into the electronic diaries, there are fewer transcription errors and less missing data.

Like other methods, electronic diaries have both strengths and weaknesses. Bolger, Davis, and Rafaeli (2003) have pointed out several limitations. One is the high development cost of such programs. Furthermore, electronic devices require maintenance and may break or need replacement. Other minor but relevant problems are related to the mobile device design: usually the font sizes are small, visual contrast is not very sharp, and the battery power of the devices does not always suffice. Furthermore, these devices are best suited for simple responses, as entering open-ended responses is difficult. However, these technical limitations are expected to lessen greatly in coming years. Fortunately, as mobile devices increase in their capabilities, their size and cost decrease (Goodwin Velicer, & Intille, 2008.)

Further studies on the feasibility of using electronic diary in a broader range of specific populations are needed. However, as mobile technologies become ubiquitous, more robust, and less expensive, new software programs to meet the needs of the clinicians will be developed (Piasecki et al., 2007.) Electronic diaries using PDAs are likely to become routine tools in clinical psychology. As Bolger et al. (2003), pointed out, technological innovations are rapidly occurring, and in the near future we might have mobile devices able to "conduct ecologically valid research that would be minimally intrusive and maximally reflective of individuals' ongoing feelings, thoughts, goals, behaviors, and circumstances."

The next phase is to study such programs' usability, analyzing problems that can emerge in the use of the diary application by children without health problems. Researchers must identify problems and suggestions for improvement for electronic redesigned registers; this will require a controlled study comparing the efficiency of an electronic diary with the classical pen-and-paper version. This will necessitate an intra-subject design, wherein the group of children with weight problems will use both systems. Once the efficacy and efficiency compared to traditional modes has been analyzed, this component will be incorporated into childhood weight loss treatment programs, and the efficacy of two groups (using electronic and traditional systems) can be compared.

It is expected that electronic PDA diaries will improve the efficacy of self-recording techniques, improving their reliability and validity, as the users will register more data with greater accuracy and consistency. Furthermore the mobile electronic version will improve adherence to these tasks, rather than allowing users' motivation to deteriorate over time. Advantages of PDA recording systems are also anticipated to increase therapeutic efficiency in childhood weight loss programs.

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DEPRESSION INFORMATION ON THE INTERNET FOR ASIAN AMERICANS

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The anonymity of the Internet may provide depression information to Asian Americans who often associate depression with shame and stigma beliefs and avoid treatment. We interviewed 20 Asian Americans regarding reasons for Internet depression information use, non-use, and relevant Web site topics. Thematic analysis was used to analyze the qualitative responses. Reasons for Internet use included difficulty talking face-to-face, confidential, useful information, and convenience. Reasons for non-Internet use included "not a good source" and denial concerning depression. The Internet can allow for depression information tailored to Asian Americans and this study suggests topics of interest to include on such a Web site.

Keywords: Asian Americans, Depression, Internet, Information Dissemination, Chinese

Introduction

In the United States, the Asian American population of 13.5 million individuals makes up of five percent of the United States population (United States Census Bureau, 2005.) Structured interviews from population-based epidemiologic studies report 12-month depression prevalence of 3.4 percent to 4.2 percent (Takeuchi, Chung, & Lin et al., 1998; Hasin, Goodwin, Stinson, & Grant, 2005.) Lifetime depression prevalence ranges from 4.3 percent to 8.8 percent (Iwamasa & Hilliard, 1999; Hasin et al., 2005.)

Treatment for depression and mental health concerns is affected by shame and stigma beliefs among Asian Americans (Root, 1985, Surgeon General, 2001.) Beliefs related to shame include that the presence of mental illness can affect the good name of a family for generations (Tabora & Flaskerud, 1994) and that a family "loses face" and is shamed by having a family member with mental illness (Tabora & Flaskerud, 1997.) Beliefs related to stigma include seeking professional help for mental health concerns indicates personal weakness, immaturity, and a lack of self-discipline (Uba, 1994.)

There are a number of variables associated with stigma beliefs for depression and mental health concerns among Asian Americans. Lower acculturation levels are associated with greater stigma levels (Atkinson & Gim, 1989; Leong & Lau, 2001.) Men have greater stigma levels than women with regard to friends and employer while there are no differences with regard to family (Fogel & Ford, 2005.) With regard to age, those ages 46 to 60 years have lower stigma levels than younger age categories with regard to stigma for friends and employer. However, the converse is true with regard to family stigma where younger age is associated with higher stigma levels for family (Fogel & Ford, 2005.)

Besides stigma concerns, Asian Americans have lower levels of treatment seeking for mental health problems than whites and other racial/ethnic groups (Leong & Lau, 2001; Surgeon General, 1999; Zhang, Snowden, & Sue, 1998.) Even for Asian Americans who seek treatment, these Asian Americans are more likely to prematurely stop treatment at a higher rate than whites (Leong & Lau, 2001.)

The Internet is used by many Asian Americans with almost as high levels of use as among whites (U.S. Department of Commerce, 2004) and can be a venue for providing access to information that may not be easily accessible elsewhere. Also, the Internet can allow for anonymous access of information related to depression and an anonymous psychoeducation approach can possibly minimize the shame and stigma perceived by Asian Americans. One study among Asian American college students using an online support group found that these participants believed that the online support group offered support, discussed relevant concerns, and that participants were comfortable using this online support group (Chang, Yeh, & Krumboltz, 2001.) Another study among Asian American college students found that the participants preferred traditional face-to-face psychological treatment rather than online psychological treatment. There were also gender differences with

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women having more positive opinions about traditional face-to-face psychological treatment than men (Chang, 2004.)

Regardless of preference or not for online treatment, providing depression information online can be very useful. One study reported on the development of a Web site about depression for college students (Meyer, 2007.) Students were very satisfied with this Web site and there were 50,000 Web site hits over the first year. One student even e-mailed the Web site developers that reading the information motivated this student to seek depression treatment from a doctor.

To our knowledge, there are no studies that focus on developing a depression information Web site for Asian Americans. Asian Americans have concerns for depression that differ from the general population. The aims of this study were to explore the reasons for use and non-use of the Internet for depression information among Asian Americans. We also asked about specific topics that should be included on such a Web site.

Method

Participants and Procedure

Participants included 20 undergraduate students enrolled at an inner-city college located in the urban area of New York City. Individuals were approached in class or in public places at the college and asked if they were Asian American. Also, snowball sampling techniques were used where after completing an interview, participants were asked to recommend friends who were Asian Americans. Of the 17 women that were approached, seven refused to participate. Of the 10 men that were approached, all 10 agreed to participate. Participants were offered $25 to participate in an interview which took approximately 30 minutes. Participants were told that they would be tape recorded throughout the interview. Data collection occurred from September through December 2007. Informed consent was obtained from participants. The study received Institutional Review Board approval.

Measures

Demographics

Demographic variables included age, sex, ethnicity, immigrant status, and years lived in the United States if they were an immigrant.

Questionnaire

Participants completed the Center for Epidemiologic Studies Depressed Mood Scale (CES–D; Radloff, 1977.) The CES-D is a 20-item scale that measures depressive symptoms with higher scores indicating greater depressive symptoms. Response options range from "0=rarely or none of the time" to "3=most or all of the time." A commonly used cut-off value of 16 or greater is often used to indicate the likelihood of clinically significant depression (Radloff, 1977.) This scale had adequate Cronbach alpha reliability levels in the original study (0.85 to 0.90) and in this sample (0.88.)

Semi-structured Interview Questions

Participants were asked to answer the following three questions as part of the interview. These questions were 1) "Why would one use the Internet for obtaining information about depression?," 2) "Why would one not use the Internet for obtaining information about depression?," and 3) "What topics would be important to include on an Internet Web site providing information for depression to Asian Americans?"

Qualitative Analytic Approach

All tape-recorded interviews were transcribed. Approximately 15 percent of this transcribed data was reviewed to ensure that they were accurately transcribed. There were no a-priori judgments about ideas to interpret for the coding. Both authors independently coded each phrase with a line-by-line approach. All these coded phrases were then reviewed together. For the approximately 10 percent of phrases where there were initial interpretation differences, both authors discussed the differences and by consensus agree on how to code. The final coding had 100 percent agreement. Thematic analysis was then used to guide the qualitative analytic approach. This included coding for each specific question, looking for semantic themes, and reviewing the themes to ensure that they related to the coded extracts and to the whole data set available for that specific question (Braun & Clarke, 2006.) Both authors independently reviewed each of the coded phrases to decide upon relevant themes/categories for each question. Both authors had the goal of creating the smallest number of themes/categories for the numerous coded phrases. After reviewing these themes/categories together and discussing them, both authors agreed upon the final themes/categories. Any differences in interpretation were discussed and agreed upon by consensus to allow for 100 percent agreement for the themes/categories.

Results

Sample characteristics included mean age of 21.1 years (SD=2.07.) The gender distribution was 50 percent men (n=10) and 50 percent women (n=10.) The ethnicity distribution was 95 percent Chinese (n=19) and 5 percent Korean (n=1.) Immigrant status included 50 percent immigrants (n=10) to the United States and 50 percent (n=10) who were born in the United States. For those who were immigrants, they had lived a mean of 6.7 years in the United States (SD=3.92.) Mean CES-D score was 14.7 (SD=8.53), with 60 percent (n=12) having scores below 16 and 40 percent (n=8) with scores of 16 or greater. Half (n=10) had previously searched for depression or depressive symptom information on the Internet.

Using the Internet to Obtain Information About Depression

As shown in Table 1, there were 11 different themes/categories regarding the question about using the Internet to obtain information about depression. Five of the themes/categories were each endorsed by 20 percent (n=4) or more of the participants. These themes/categories are described below.

Table 1
Themes/Categories Regarding Internet Use to Obtain Information About Depression

Theme	# of individuals	# of themes
Difficult talking to someone about depression	6	9
Confidential	5	6
Obtain specific information about understanding depression or treatments for it	5	7
Convenient	5	5
Information about personal emotional component	4	6
Excellent source	3	3
To help oneself	2	2
Free way to obtain information	1	2
Educational activity	1	1
Obtain professional contact information	1	1
Communicate with others with depression	1	1

Difficulty Talking to Someone About Depression

This included, "If they don't have many friends around them, so they have to look up information from the Internet instead of communicate with his friends" and "I think because they don't want to tell another person thinking what they might say or might think."

Confidential

This included, "It's more confidential I guess because you don't have to worry about anyone knowing who you are. You could speak freely on these type of things and look at stuff freely without worrying about any consequences" and "I think it's more privacy because you are the only one that's there looking and reading."

Obtaining Specific Information about Understanding Depression or Treatments for Depression

This included, "Someone use [the] Internet because it's available, there's a lot of information on it so they can quickly and easily access a lot of information about a specific topic such as depression" and "The Internet has a lot of Web site[s] from different countries and you could look it up many in-

formation instead of looking it up in the books and you don't know which book is useful for you."

Convenient

This included, "I don't usually go to the library so it's very convenient at home to go on the Internet and research for anything you want" and "It's easy, convenient … you could look up the information whatever time of the day you want."

Information About Personal Emotional Component

This included, "They wouldn't know much why they feel depressed" and "From my opinion maybe themselves has some kind of feeling; their friend or family has those kind of feeling."

Excellent Source

This included, "You're comfortable to really look up whatever you want and expand your search if necessary because all the resources are there" and "I think the Internet has a lot of Web site[s] from different countries and you could look it up many information instead of looking it up in the books and you don't know which book is useful for you and also like sometimes people's opinion about certain things you will find out other people's opinions too. So I think that's the most useful for the Internet; just click in the words and you can get the information you want."

To Help Oneself

This included, "I think most of the time people search depression because they might be depressed and are trying to find a way to help themselves."

Free Way to Obtain Information

This included, "I don't need to pay the money to see a psychologist, but a lot of information on the Web is free."

Educational Activity

This included, "Maybe they are writing a topic about [depression]."

Obtain Professional Contact Information

This included, "They want to get professional help and they don't know enough about it and maybe they have social phobia; they don't want to go out, they just want to stay home."

Communicate With Others With Depression

This included, "They could not only find definitions in dictionary terms but they can also find forums where they discuss these topics. For instance, if you're feeling depressed you can maybe go online and find a forum where other people are feeling the same way as you and you can ask them for advice."

Not Using the Internet to Obtain Information About Depression

As shown in Table 2, there were nine different themes/categories regarding the question about not using the Internet to obtain information about depression. Two of the themes/categories were each endorsed by 20 percent (n=4) or more of the participants. These themes/categories are described below.

Internet Is Not A Good Source

This included, "It's too much distraction online, like you can do other things, play video games, watch videos to get their mind off depression instead of searching for about it" and "I would say it's not really safe in a way because they don't know who is posting all those comments."

In Denial

This included, "Maybe he is in denial and he doesn't want people to know" and "I think they might be too stubborn for not believing that they themselves are depressed, like they just don't want to admit that they are depressed."

Ashamed About Depression

This included, "He feels helpless, you can't get help from others."

Wants Professional Help

This included, "It's definitely not the same as seeking professional medical advice especially if you're looking for something that is serious, you might not want to trust the Internet for that. You might actually want to see someone."

Prefers Live Person

This included, "They might not be comfortable without face-to-face contact with someone. Some people like confidentiality, some people prefer to see someone face-to-face and actually talk about it."

Technology Issues

This included, "They are not technologically savvy, they don't really know that resource is there."

These Feelings Are Normal

This included, "They don't feel that way, maybe they think it's a normal thing."

Not Depressed

This included, "If he is not depressed then he wouldn't."

Lazy

This included, "I think they feel they don't have those kind of problem, maybe they're lazy. For me I don't think I never bother to think about those topics."

Table 2
Themes/Categories Regarding Not Using the Internet to Obtain Information About Depression

Theme	# of individuals	# of themes
Internet is not a good source	11	12
In denial	7	11
Ashamed about depression	3	3
Wants professional help	2	2
Prefers live person	2	2
Technology issues	2	3
These feelings are normal	1	1
Not depressed	1	1
Lazy	1	1

Useful Topics to Include on an Internet Web site

As shown in Table 3, there were 17 different themes/categories regarding the question about useful topics to include on an Internet Web site providing depression information to Asian Americans. Three of the themes/categories were each endorsed by 20 percent (n=4) or more of the participants. These themes/categories are described below. For this question, one participant chose not to provide an answer.

Sharing Personal Experiences

This included, "I think the best way is to get some people who had depression experience to talk about it and probably to put personal experience up there to explain" and "It was always helpful if you find other Asian Americans who talk about depression on the Web site."

Causes and Types of Depression

This included, "Maybe you could have different types of depressions."

How to Help Oneself

This included, "Ways to some advice to give to them if they were to tell their parents" and "Maybe something for free, like kind of service."

Social Skills Building

This included, "Maybe about how to make friends."

Cultural Aspects of Depression

This included, "Like how other people in other culture would feel."

Chinese Language

This included, "Have a person that can speak their language."

Normalizing Depression

This included, "The Web site should let the Asian people know that it's not a shame for you to get an illness."

Treatments

This included, "Medication that would be offer[ed] and definitely links to the different pharmacy companies" and "Look for herbs, something to eat or drink."

Table 3
Themes/Categories for Useful Topics to Include on an Internet Web site Providing Depression Information to Asian Americans

Theme	# of individuals	# of themes
Sharing personal experiences	6	6
Causes and types of depression	4	5
How to help oneself	4	8
Social skills building	3	3
Cultural aspects of depression	3	3
Chinese language	2	2
Normalizing depression	2	4
Treatments	2	3
Religious topics	1	1
Demographics	1	1
Miracle cure	1	1
Questions and answerers	1	1
Seeking help can be confidential	1	1
Professional's opinion	1	1
Emotional topics	1	2
Thinking positively	1	1
Freud	1	1

Religious Topics
This included, "More on the philosophical side, more realistic, you know religious type of stuff how to be happy."

Demographics
This included, "Statistics would be helpful, what demographic of Asians, like what demographic of Asians would usually suffer from this."

Miracle Cure
This included, "Something about miracles solutions or miracles to curing all the depression."

Questions and Answers
This included, "Question answer; do you feel lonely most of the times, how do you feel like sad or do you not want to talk to people."

Seeking Help Can Be Confidential
This included, "Where to look for help [to] assure them that it's confidential."

Professional's Opinion
This included, "I would rather some like the professional's opinion."

Emotional Topics
This included, "Do you feel lonely most of the times, how do you feel like sad."

Thinking Positive
This included, "Some way on the opposite side of looking at things on the outlook more how not to be depressed."

Freud
This included, "It's the Chinese version analysis of dreams by Freud, he talks a lot about dreams and what reflects that dream."

Discussion
The most common reasons for use of the Internet to obtain information about depression are that it is a source of information since it is difficult to talk to someone about depression, it is confidential, in general it is useful to obtain specific information about understanding depression or treatment for it and it is convenient. The most common reasons for not using the Internet to obtain information about depression are that the Internet is not a good source and because people are in denial about depression. The most common useful topics to include on an Internet Web site to provide depression information to Asian Americans are sharing personal experiences, causes and types of depression and how to help oneself.

In our study, participants felt that using the Internet to obtain information about depression is a good source since it's difficult to talk to someone about depression. They also reported it as more confidential. A study inquiring about using the Internet for depression information found that participants responded that information on Web sites would be helpful since a Web site allows one to deal with mental health problems alone (Leach, Christensen, Griffiths, Jorm, & Mackinnon, 2006.) Similarly, these Asian American participants may have felt that working alone on one's mental health issues allows one to obtain this information in a confidential manner. It also may even allow one to avoid the challenging part of talking to someone about one's depression.

Participants in our study stated that the Internet is useful to obtain specific information about depression or treatment for it. Previous work has shown that student-focused Web sites for providing depression information are useful, helpful, and popular among college students (Meyer, 2007.) The information obtained from our study suggests that there is a need and interest for such a Web site among Asian Americans.

In our study we found that using the Internet to obtain information about depression is more convenient than seeking professional help. Adolescents who grew up as part of the "Internet generation" actually prefer the convenience of using online information to guide them rather than visiting a health professional which can be less convenient (Gray, Klein, Noyce, Sesselberg, & Cantrill, 2004.) As we found, our young adult college student participants are also those that prefer the convenience of using the Internet to obtain depression information. However, we cannot determine if these Asian Americans specifically prefer to use the Internet at the expense of not seeing an actual health care professional.

Participants also reported that the Internet is not a good source for obtaining information about depression. This is similar to what has been reported among adolescents who believe that there may be limits to the expertise and utility of the Internet as a source of health information (Gray et al., 2004.) Another popular reason for not using the Internet to obtain information about depression is because people are in denial about depression. This sense of denial is not limited to the Internet. In general, those of Asian ethnicity often are concerned about a sense of losing face and are often hesitant to seek psychiatric treatment. They may even rationalize that their symptoms are not severe enough to consider getting help (Lau, & Wong, 2008.) Even though the Internet is available, the rationalization that one does not have symptoms sufficient to look for depression information apparently still is common.

We found that participants felt that personal experiences were some of the useful topics to include on an Internet Web site to provide depression information to Asian Americans. Online support groups for depression have been found to be helpful (Hous-

ton, Cooper, & Ford, 2002.) The reasons often cited for this helpfulness is that people benefit when seeing and reading about the experience of others like themselves who have struggled with depression (Lamberg, 2003.) Apparently it is not just online support groups that can provide this personal connection. Web sites with information shared about personal experiences with depression are perceived too as very useful and important.

In our study, participants said that topics that include causes and types of depression are useful to include on an Internet Web site to provide depression information to Asian Americans. The Internet is helpful since it is a tool that has the capability to reach large audiences at relatively low cost, and it can even target a specific group in need of information (Stjernsward, & Ostman, 2006.) Web sites targeting Asian Americans with relevant topics that are culturally tailored can potentially be very useful to help those Asian Americans experiencing depression at minimal expense.

Participants felt that topics such as how to help oneself are useful to include on an Internet Web site to provide depression information to Asian Americans. Web sites have been reported as useful for providing information for college students to help them address the challenges associated with depression (Meyer, 2007.) It may be even more useful, although research is needed to prove this point, that culturally tailored information for Asian Americans can be very useful above and beyond a general depression Web site.

Study limitations include that our sample is from one university. As the sample was predominately Chinese American, these results are most likely generalizable to this Asian American group and not necessarily to other Asian American groups. Also, as participants were interviewed face-to-face, some may have felt uncomfortable or ashamed to share their true opinion about mental illness. Lastly, it is possible that the approach of asking about "why would one" rather than "why would Asian Americans" allowed for Asian Americans to interpret the question as referring to all individuals and not just Asian Americans.

Conclusion

In conclusion, our study shows that Asian Americans have a number of different opinions with regard to using the Internet to obtain depression information. Some individuals believe that the Internet is a good source of information, as well as convenient and confidential. Others believe that the Internet is not a good source of information and since people are in denial about depression, they might not even use the Internet for this purpose. Topics such as causes and types of depression, personal experiences, and how to help oneself are considered useful topics to include on an Internet website. The need for topics on depression and mental health is extremely crucial to Asian American society. The Internet may be an approach useful for educating Asian Americans about addressing their depression.

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EDITED BY:
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Dr. Elmar Schmeisser, Ph.D.

BEYOND BRAIN MACHINE INTERFACE: MOTOR, COGNITIVE, AND VIRTUAL

On Sept. 2, 2009 the ARO Workshop, Beyond Brain Machine Interface: Motor, Cognitive and Virtual, drew over 100 attendees to meet face-to-face with specialists in the field of biomedical engineering. Held in Minneapolis, the workshop featured twelve prominent speakers representing diverse fields within the scientific community. Speakers discussed state-of-the-art neural interfacing technologies in brain-computer interface. The workshop was organized by Professor Brenda K. Wiederhold, the Interactive Media Institute (IMI) and Nitish Thakor of Johns Hopkins Medical School.

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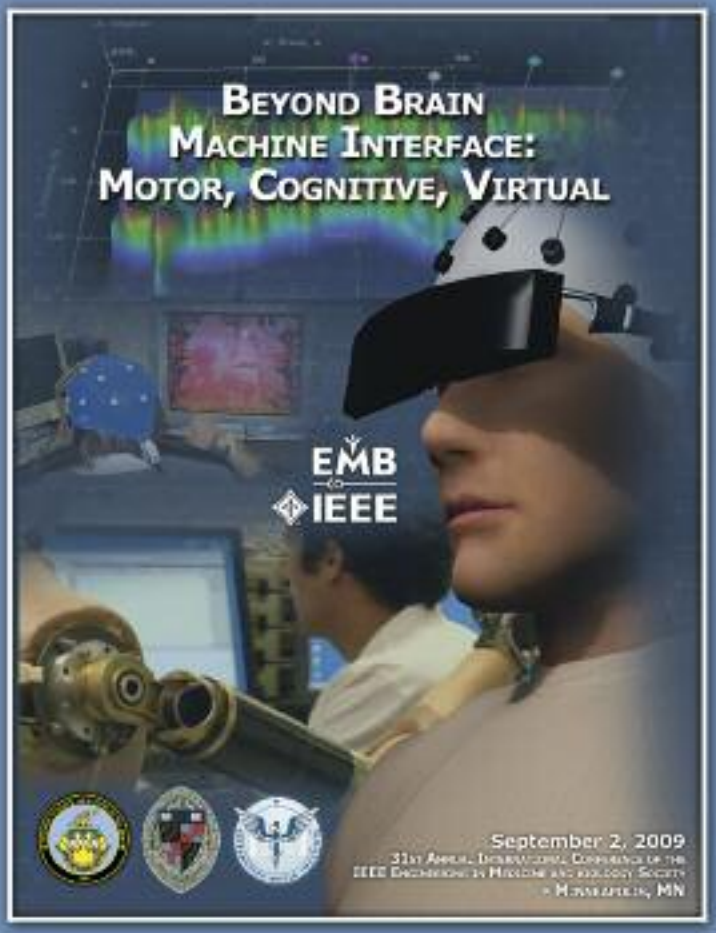

The post-conference book reflects the key topics discussed in the four sections at the workshop:

First Session – Neural Interface and Neural Prosthetics

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Third Session – Cognitive Interface

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CYBERPROJECTS

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

Robotics in rehabilitation: the latest trends

Modern robotics provides many hopes in the field of medicine. Patients in rehabilitation can expect a closer working relationship with robotics, yielding impressive results.

The MAIA project team at the IDIAP Research Centre for Artificial Intelligence in Valais, Switzerland is designing and experimenting with robots intended to assist in medical rehabilitation. The controlling of machinery with mere thought power is becoming reality with the use of a helmet attaching electrodes to the brain. The electrodes monitor the subject's neural network, interpret the signals in real time and activate the responding mechanisms. With such a system it is possible for a patient to drive and accurately steer his or her wheelchair, with nothing more than a bit of concentration.

The general aim of the project is to understand the mechanisms of human thought and then put them into active use. Because of the complexity of the neural processors in the human brain, the machinery must work on probabilities. While the highly-sophisticated system is still being developed, errors in the mechanical responses are recorded so that researchers can later make improvements. The devices, such as wheelchairs, are also equipped with sensors so that errors can automatically be corrected. It is envisioned that this technology can later be applied to prosthetic limbs.

The Robotic Team at the Vrije Universiteit in Brussels is working towards a similar goal. They have developed several robot prototypes to assist patients in various ways. ALTACRO (Automated Locomotion Training using an Actuated Compliant Robotic Orthosis) is a full scale walking robot, for example. Developed using a lightweight, compliant actuator with a high force output, namely the Pleated Pneumatic Artificial Muscle (PPAM,) it's walking is based closely on the movements of human walking. The primary objective is to enhance the quality of automated step rehabilitation training both for patients and therapists, in this way increasing its availability.

Integrating the expertise of neurological rehabilitation, functional anatomy, biomechanics, physiology and robotics, ALTACRO aims to develop and assess an original robotic rehabilitation system, providing the capacity to substantially enhance the prognostic health profile of the patient.

Another robot, the Soft Arm is, like ALTACRO, equipped with tubes of pressurized air acting as muscles, enabling the arm to lift heavy loads. ANTY, finally, is a robotic cuddly toy designed to respond emotionally, with eye contact and an animated face, to hospitalized children (already to be available in summer 2010.)

For more information visit http://www.idiap.ch/ or http://altacro.vub.ac.be/.

Compiled by Giuseppe Riva, Ph.D. and
Alessandra Gorini, Ph.D. candidate
Istituto Auxologico Italiano

CYBERFOCUS

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

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

CyberPsychology & CyberTherapy 15
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The Journal of CyberTherapy & Rehabilitation is the official journal of the CyberTherapy Conference. The 15th Annual International CyberTherapy Conference (CT15) brings together researchers, clinicians, policy makers and funding agencies to share and discuss advancements in the growing discipline of CyberTherapy & Rehabilitation, which includes training, education, prevention, rehabilitation, and therapy. The focus of this year's conference is two-fold–first, "Technologies as Enabling Tools" will explore the use of advanced technologies in diagnosis, assessment and prevention of mental and physical disorders. In addition, attention will be drawn to the role of interactive media in training, education, rehabilitation and therapeutic interventions. Secondly, CT15 will investigate the "Impact of New Technologies" and how they are influencing behavior and society through cyberadvertising, cyberfashion and cyberstalking, among others. Technologies featured at the conference include VR simulations, video games, telehealth, the Internet, robotics, brain-computer interfaces, and non-invasive physiological monitoring devices. Conference attendees have the opportunity to play a role in designing the future of mental healthcare. CT15 features interactive exhibits at the Cyberarium allowing participants to experience the technologies firsthand as well as the opportunity to display their exhibits in a forum-type setting.

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Society for Psychophysiological Research: 49th Annual Meeting
October 21 - 24
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http://www.sprweb.org/

PRESENCE 2009: The 12th Annual International Workshop on Presence
November 11 - 13
Los Angeles, California, USA
http://www.temple.edu/ispr/conference/

ABCT 2009
November 19 - 22
New York City, New York, USA
http://www.abct.org/conv2009/

2010 Conferences

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http://spie.org/x1375.xml

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www.iaria.org/conferences2010/DigitalWorld10.html

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Tel Aviv, Israel
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IASTED International Conference on Artificial Intelligence and Applications
February 15 - 17
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http://www.iasted.org/conferences/

The World of Health IT Conference & Exhibition
March 15 - 18
Barcelona, Spain
http://www.worldofhealthit.org/

IEEE VR 2010
March 20 - 24
Waltham, Massachusetts, USA
http://conferences.computer.org/vr/2010/

Applied Psychophysiology & Biofeedback 2010
March 24 - 27
San Diego, California, USA
http://www.aapb.org/

SPIE Defense, Security, and Sensing
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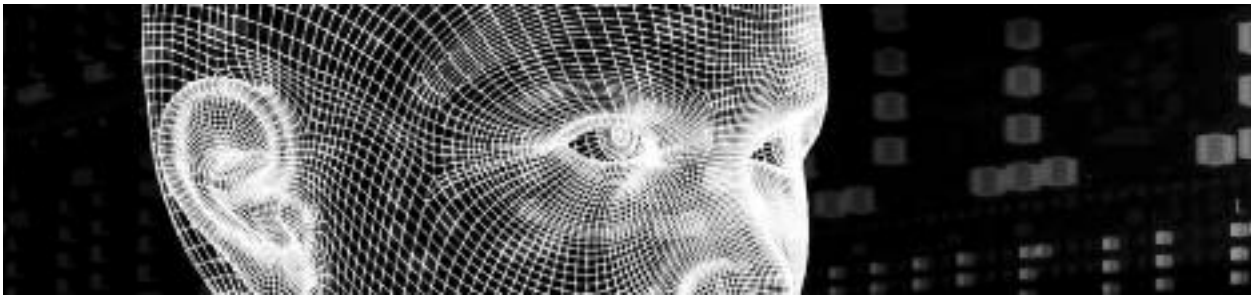

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