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Preface

Healthcare delivery systems have been evolving to rely more heavily on technology. There has been a shift in care diagnosis and treatment which has decreased the importance of traditional methods of care delivery. Technology provides new ways to monitor and treat heart disease, inflammation, infection, cancer, diabetic condition, and chronic conditions. Monitoring technologies and blood work are being used in combination with imaging and telemetrics to provide a real time, continuous evaluation of patients' conditions. In addition, technology has not only helped to extend our lifespan but it has improved the quality of life for all citizens.

We have put a great deal of effort into the definition of the structure of the volume and in the sequence of the contributions, so that those in search of a specific reading path will be rewarded. To this end we have divided the different chapters into five main sections:

1. *Critical Reviews*: These chapters summarize and evaluate emerging cybertherapy topics, including technology-enhanced rehabilitation, Interreality, and Intersubjectivity;
2. *Evaluation Studies*: These chapters are generally undertaken to solve some specific practical problems and yield decisions about the value of cybertherapy interventions;
3. *Original Research*: These chapters research studies addressing new cybertherapy methods or approaches;
4. *Clinical Observations*: These chapters include case studies or research protocols with long-term potential;
5. *Work in Progress*: These chapters include papers describing a future research work.

For both health professionals and patients, the selected contents will play an important role in ensuring that the necessary skills and familiarity with the tools are available, as well as a fair understanding of the context of interaction in which they operate.

In conclusion, this volume underlines how cybertherapy has started to make progress in treating a variety of disorders. However, there is more work to be done in a number of areas, including the development of easy-to-use and more affordable hardware and software, the development of objective measurement tools, the need to address potential side effects, and the implementation of more controlled studies to evaluate the strength of cybertherapy in comparison to traditional therapies.

We are also grateful to Chelsie Boyd, Tanisha Croad and Laura Masterton from the Interactive Media Institute for their work in collecting and coordinating chapters for this volume.

We sincerely hope that you will find this year's volume to be a fascinating and intellectually stimulating read. We continue to believe that together we can change the face of healthcare.

Brenda K. Wiederhold   *Giuseppe Riva*

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Contents

Section I

Critical Reviews

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Guided Internet Treatment for Anxiety Disorders. As Effective As Face-To-Face Therapies?

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Abstract. Introduction: Guided Internet-delivered treatments were developed in the late 1990s and have since been tested in numerous controlled trials. While promising, there are yet few direct comparisons between Internet treatments and traditional face-to-face treatments. The aim of the present study is to present an overview of the evidence in the field of anxiety disorders. Method: Studies were located, including unpublished trials from our research group in Sweden. Results: Results of direct comparative trials on panic disorder (n=3) and social anxiety disorder (n=3) show equivalent outcomes. One study on specific phobia did not show equivalent outcomes with an advantage for face-to-face treatment. However, a systematic review by Cuijpers et al. (2010) found equivalent outcomes across several self-help formats, suggesting that guided self-help overall can be as affective as face-to-face treatments. Conclusion: Overall, there are still few large-scale trials and statistical power is often limited. A preliminary conclusion is that guided Internet treatment can be as effective as face-to-face treatments, but there is a need to investigate moderators and mediators of the outcome.

Keywords. Guided internet-delivered cognitive behaviour therapy, panic disorder, social anxiety disorder, specific phobia

Introduction

Using the internet to deliver evidence-based psychological treatments has a rather short history butthere are now already numerous applications in which cognitive behavioural therapy (CBT) has been transferred to the Internet [1]. There are various forms of Internet-based CBT (ICBT) approaches, ranging from open access programs that are unguided to guided ICBT programs that involve minimal therapist contact [2]. Evidence to date suggests that guided programs yield larger effects than unguided treatments [3], but there are exceptions where unguided programs have been found to be affective[4]. The aim of this paper is to review the literature in which guided ICBT has been directly compared with traditional face-to-face delivered CBT within the same studies in the field of anxiety disorders.

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1. Method

1.1. Selection of studies and coding

Studies were located by means of literature searches on Medline and Psychological Abstracts. Moreover, studies known to the author were included. Each study reviewed is presented in terms of the within-group standardized mean difference (Cohen's *d*), where the difference between the average score at post treatment score was subtracted from the pre-treatment score and divided by the pooled standard deviation. Between the group effect sizes were calculated. Effect sizes of 0.8 are assumed to be large, while effect sizes of 0.5 are moderate, and effect sizes of 0.2 are regarded as small [5].

2. Results

2.1. Panic disorder

To my knowledge there are three direct comparisons between live therapy and guided ICBT for panic disorder. The first study was by Carlbring and co-workers in Sweden. They conducted a randomized trial in which they compared 10 individual weekly sessions of cognitive behaviour therapy for panic disorder with or without agoraphobia with a 10-module guided self-help program on theInternet[6]. Composite within-group effect sizes were high in both groups, while the between-group effect size was small (Cohen's *d* =0.16). A similar trial was conducted in Australia where the authors compared their internet treatment with a standard face to face treatment and found equivalent outcomes [7]. The authors found that 30.4% (14/46) of their *Panic online* treatment participants reached the criteria of high end-state functioning, with the corresponding figure in the face-to-face group being 27.5% (11/40). Between group effect sizes were small across all measures. For example on the clinician rated panic disorder rating the between group Cohen's d effect size was *d*=0.15. The latest and largest controlled trial on live versus guided ICBT for panic disorder was conducted by a Swedish group [8]. A total of 113 consecutive patients were randomly assigned to 10 weeks of either guided ICBT (n = 53) or group CBT (n = 60).For the internet treatment the within-group effect size (pre-post) on the panic disorder severity scale, PDSS[9] was Cohen's *d* = 1.73, and for the group treatment it was *d* = 1.63. Between group effect sizes were low (on the PDSS it was *d* = 0.00), and treatment effects were maintained at 6-months follow-up.

2.2 Social anxiety disorder

For social anxiety disorder (SAD), also referred to as social phobia, there are at least three randomized controlled trials directly comparing guided ICBT with face-to-face treatment. The first study published was conducted by a research group in Spain[10]. While they focused on fear of public speaking all had a diagnosis of social phobia. There were three groups in the trial with 62 participants being randomized to ICBT, 36 to live therapy and 29 to a waiting list group. Results showed improvements in both treatment groups with effects being sustained in the 12-month follow-up. The between group effect sizes were small between the two active treatments. In a small study a

group of Australian researchers compared guided ICBT (n=23) with face-to-face CBT (n=14) [11]. They found large within group effects and no difference between the two conditions. For example, on the social interaction anxiety scale [12] the between group difference was d=0.00. The most recent study on live versus ICBT for SAD was conducted by a Swedish group and this is the largest study to date on SAD [13]. They included and randomized participants to either guided ICBT (n = 64) orto cognitivebehavioural group therapy (CBGT) (n = 62).Results showed that both groups made large improvements, which were sustained at six months follow-up. At post-treatment and follow-up respectively, Cohen's d betweengroup effect sizes were 0.41 and 0.36 favouringICBT, which was not significant.

2.3. Specific phobia

There is to my knowledge only one small controlled small study on ICBT versus live treatment of specific phobia [14], which was conducted in Sweden. The authors compared guided ICBT with one session of live-exposure treatment in a sample of 30 spider-phobic patients. The Internet treatment consisted of five weekly text modules, which were presented on a web page, a video in which exposure was modelled, and support provided via Internet. The live-exposure treatment was delivered in a 3-hr session following a brief orientation session. Results showed that the groups did not differ at post treatment or follow-up, with the exception of the proportion showing clinically significant change on abehavioural approach test. At post treatment 46.2% of the Internet group and 85.7% in the live-exposure group achieved this change. At follow-up the corresponding figures were 66.7% for the Internet group and 72.7% for the live treatment. Within-group effect sizes for the spider phobia questionnaire were large (d=1.84 and 2.58 for the internet and live-exposure groups, respectively, at post treatment).

3. Discussion

There are now an increasing number of studies showing that guided self-help can be as effective as face-to-face CBT [15]. In this review a selection of studies dealing with specific anxiety disorders were described and the overall result suggests that guided ICBT is as effective as face-to-face CBT. The possible exception is the small trial on spider phobia.

Most of the trials reviewed here were small and have insufficient power to detect small effect sizes. Indeed, testing for equivalence of treatment usually require very large samples [16], which goes far beyond the resources for psychotherapy researchers. Even if large studies on ICBT are starting to appear, for example on SAD [17] and irritable bowel syndrome [18], there are no trials with more than 200 participants where face-to-face and guided ICBT has been studied.

There are limitations with this review. First, there are unpublished trials which could not be included on conditions like generalised anxiety disorder. Second, the face-to-face comparisons have varied with some comparing guided ICBT with group treatment and some with individual treatments. Third, I did not include a review on the cost-effectiveness of ICBT versus face-to-face treatment. There is some evidence to suggest that guided ICBT is more cost-effective [19], but more research is needed.

Finally, most of the studies have been conducted in specialist settings and in real life most patients with anxiety disorders are treated in primary care settings.

In spite of these limitations, there is now emerging evidence that guided ICBT can serve as a complement and sometimes replacement for face-to-face CBT. There are several advantages to ICBT such as freedom to work from home outside of office hours and also not needing to travel to clinics for treatment sessions. A major challenge is dissemination of ICBT and also to develop reliable diagnostic procedures. Finally, research should investigate moderators and mediators of outcome since there may be differences between what makes ICBT and face-to-face treatments work [20].

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Inter-Reality in the Evaluation and Treatment of Psychological Stress Disorders: the INTERSTRESS Project

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Abstract. "Psychological stress" occurs when an individual perceives that environmental demands tax or exceed his or her adaptive capacity. According to the Cochrane Database of Systematic Reviews, the best validated approach covering both stress management and stress treatment is the Cognitive Behavioral (CBT) approach. CBT has undergone a very large number of trials in research contexts. However, it has been less efficacious in clinical contexts and it has become obvious that CBT has some failings when applied in general practice. INTERSTRESS is a EU-funded project that aims to design, develop and test an advanced ICT-based solution for the assessment and treatment of psychological stress that is able to address three critical limitations of CBT: a) the therapist is less relevant than the specific protocol used. b) the protocol is not customized to the specific characteristics of the patient; c) the focus of the therapy is more on the top-down model of change (from cognitions to emotions) than on the bottom-up (from emotions to cognitions). To reach this goal the INTERSTRESS project applies an innovative paradigm for e-health – Interreality – that integrates assessment and treatment within a hybrid environment, bridging physical and virtual worlds. On one side, the patient is continuously assessed in the virtual and real worlds by tracking the behavioral and emotional status in the context of challenging tasks (customization of the therapy according to the characteristics of the patient). On the other side, feedback is continuously provided to improve both the appraisal and the coping skills of the patient through a conditioned association between effective performance state and task execution behaviors (improvement of self efficacy). Within this conceptual framework, it is possible to set up and test psychological treatments that could be extended also beyond the traditional research and clinical setting by using more and more emerging mobile technology to deliver real-time interventions during daily activities and ecological contexts.

Keywords. Psychological stress, physiological monitoring, wearable sensors, knowledge models, decision support system

Introduction

According to Cohen and colleagues [1] "Psychological Stress" occurs when an individual perceives that environmental demands tax or exceed his or her adaptive capacity. In this view, stressful experiences are conceptualized as person-environment transactions, whose result is dependent on the impact of the external stimulus.

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The Cochrane Database of Systematic Reviews [2, 3] identified in the Cognitive Behavioral (CBT) approach, the best-validated approach for stress management and stress treatment. Even if CBT is the treatment of choice for psychological stress, there is still room for improvement.

Specifically, there are three major issues to solve:

- The therapist is less relevant than the specific protocol used;
- The protocol is not customized to the specific characteristics of the patient.
- The focus of the therapy is more on the top-down model of change (from cognitions to emotions) than on the bottom-up (from emotions to cognitions).

To overcome the above limitations, Riva and coll. [4] recently introduced a new paradigm for e-health – "Interreality" - that integrates assessment and treatment within a hybrid environment, bridging physical and virtual world. By creating a bridge between virtual and real worlds, Interreality allows a full-time closed-loop approach actually missing in current approaches to the assessment and treatment of psychological stress: first, the assessment is conducted continuously throughout the virtual and real experiences: it enables tracking of the individual's psycho-physiological status over time in the context of a realistic task challenge; second, the information is constantly used to improve both the appraisal and the coping skills of the patient: it creates a conditioned association between effective performance state and task execution behaviours. The potential advantages offered to stress treatments by this approach are: (a) an extended sense of presence [5]: Interreality uses advanced simulations (virtual experiences) to transform health guidelines and provisions in experience; (b) an extended sense of community: Interreality provides social support in both real and virtual worlds; (c) a real-time feedback between physical and virtual worlds: Interreality uses bio and activity sensors and devices (PDAs, smartphones) both to track in real time the behaviour and the health status of the user and to provide suggestions and guidelines [6, 7].

Fig. 1. A Virtual Reality based stressful situation.

1. Method

From a technological viewpoint Interreality is based on the following devices/platform:

- 3D Individual and/or shared virtual worlds: They allow controlled exposure and objective assessment;
- Personal digital assistants and/or mobile platforms (from the virtual world to the real one): It allows an objective assessment, provision of warnings and motivating feedbacks;
- Personal biomonitoring system (from the real world to the virtual one): It allows a quantitative assessment and decision support for treatment.

These devices are integrated around two subsystems: the *Clinical Platform* (in patient treatment, fully controlled by the therapist) and the *Personal Mobile Platform* (real world support, available to the patient and connected to the therapist) that allow a) monitoring of the patient behavior and of his general and psychological status, early detection of symptoms of critical evolutions and timely activation of feedbacks in a closed loop approach; b) Monitoring of the response of the patient to the treatment, management of the treatment and support to the therapists in their therapeutic decisions. The clinical use of these technologies in the Interreality paradigm is based on a closed-loop concept that involves the use of technology for assessing, adjusting and/or modulating the emotional regulation of the patient, his/her coping skills and appraisal of the environment (both virtual, under the control of a clinician, and real, facing actual stimuli) based upon a comparison of that patient's behavioral and physiological responses with a baseline or performance criterion.
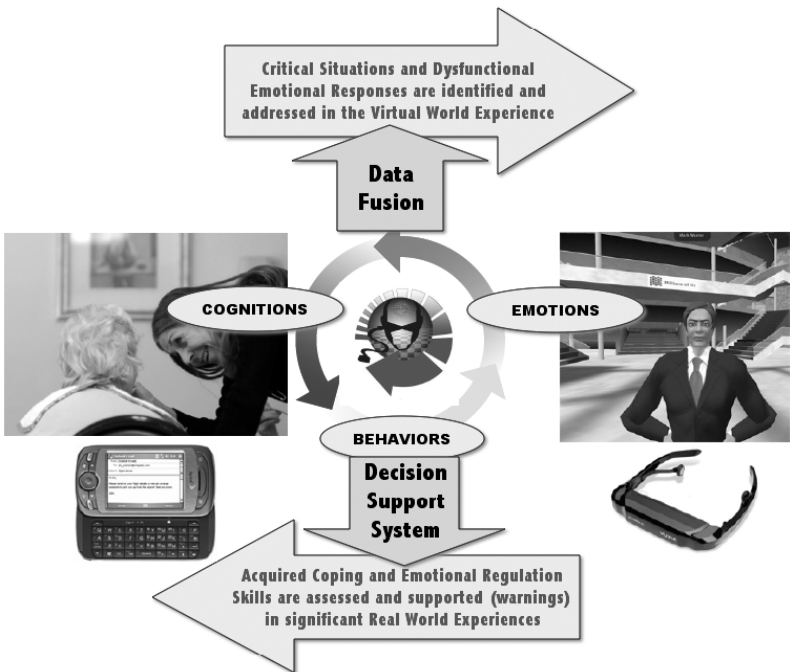
Figure 2. Inter-reality: A link between Virtual and Real world.

2. Results

The release of the main INTERSTRESS technological components was successfully completed and the integrated service platform is currently in an advanced development stage. The formative evaluation studies have involved so far over 100 participants in three EU countries (Italy, Spain, Germany). The full trials are expected to run for nine months, during which the efficacy and effectiveness of the Interreality approach in supporting stress management will be compared with conventional cognitive-behavioral programs. The assessment phase features psychological questionnaires, a clinical interview and a self-monitoring week, where the participants will monitor their physiological and psychological stress reactions by means of biosensors and a smartphone (experimental group) or by a diary (control group). In the experimental training phase, participants in the experimental condition will be exposed to typical of stressful scenarios in a virtual reality simulator, and then the participants will learn basic coping strategies.

3. Conclusion

Stress is an increasingly recognized phenomenon that has negative effects on growing numbers of people. Chronic stress is responsible for premature mortality in Western countries, and work-related stress accounts for premature cardiovascular mortality rates. INTERSTRESS aims to improve links and interaction between patients and doctors, facilitating more active participation of patients in the care process. Also, it envisions a better quality of life, where personalized, immersive e-therapy allow the ability to detect and manage stress anytime, anywhere.

Acknowledgments

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Modeling the Social Networking Experience Objectifying the Subjective

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Abstract. This study aimed at measuring objectively the experience of using social network sites (SNSs). At this aim, a model of experience has been defined, focusing on three main aspects of time-space continuum of individuals' states: physiological arousal, emotional valence, and attentional resources. At this purpose we developed a new approach to assess such an experience. The main idea is to consider arousal, valence and attention to track the users' experience collecting psychophysiological indexes at predefined period (for example each 10 seconds) to build an empirical model based on these data. Once we got the empirical curve we can fit these data using mathematical models.

Keywords. Social networking, Social Network Sites, Psychophysiology, Modeling, Mathematical Models, Data Fitting

Introduction

Social networking experience has been deeply investigated in many studies in the last few years, also by using psychophysiology as objective measures of subjects' responses [1-4]. Nonetheless an aspect that hasn't been taken into account yet is the dynamic nature of this experience. A broad psychophysiological analysis can go beyond punctual pre-post recordings and also overcome the limits of the self-reported measures, permitting a wide comprehension of the whole session considered, instead of limiting the analysis to the start and the end of this. Practically, a phenomenon is analyzed in a dynamic way, considering the fluctuations in the psychophysiological space all over the time of the experience.

1. Physiological measures to be considered for a three-variable model

A model of experience can bedefinedfocusing on three main aspects of time-space continuum of individuals' states: physiological arousal, emotional valence, and attentional resources. This three-dimensional space can be accordingly expanded from R^3 Cartesian space to higher dimensions by considering more variables. Briefly, physiological arousal can be measured using Skin Conductance (SC), Beta Waves from electroencephalogram (EEG), Heart rate extracted from electrocardiogram (ECG), and respiration signal (RSP); emotional valence can bemeasured using alpha wave

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asymmetry on frontal channels of electroencephalogram (EEG), facial EMG corrugator and facial EMG zygomatic [5-8]. Attention can bemeasured through the use of slow-alpha waves extracted from an electroencephalogram (EEG) [8, 9].This approach has been extensively used in psychophysiological research [5] as an objective way to measure affective states during a computer-mediated experience, and showed to be able to correctly discriminate relax, boring, stress and engagement states, among the others.The "value added" to use the Arousal-Valence-Attention space that we propose, is given by the possibility to measure these three dimensions through the use of wearable biosensors and psychophysiological indexes, one of the most objective and accepted methodology for these kind of assessments.

2. Empirical and theoretical models

The standard analysis in psychophysiological research is based on indexes computation and statistical data analysis. However, in this study we aim at modeling the whole experience of the subjects during social network sites use. At this purpose we will give the general idea to develop a new approach to assess such an experience. The main focus is to consider three assets to track the users' experience collecting psychophysiological indexes at predefined period (for example each 10 seconds) to build an empirical model based on these data (Figure 1a). Once we got the empirical curve we can fit these data using mathematical models (Figure 1b). Eventually we get a model of each subject's experience based on objective data that can help the researcher to interpret the experienced users' navigation. More, statistical analysis can be computed basing on new indexes extracted by the fitted model.
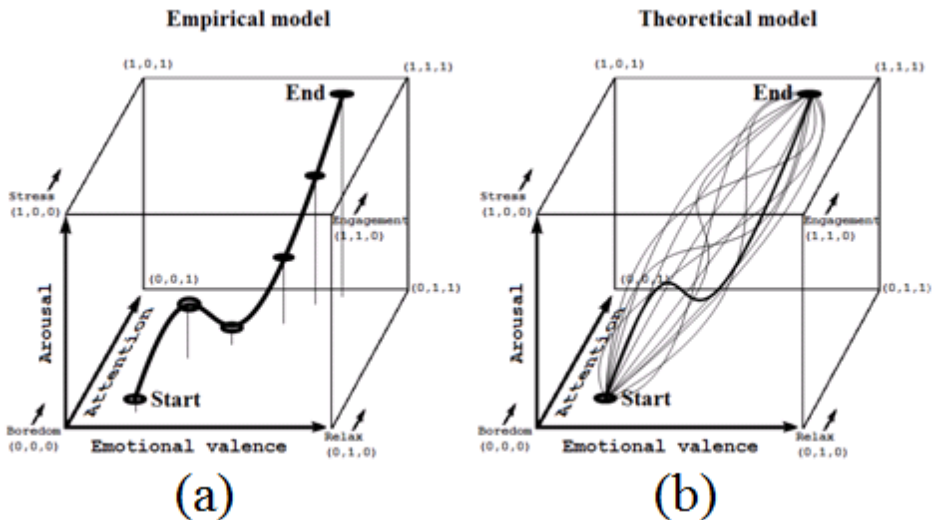
Figure 1. On the lefthand side there is a representation of an empirical-based model fitted by only one theoretical trajectory, obtained joining the six coordinates (circles) and analyzing partial derivative (a).On the right hand side a 3D graphical representation of the theoretical model, considering different kind of trajectories that fit the data(b).

3. Mathematical models to fit data

Once collected data and calculated psychophysiological indexes, we should define a complex model into the R^3 cartesian space. Moreover, we should consider the time to take into account the dynamics of the model.

To simplify such a process we can just consider the three assets one by one. Thus, we begin with a variable for that asset: for example we consider the skin conductance to take into account the physiological arousal. Then we extract the statistics per each period, for example a mean value per each 10-second periods spent to use the social network site. Once we computethe entire mean we have a succession of skin conductance data by time. To represent them graphically we can track the time in the horizontal axis and the mean value of skin conductance in the vertical axis, per each time period considered. In this way we can build an empirical model for all the physiological indexes considered.

To fit data and create the theoretical model there are many mathematical models that can be used. Following this, we present some of these models to give a better idea of the described process.

3.1. Linear and quadratic polynomialsmodels

The simplest models that can be used are the linear and the quadratic polynomial models, respectively $f(x) = p1*x + p2$ (see Figure 2a) and $f(x) = p1*x^2 + p2*x + p3$(see figure 2b).

3.2. Other possible polynomials models

Other polynomial models are possible candidate to fit data. Two examples are the cubic model and the 8th degree polynomial model, respectively $f(x) = p1*x^3 + p2*x^2 + p3*x + p4$ (see Figure 3a) and $f(x) = p1*x^8 + p2*x^7 + p3*x^6 + p4*x^5 + p5*x^4 + p6*x^3 + p7*x^2 + p8*x + p9$ (see Figure 3b).

3.3. Sum of sin functions models

Other models that can be used are the Sum of Sin functions models: for example considering two or eight Sin functions, respectively$f(x) = a1*\sin(b1*x+c1) + a2*\sin(b2*x+c2)$ (see Figure 4a) and$f(x) = a1*\sin(b1*x+c1) + a2*\sin(b2*x+c2) + a3*\sin(b3*x+c3) + a4*\sin(b4*x+c4) + a5*\sin(b5*x+c5) + a6*\sin(b6*x+c6) + a7*\sin(b7*x+c7) + a8*\sin(b8*x+c8)$ (see Figure 4b).

3.4. Fourier models

Other really interesting models that can be used are the Fourier models, for example$f(x) = a0 + a1*\cos(x*w) + b1*\sin(x*w)$ (see Figure 5a) and $f(x) = a0 + a1*\cos(x*w) + b1*\sin(x*w) + a2*\cos(2*x*w) + b2*\sin(2*x*w) + a3*\cos(3*x*w) + b3*\sin(3*x*w) + a4*\cos(4*x*w) + b4*\sin(4*x*w) + a5*\cos(5*x*w) + b5*\sin(5*x*w)$ (see Figure 5b).
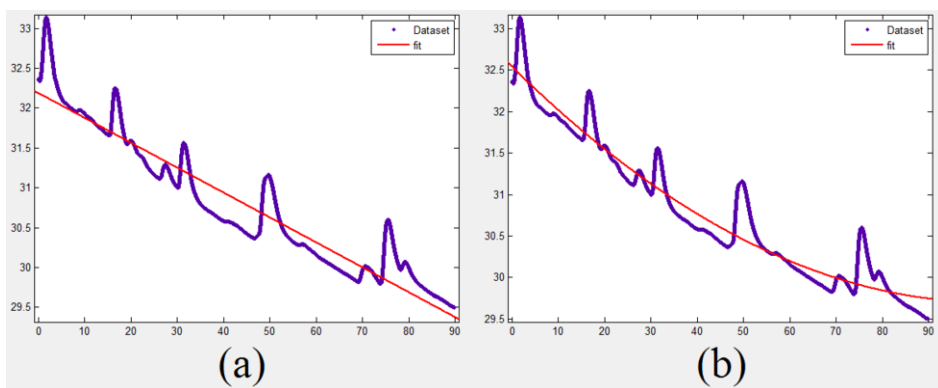
Figure 2. Linear (a) and the quadratic (b) polynomial model.
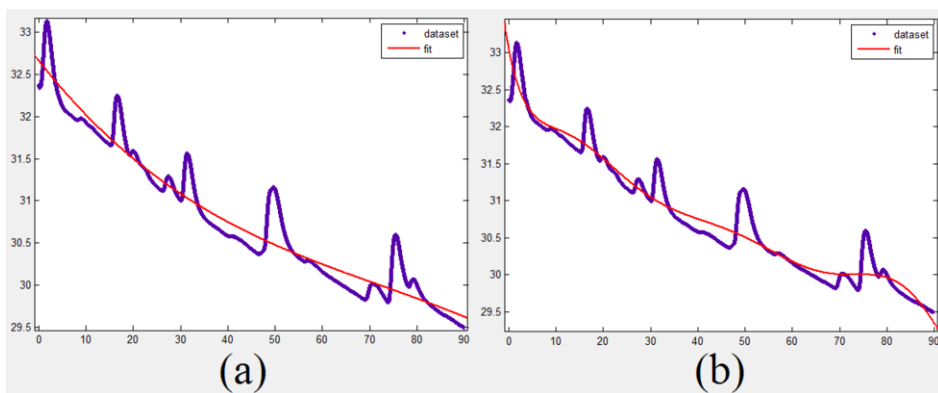
Figure 3. Cubic model (a) and 8th degree polynomial (b) model.
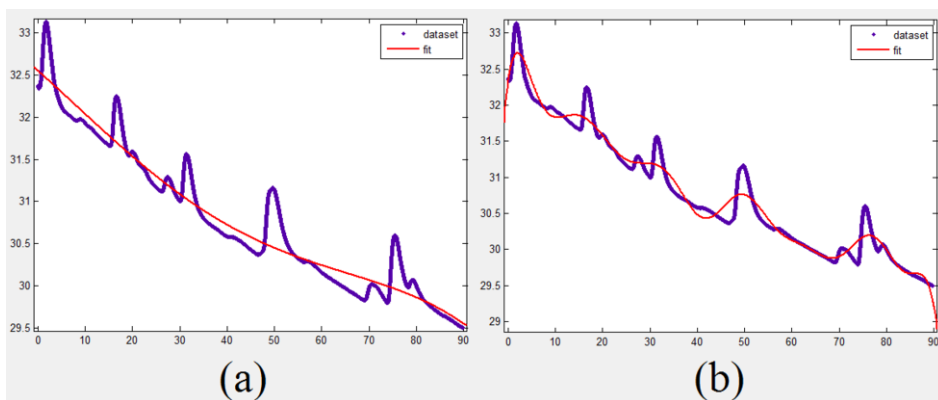
Figure 4. Sum of two (a) and eight (b) Sin functions model.
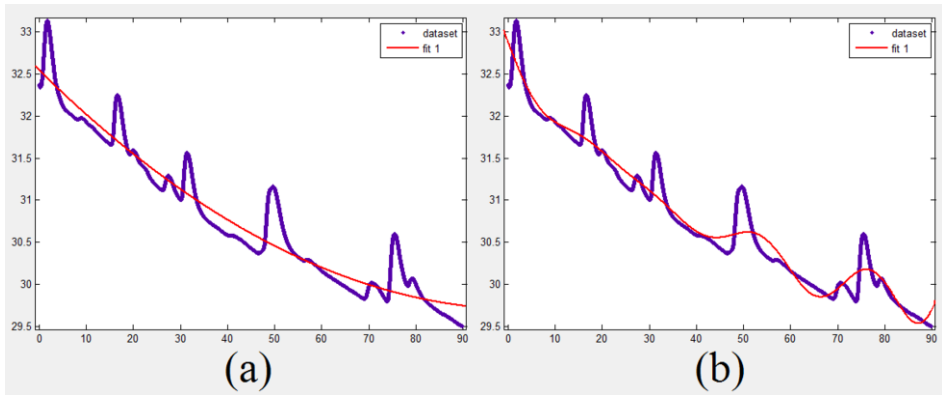
Figure 5. Two examples of Fourier models.

4. Conclusion

Models have many limitations. However, as the aim of a map is to represent a territory, the purpose of a model is to simplify complex processes and to give access to new information making them manipulable, *ceteris paribus*.

Our suggestion for future research is to keep in mind the words of Albert Einstein: "Make everything as simple as possible, but not simpler."

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The Use of Virtual Reality in the Treatment of Eating Disorders

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Abstract. A high percentage of patients with eating disorders (ED) respond to treatments such as cognitive-behavioural therapy. However, some patients do not progress significantly with these treatments, or suffer relapses. The incorporation of new technologies may help to increase the efficacy of standard treatments. Virtual reality has been successfully used to treat body image disturbances in ED patients and seems a suitable technology for cue exposure therapy in this setting. We review the published literature and discuss the results.

Keywords. Virtual Reality, treatment, eating disorders, review.

Introduction

There are effective and well-established treatments, such as cognitive-behavioural therapy (CBT), for patients with eating disorders (ED). However, there are a percentage of patients who do not improve despite the intervention, or who suffer relapses. It is necessary to explore ways of improving these treatments with the incorporation of advanced technologies such as virtual reality (VR), the efficacy of which has been demonstrated for other disorders [1-6].

The term virtual reality refers to computer-simulated environments where the user experiences a sense of presence. Presence is defined as the sensation of "being there" that a person has on entering a virtual environment. The concept of presence is essential in this topic because VR environments are only useful for clinical psychology if they are able to produce similar responses in users to those produced in the real world. High tech devices play an important role in achieving a good sense of presence and reproducing life-like situations but there are other aspects, not related with technology that should be taken into account. Internal characteristics of the user and emotional involvement are especially relevant in clinical populations. Involvement depends mainly on the degree of emotional significance attributed to the activity. Studies have shown that for a subclinical or clinical population there is no need for high quality graphic representations on the computer to elicit a sense of presence [7, 8]. On the other hand, for a non-clinical population the realism of graphics and the degree of immersion are determinants in order to experience a sense of presence. Thus, the ability to elicit emotions seems to be a key factor in the attribution of reality and presence in virtual reality environments and, consequently, the achievement of strong emotion should be the main objective when designing a VR application intended for clinical use.

1. Method

The literature on the use of VR technology for the treatment of ED was reviewed. The PsycInfo, Medline, and PsycArticles databases were searched for the period from 1980, the decade in which the term virtual reality was coined [9], to 2012. Only studies with samples that included clinical populations (patients with anorexia nervosa, bulimia nervosa, EDNOS, or binge eating) were considered. Eight papers were selected: four case studies and four controlled studies.

2. Results

Since the late 1990s, pioneering researchers have developed VR-based software systems for ED treatment. These applications have mainly focused on body image disturbances. Body image is the mental representation of the physical appearance of one's own body. This mental representation includes perceptual, cognitive, and affective aspects, and influences the person's behaviour. It is a dynamic representation that the person builds during lifetime from their everyday experiences and in a specific socio-cultural context. Due to this complexity, most research focuses on the study of two disturbances derived from two components of body image (the perceptual and the cognitive-affective). These two disturbances are the perceptual distortion of body image and body dissatisfaction. Body image distortion refers to the inability to perceive the size of the body accurately. Body dissatisfaction refers to the degree to which a person likes or dislikes the size and shape of his/her body.

VR-based therapies are especially suitable for improving body image in ED patients. VR allows patients to create three-dimensional figures that represent their own body and which can be modified in order to reproduce different components of the body image, such as perceived or ideal body image. The use of immersive devices such as VR goggles or head-mounted displays allows participants to interact with their full-size virtual body. Furthermore, computer technology provides ED patients with therapist-independent information about their distorted body image. Finally, VR allows simulation of real-life situations related to body image concerns in which participants are exposed to situations and events that trigger their ED symptoms.

The literature shows that only eight papers including a clinical population have been published (Table 1). In these studies, VR-based exposure was administered in addition to other psychological intervention, such CBT. Results obtained in these studies showed that all treated patients improved ED symptoms, but those who were treated with the VR component showed a significantly greater improvement in body image related disturbances, specially, body image dissatisfaction. These improvements were even greater at the follow-up [18]. Despite positive results, there are several methodological drawbacks that should be taken into account: first, only four controlled studies have been published and they all used small samples; second, only two case studies and one controlled study include follow-up. Moreover, available data about the use of VR in the treatment of body image disturbances in ED come mainly from two research groups: the group of Giusseppe Riva (Milano, Italy) and the group of Perpiñá, Botella and Baños (Valencia, Spain). Consequently, although examined results suggest that the addition of a VR component improves body image in ED patients; further research using stronger methods is needed.

Table 1. Studies about the effectiveness of including VR-exposure in the treatment of ED

	Authors	Conditions	N	Outcome
Case studies	Riva, Bacchetta, Baruffi, Rinaldi, & Molinari [10, 11]*	1 VEBIM 2	1 female AN 22-year-old	Increment of body awareness. Reduction of body image dissatisfaction.
	Perpiñá, Baños, Botella, & Marco [12]	1 CBT + VR	1 ED participant	One-year follow-up data Improvement of treatment achievements during the period.
	Salorio, Gómez, Morales, Torres, Díaz, & Alegría [13]	1 CBT + VR	1 female AN	Improvement of body satisfaction. One-year follow-up data: higher body satisfaction
Controlled studies	Perpiñá, Botella, Baños, Marco, Alcañiz, & Quero [14]	2 (between subject): CBT + relaxation & CBT + VR	18 ED female.	VR condition participants showed a greater significant improvement in specific BI variables, depression and anxiety.
	Riva, Bacchetta, Baruffi, & Molinari [15]	2 (between subject): VREDIM (+ low-calorie diet and physical training) & NG (+ low-calorie diet and physical training)	20 BED female	VREDIM was more effective in improving body satisfaction, self-efficacy, and motivation for change.
	Riva, Bacchetta, Cesa, Conti, & Molinari [16]	4 (between subject): WL, NG, ECT, CBT	36 ED female	ECT was more effective than CBT in improving BI (body awareness, body satisfaction, and physical acceptance).
	Perpiñá, Marco, Botella, & Baños [17]	2 (between subject): SBIT & CBT + VR	12 ED female	The combination of CBT and VR increased the power of the results of SBIT. Results at post-treatment improved over 1 year and extended to ED and general psychopathology.

*Note***:** AN (anorexia nervosa), BE (binge eating), BED (binge eating disorder), BI (body image), EDNOS (eating disorders not otherwise specified), CBT (cognitive-behavioural therapy), ECT (experiential cognitive therapy: based on VR), NG (Nutritional group, on cognitive-behavioural approach), SBIT (standard BI treatment), VEBIM 2 (enhanced version of VEBIM), VR (virtual reality), VREDIM (Virtual Reality for Eating Disorders Image Modification: Improved version of VEBIM), WL (waiting list)

* Both papers refer to the same study despite addressing different aspects of the case.

Studies also indicate that exposure to virtual food provokes physiological and psychological reactions in ED patients similar to those produced by exposure to real food [19-21]. These findings have led some researchers [22] to propose VR technology for cue exposure therapy in ED patients. Previous studies [23, 24] provided evidence of the effectiveness of in vivo cue exposure therapy for reducing bulimic symptoms, especially binge eating episodes. Given that VR has been successfully used for cue

exposure therapy in the treatment of addictions [22], a future step could be the application of this technology for cue exposure therapy in ED. In vivo exposure in the context of treatment presents logistical difficulties and, moreover, lacks ecological validity. VR allows simulation of real-life situations, providing an ecological, secure, flexible, and controlled environment where patients can be assessed and treated.

3. Conclusions

The studies reviewed suggest that the incorporation of VR may increase the effectiveness of standard treatments. VR-based therapies significantly improve body image disturbances in ED patients. Moreover, studies suggest that VR cue exposure therapy may be an effective procedure for reducing ED symptoms, especially binge eating episodes. VR has great potential in the treatment of ED, but further studies of its use are required.

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Lessons Learned from the Development of Technological Support for PTSD Prevention: A Review

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Abstract. This review [2] describes the state-of-the-arttechnologiesthat support mental resilience training for PTSD prevention. It characterizes four current systems across training approaches; seeks insights via interviews with the systemdevelopers; and extracts from thesea set of essential guidelines for future developers. The guidelines include four distinct project-limiting factors, which were found to constrain the reviewed developments. These were Culture, Effectiveness, Engineering, and Resource constraints.This research is novel in reviewing technologiesfor PTSD prevention as opposed to treatment, and in analyzing from the perspective ofsystem development and designissues.

Keywords. System development, PTSD, prevention, mental resilience

Introduction

The training of mental resilience is gaining increasing importance as a way to prevent post-traumatic stress disorder (PTSD). Such training can include technological supports as an essential tool. These systems train resilience to traumatic stress in healthy persons, to preventdevelopment of pathology, in contrast to treatment systems which aim to reduce the symptoms of patients diagnosed with PTSD,such as (1)VRET for PTSD and (2)the 3MR memory reconstruction system [3]. This review of PTSD prevention systems focuses on emerging lessons for their design and development. Four systems are profiled. A focus on design and development issues was chosen, rather than on preventioneffectiveness—the design and development process is important for success but less covered in the scientific literature. Training strategies are characterized, andpractical issues and solutions uncovered for the benefit of future developers.

1. Method

Systems were selected based on their intention for primary prevention of PTSD symptoms, via literature search or referral, and excluding therapy systems. Five key

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personswere contacted, and, those who agreed participated in semi-structured interviewsabout system design and development. Key lessons were extracted from these as well as literature descriptions. A Grounded Theory clustering analysis integrated the results.Grounded Theory provides a method for the discovery of empirically testable theories by interpreting data in the social sciences [6]. It is often used as a qualitative analysis method for text-based data. Different theories can emerge depending on the data collected, and can be later validated using other methods.

Since the focus is on technology development, the interview questions followed two main threads: (1) Human-Computer Interaction (HCI) technology and (2) system development phases. HCI questionscovered automation, agents and artificial intelligence, physiological computing, affective computing, virtual reality, biofeedback, and games. Questions relating to the phases of system development were covered, including problem definition, analysis and design, construction, testing, and deployment [9]. Applicable questions were selected for each interviewee, appropriate for the time allowed (30-90min).

2. Results

This section contains a characterization of the reviewed PTSD prevention systems, giving a framework for comparison. A brief review of each system provides a context for understanding the ensuing analysis. The interview analysis comprises of a coding scheme developed by clustering key insights.The insights and resulting codes lead to a grounded set of guidelines.

2.1. Characterization

Table 1 characterizes the prevention strategies of the systems. It shows three key underlying prevention strategies that are currentlyused: Stress Inoculation Training (SIT), Cognitive-Behavioral Therapy (CBT) and biofeedback training.These methods teach and rehearse coping and self-regulation skills that may improve PTSD outcomes in those exposed to traumatic stress.

SIT is a three-phase training which involves cognitive restructuring, coping-skills acquisition, and coping-skills application in the presence of graduated stressors[10]. CBT is a therapeutic restructuring of negative thoughts and behaviors based on conscious awareness of these and their relationship to feelings. Biofeedback is the display of one or more of a person's physiological indicators to him or herself. The display of the indicator allows a person to consciously influence his or her physiology, which feeds back to the display.

Table 1. PTSD prevention systems with prevention stage and strategy.

System	Prevention Strategy
PRESIT + MSE [8]	Biofeedback breathing and attentional training, with SIT-based practice in a multimedia stressor environment; group-based delivery.
STRIVE[12]	Cinematic VR immersion with free-agency, including CBT-based cognitive restructuring with a virtual human coach.
Game-based Biofeedback[1]	SIT-based, stressful VR game requiring successful biofeedback as a performance tactic.
Physiology-Driven VR[5]	SIT-based exposure training using automated physiology-driven regulation.

2.2. Review of systems

Hourani, Kizakevich (RTI International) et al.[8] developed a pre-deployment stress inoculation training (PRESIT) for the practice of stress-coping skills using a multimedia stressor environment (MSE). PRESIT is done in group format with members of the same squad, and includes biofeedback-assisted breathing retraining, as well as attentional control training for staying in the moment. Following a SIT protocol, marines practiced these skills using the MSE. Here they are seated in groups in front of a screen displaying a scripted first-person journey through a virtual Iraqi village. The MSE included sudden stressful events (such as IED explosions) and suspicious things trainees were required to notice. This simulated potential mission conditions while providing stress. In addition, a target identification task requiring joystick responses was included in order to measure any effects of the training on performance. A controlled study was carried out to evaluate the effectiveness of PRESIT, and showed improved relaxation, as measured by heart-rate variability, for previously deployed marines, especially those with PTSD symptoms.

The Stress Resilience in Virtual Environments, or STRIVE system [12] of the Institute for Creative Technologies is a multi-episode narrative of interactive combat simulations. The trainee's experience is similar to that of being inside amovie as a marine in Afghanistan. In the roughly 10-minute episodes, cinematic devices build up an emotional backstory, setting up relationships with other virtual characters. At some point, an emotionally challenging event occurs—for example the accidental death of a civilian child—at which point a virtual mentor appears to guide the participant through cognitive-behavioral appraisal of the experience and the acquisition of emotional coping skills. The mentor sessions include various lessons on cognitive stress coping, which incorporate material from existing classroom-based training programs. The STRIVE environment is distinct in maintaining free-agency of the trainee within the environment. In this way trainees areactively engaged while exposed to stressful virtual events, and learn in an experiential way.A battery of physiological measures are used to measure Allostatic Load (AL), taken from multiple systems including immune, cardiovascular and metabolic. It is a measure of how environmental stressors contribute to the wear of the stress response. AL will be studied for its ability to predict the trainee's acute stress response to the stresses of the virtual environment.

Cosic, Popovic et al.[5]of the University of Zagreb describe an concept for a physiology-driven, adaptive virtual affect stimulation system. It usesadaptive automation to select and present graded images and video for exposure training. The exposure levels are controlled according to physiological input levels. They describe the components of such a system, applications and engineering strategies for their implementation. Three main components are elaborated. First, a stimulus generator contains various multimedia stimuli that have been rated and categorized in machine-readable dimensions. Second, the emotional state estimator monitors the trainee's physiological and subjective experience, by sampling emotion indicators during a fixed interval before the estimation is required. Third, the adaptive controller uses this estimation to apply a strategy for the control of the stimulus generator. The original paper describes a stimulus delivery algorithm for SIT, based on a trainee's physiological habituation to stimuli.

Bernier et al.[1]developed a SIT-based biofeedback training game for soldiers that involves relaxation and attentional focus simultaneous with exposure. Soldiers were

required to practice deep breathing while under attack by zombies in a virtual reality first-person shooter game. The visual field of the trainee would close in if physiological measures (e.g. heart-rate variability) were outside acceptable ranges. It would reopen when returned to acceptable levels. Via such biofeedback, performance in the game depends upon successful application of relaxation strategies. The game itself is stressful, characterizing this as a SIT application. The authors evaluated the effects of the training by physiological responses during a live first-aid training simulation.

2.3. Analysis of Interviews

To understand common threads underlying the interview data as a whole, a Grounded Theory analysis was used. This meant that insights, issues and lessons gathered from interview notes and papers were clustered, leading to a coding scheme. The clustering analysis revealed four code-able factors describing the insights: Resource-, Cultural-, Effectiveness-, and Engineering-related (Table 2). These four codes seem to refer to the constraints, or limiting factors, that characterize system developments. Next, two coders used these four codes to jointly tag all 66 insights that were abstracted from the interviews. To study the reliability of their coding and the clarity of the coding scheme, a third coder, after being trained on a sample of 15 insights, coded the remaining insights independently. Agreement between the third coder and first two coders could be classified as fair to good [9] for all codes except for Effectiveness—the calculated Cohen Kappa values were: Culture, 0.58; Engineering, 0.68; Resource, 0.65; and Effectiveness, 0.25. Of the 66 insights, 58% were assigned with only a single code. In the remaining 42% that received multiple codes, there seems to be no strong indication that specific codes were often assigned together—the proportion of dual coding in 2-by-2 crosstabs of two specific codes ranged from only 4 to 17%. This suggests that four clearly distinct factors underlie the collected interview data.

Table 2.

Code	Definition	Example
Culture	Refers to a social aspect with the parties or stakeholders involved in the development	*Building this for front line soldiers and the issues they face, and most of them are male. Women soldiers face some different challenges.*
Effectiveness	Refers to the ability of the system to achieve its goals	*There is no well-validated stress-resilience questionnaire to test effectiveness.*
Engineering	Refers to ingenuity required to solve problems, design, or implement; includes development processes and methods, design principles	*A steering wheel is not necessary as an input device for driving. Other solutions can be used.*
Resource	Refers to the use of a resource (time, money, information, expertise)	*An operational problem was timing the funding of the study together with availability of the troops' deployment schedules.*

The first guideline this analysis provides is that developers should be aware of these four potential constraining factors. Besides these, interviews revealed some insights shared by more than one system: resilience training should not interfere with operational effectiveness[2][7]; technology is seen positively by trainees and stakeholders [7][2]; buy-in and user-centered design is important [7][11][4]; stress and emotion estimation are complex challenges[4][11]; and there is some degree of stigma toward addressing psychological problems in the military[4][2]. These form a basis on which to complete anessential set of development guidelines (Table 3).

Table 3. Guidelines for developers of PTSD prevention systems, related to project constraints.

Guideline	Constraints
1. Beconscious of project-limiting factors Culture, Effectiveness, Engineering, and Resources	
2. Beware that the training does not negatively affect operational effectiveness of the trainee	Effectiveness, Engineering
3. Capitalize on the positive regard for high-tech approaches	Culture
4. Ensure stakeholder buy-in and employ a user-centered design process	Culture, Effectiveness, Engineering, Resource
5. Prepare for the challenges of using stress and emotion measures	Effectiveness, Engineering
6. Acknowledge the stigma toward psychological and emotional topics in military settings	Culture

3. Discussion

Of the four systems studied[3], the PRESIT+MSE of Hourani, Kizakevich et al. is perhaps the farthest along in the development cycle, having stepped toward large-scale deployment. The issues faced by developers can be mostly described as affecting at least three project-limiting constraints: Culture, Engineering and Resources. It may be that the current definition of Effectiveness does not fit the meaning of a project-limiting constraint, and it might be reworked to better describe the dataset. A set of initial guidelines was completedfrom shared insights, which may represent an essential, if not yet comprehensive, list—besides the issues noted by multiple developers, a number insights made by a single developer seemed to berelevant as well. The generalizability of these might be validated by concisely asking other developers if they concur.

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Virtual Worlds and Avatars as the New Frontier of Telehealth Care

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Abstract: We are entering a new age where people routinely visit, inhabit, play in and learn within virtual worlds (VWs). One in eight people worldwide are VW participants, according to the latest 2011 figures from KZERO [1]. VWs are also emerging as a new and advanced form of telehealth care delivery. In addition to existing telehealth care advantages; VWs feature three powerful affordances that can benefit a wide range of physical and psychological issues. First, the highly social nature of VWs encourages social networking and the formation of essential support groups. Secondly, the type of spaces that have been proven in the physical world to promote psychological health and well-being can be virtually recreated. Finally, research suggests that embodied avatar representation within VWs can affect users psychologically and physically. These three aspects of VWs can be leveraged for enhanced patient-client interactions, spaces that promote healing and positive responses, and avatar activities that transfer real benefits from the virtual to the physical world. This paper explains the mounting evidence behind these claims and provides examples of VWs as an innovative and compelling form of telehealth care destined to become commonplace in the future.

Keywords: telehealth, health care, virtual worlds, avatars, social networking, support groups

Introduction

In this past decade, the use of virtual worlds (VWs) – those socially connected, persistent, online spaces one inhabits by means of a personal avatar – has been rapidly increasing. According to British social media research company, KZero Worldswide, 56% of worldwide VW users, or 1 billion people, are in the 5-15 year old demographic in the first quarter of 2012 [1]. This figure for youth alone actually surpasses the number of people using Twitter or Facebook, but goes largely unnoticed by the general public. This heavy usage suggests that the upcoming generation will be finely attuned to receiving social connections and services through the medium of virtual worlds.

1. A Case for Virtual Worlds as an Advanced Form of Telehealth care

Virtual Reality (VR) technology came to popularity in the last decade of the 20th Century, and preceded the recent rise of virtual worlds by at least a decade. VR utilized

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as a therapeutic tool has been shown to be clinically effective at helping with some persistent mental health issues, such as phobias and PTSD [2; 3; 4]. Virtual Reality, however, is not easily accessible outside a clinician's office, nor is it built with social connectivity in mind. In addition, most Virtual Reality environments do not provide the user with any sort of embodied, personal avatar; most often the user is given a "first person, through the eyes" camera view into the virtual environment. If an avatar representation is used, it tends to be a generic "one type fits all."

VWs, by contrast with established VR, provide much easier accessibility, as all a user needs is a computer and an Internet connection. VWs are connected social spaces, so that many hundreds or thousands of users can be concurrently online. VWs also allow for highly focused forms of environments that can be specially built and targeted to assist in any health care process that is delivered by them. Finally, almost all VWs provide the means for a participant to create and customize their avatar with which they will navigate the world and interact with others.

These characteristics have allowed Virtual Worlds to make inroads to the health care field as an emerging type of "telehealth care." Traditional telehealth care provides several proven advantages that complement traditional, face-to-face health care, including 1) accessibility from rural locations, 2) remote patient monitoring, 3) reduction in need for travel, 4) fostering a positive client-patient relationship, 5) providing enhanced continuity of care, 6) reduction of hospitalization, and 7) overall savings in cost of care, even with increased contact [5; 6]. We believe that Virtual worlds can provide these same benefits, but exceed them in three important ways mentioned above: their social networking functions, their support of customizable environments that can be created to complement and enhance healing functions, and finally the use of a personal avatar. We will look at each of these in more detail.

2. The Unique Affordances of Virtual Worlds for Telehealth care

First and perhaps most importantly, virtual worlds provide powerful means for social connectivity. People in virtual worlds can converse with each other, share experiences, visit in social situations, and work collaboratively toward goals. This social functionality allows for networking to health care providers and others with similar issues. Such Internet-connected social support groups have been shown to facilitate improved healing and maintenance of higher levels of recovery [7; 8; 9].

Secondly, since virtual worlds are malleable, environments within them used for health care can be made to resemble those that research has found over the last half century to be most beneficial to psychological health. No longer is someone relegated to a stark bedroom or clinical setting, but can continue their care in simulated natural settings, such as woodlands, water areas, or mountains, which are more soothing and accessible from their own home no matter where the patient lives [10; 11; 12]. The importance of this was shown to our ICT team when we started working with U. S. military veterans in the virtual world Second Life (SL). We found that they were unable to deal with an Iraqi Village environment we had set up for a previous project, and in fact, one of them could not even remain in the desert overlooking the gates to the village, but had to teleport away immediately, saying "it was just calling back too many bad memories." This led us to create a veterans' environment that was based on a woodland setting with water features and a warm, comfortable lodge for social

gatherings. Much of the design work was done with reference to 6o years of research that looks at how environments can contribute to psychological well-being.

Finally, and perhaps most importantly, virtual worlds provide the affordance of an avatar, which is an embodied and psychological projection of a person. People are able to create and customize the avatars with which they will interact, thus engaging with them in a very personal way. Research is beginning to reveal the power that one's avatar representation can have on behaviors, perceptions, and psychological health [13; 14; 15]. One of the first studies to show the effect using an avatar could have on people was done by Nick Yee as part of his dissertation work at Stanford University in 2007 [16]. Two of his studies dealt with manipulation of avatar characteristics to relate them with behaviors. In the first study, people provided with a more attractive avatar tended to confide more in a confederate of the opposite gender than those given a less attractive representation. In a second study, Yee manipulated the height of the avatar, and showed that people assigned a taller avatar in the virtual world tended to negotiate with more confidence in a known negotiating task than those with a shorter avatar. A later extension to this last study revealed that the effects noted in the virtual world tended to carry over to the actual world. Yee termed these virtual characteristics that affected physical world behavior "The Proteus Effect," concluding that our digital self-representations may, in fact, have potentially profound actual world impact.

3. Examples of Virtual Worlds as Telehealth care

Because of these affordance provided by virtual worlds, and the increasing number of global users, their use as an advanced form of telehealth care is expected to grow in the coming years. While more studies are needed to prove the efficacy of the virtual world approach for specific uses, a few key groups are piloting programs that suggest virtual worlds can be effective as a telehealth care mechanism:

VW enthusiast Dick Dillon expanded Preferred Family Health Care's substance abuse treatment program for teens, in Kirksville, Missouri, to include sessions in SL. Dillon found that the teens spent considerably more time in the virtual world than those in a clinical setting. More importantly, the rate of those completing the program jumped from the usual 30% for in-person care to an astonishing 90% for VW groups [17].

Club One™ Fitness Center followed a similar model, launching a virtual Club One Island™ (COI) in SL. Results of their Virtual World-based weight loss intervention were compared with traditional face-to-face interventions, and the results showed both groups were able to reduce overall weight and their Body Mass Index. The COI group had increased confidence in their ability to continue healthy habits such as frequent exercise and avoiding unhealthy food [9].

Other notable developments have grown from research aimed at supplementing support for military veterans. The authors of this paper are involved in one such endeavor taking place at the University of Southern California's Institute for Creative Technologies (ICT), who have partnered with the National Intrepid Center of Excellence (NICoE)- the DoD's premier research institute for traumatic brain injury and psychological health conditions. Working together, ICT and NICoE have built a virtual version of the Bethesda MD facility, where each department will place educational materials, activities and ongoing connectivity for their patients to utilize while they are in their 4 week program at the NICoE and after they leave [18]. YEAR 1 (2011-2012)

focused on building a version of NICoE for use in the virtual world, and on working with the NICoE leadership to determine appropriate content to be included in the project, and also on training the staff in the use of Virtual Worlds. Year 2 will allow stakeholders to test and enhance the functionality of the Virtual NICoE platform to ensure maximum functionality. Year 3 will involve focused studies on effectiveness with a patient cohort using the virtual world.

ICT has also explored leveraging activities for stress relief that have substantial evidence-based support for their efficacy, such as Mindfulness-Based Stress Reduction (MBSR). MBSR has over twenty-five years of studies that show it can relieve chronic pain, improve sleep, and reduce stress [19; 20]. Working with MBSR experts from the University of San Diego Mindfulness Center, we adapted the 8-week program to be deployed in Second Life and did a pilot study to inform improvements to the virtual MBSR classes in preparation for a longitudinal study comparing traditional versus virtual results from two groups of military personnel.

Another study at ICT involved an engaging virtual world activity that resulted in physical world benefits to the participants. Inspired by a request from a military social worker, we devised a means for the running to be controlled by a person's even, relaxed breathing rather than a keyboard. When the user matches the sound of their breath (recorded by a microphone) to a rhythm indicated on screen, the avatar will run without being controlled by keys. A small study done with the jogging activity showed that it was effective in reducing stress markers in users [21].

Other developments associated with expanding military care include work by Alice Krueger and Virtual Ability, Inc. [22]. With funding from the Army's Telemedicine and Advanced Technology Research Center (TATRC), Krueger's team built a specially designed space in Second Life expressly for military amputees to find camaraderie and participate in fun activities and challenges. Hoping to expand the initial promise of this space, TATRC called for contributions that would enhance the virtual space or the lives of amputees overall. Many unique ideas were proposed and ultimately developed for a Phase 1 Small Business Innovation Research grant (SBIR) in 2011 [23]. Phase 2 of the TATRC work is soon to be awarded and should expand the therapeutic potential of these VW activities to many more of these military veterans.

4. Conclusion

These are exciting times for technological solutions that provide improved, more accessible and more personalized health care for people, regardless of their geographical proximity to such care. Virtual Worlds are a part of the promise that technology can deliver advanced forms of telehealth care that provide better environments, more peer support, and an embodied avatar to help motivate and modify behaviors. While there remains much research to be done, especially in the how of why avatars affect their users, we believe there will be many studies completed in the near future that inform this area. Understanding the full potential of both virtual worlds and avatars to deliver and improve health care, especially for upcoming generations who feel at home with these technologies, will inspire new ideas and provide innovative personal incentives, making virtual world healthcare options very real indeed.

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Adapting Computerized Treatments Into Traditional Psychotherapy For Depression

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Abstract. Recent developments in technology have helped to improve the process of psychotherapy. Unfortunately, many therapists lack the computer skills or financial resources needed for the newest technology. Nonetheless, even basic advances in technology may help to improve the treatment of depression. **Method**: The literature is reviewed for journal articles on the treatment of depression published during the past seven years in which treatments have been guided by technology. **Results**: Six novel findings are summarized that may be helpful even when the therapist lacks skill or resources for advanced technology. 1) The efficient assessment of depression can be facilitated by technology, whether using standardized measures or simple daily ratings of mood. 2) Technology tools can be used to send semi-automated daily reminders to help clients develop more adaptive habits in thoughts or actions. 3) Depressed clients can begin to confront their negative view of self, often triggered by some form of loss, failure, or rejection, whether real, imagined, or anticipated. 4) Clients can confront their problems through therapeutic dialogue, whether conducted in person, over the telephone, or via video conference. 5) Clients can use writing assignments to identify, label, explore and express their thoughts and feelings. These writing assignments can be conducted via paper, email, or internet forms. 6) Clients value rapport with a therapist, and this bond seems important to ensure participation and adherence with treatment. **Conclusion**: Even low-tech therapists can strengthen the treatment of depression using basic technology tools to replace, extend, or supplement traditional sessions. However, it is important to protect the rapport needed for sustained participation in therapy.

Keywords. Depression, Psychotherapy, Technology

Introduction

Recent developments in technology have helped to improve the process of psychotherapy. Technology-assisted therapy has included virtual reality exposure simulations, internet web sites with psycho-educational resources, dialogue over video-conferencing, or daily emails with a therapist. Some computer applications can allow for personalized experiences that feel vivid yet safer than other options.

Technology has improved tremendously over the past 20 years. All therapists and most clients now rely on computers, email, internet searches, and text messaging. However, some therapists may lack the computer skills or financial resources needed for the newest technology. More mature therapists may have been raised (personally and professionally) before the boon of technology. It may not be second-nature to use a

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smart phone for email and other applications. Some clients lack education, training, computer savvy, or personal finances needed to remain current with the latest technology. Some older adults do not use computers or the internet except on an infrequent basis. In addition, many clients are struggling with the weak economy, widespread unemployment, and risk of home foreclosure (27). Suddenly home access to the internet may be a luxury that cannot be afforded.

It is hoped that even basic advances in technology may help to improve the treatment of depression. Therefore, the present review will seek to identify strategic changes in therapy that have been learned through the latest technology-assisted forms of treatment. The goal is to identify various goals for therapy or mechanisms of change that might be adapted for use even when the therapist does not rely extensively on computers, internet sites, or virtual-reality technology.

1. Method

The psychotherapy literature is reviewed for journal articles on the treatment of depression published during the past seven years in which treatments have been guided by technology. Although the primary focus will be on studies pertaining to the treatment of depression, the review will also include several useful studies on the treatment of anxiety disorders or other forms of mental illness. A comprehensive search was used to find all recent journal articles. PsychInfo, PsychArticles, and Google Scholar were the search engines used to identify the latest publications in the field. Although the review is focused articles published during the past 7 years, where relevant, the review will extend further back for a comprehensive review.

2. Results

After an extensive review of the published literature, six novel findings were identified that could be adapted onto more traditional forms of psychotherapy for depression. The six strategies are summarized that may be helpful even when the therapist lacks skill or resources for advanced technology.

2.1. Conduct an Efficient Assessment of Depressive Symptoms

The assessment of depression can be facilitated by technology, whether using standardized measures or simple daily ratings of mood. A simple framework can guide the assessment to include the "ABC'S of symptomatology": (A) Affective reactions, (B) Behavior changes, (C) Cognitive distortions, and (S) Social functioning (26). Assessment strategies can help increase awareness of emotional reactions. Using mobile phone applications, clients can report their mood several times a day for one month, and record their mood and negative cognitions (24). Even simple ratings of mood can be quite useful to guide therapy and monitor progress (34). Clients can learn to record their mood and daily activities (10), and begin to identify patterns in daily fluctuations of depressive symptoms.

2.2. Help clients to develop adaptive behaviors

Most forms of technology provide a fair amount of structure. Online educational materials can be used to enhance a person's knowledge of common symptoms and

various treatment options (9). Technology tools can be used to send semi-automated daily reminders to clients to help them develop more adaptive habits in their thoughts or actions. Daily reminder notes can be sent via email or text messages to promote adherence to therapy and cooperation with behavioral activities between sessions. Behavioral activation strategies can be easily incorporated into online treatments (22).

2.3. Cultivate effective problem-solving skills

Problem-solving therapy can provide a simple framework for psychotherapy sessions. Many depressed clients have struggled because of recent stressful events. They may not know how to respond effectively, or they may be limited by maladaptive habitual responses. Brief, structured training in problem-solving skills can be effective in the treatment of depression (11), and has been more effective than many other types of treatment (20). Even when provided through a training videotape, problem-solving training can help to reduce depression and suicide risk (13).

2.4. Restructure negative attitudes and pessimistic expectations

For most depressed clients, cognitive restructuring is essential for effective therapy. Clients can be helped to identify, clarify, challenge, and change negative interpretations, attributions, and expectations. Internet modules (completing one module each week for 5 weeks) can be used to increase the person's awareness of negative automatic thoughts and to confront and change these negative attitudes (6). Computerized therapy can help clients to reduce tendencies for a negative attributional style (30).

2.5. Use writing activities to explore and express negative emotions

A therapist can use a series of written assignments structured to help clients (a) identify, (b) label, (c) explore and (d) express their thoughts and feelings. These writing assignments can be conducted via paper, email, or internet forms. A therapist can develop a series of templates that guide the client through thoughts and recollections. The client's responses can be emailed back to the therapist once a week or more often. Clients can be guided through a series of writing projects, to explore positive memories and move forward with a more positive attitude (35).

2.6. Protect the therapeutic relationship

Clients value rapport with a therapist, and this bond seems important to ensure participation and adherence with treatment. Without a sound therapeutic alliance, therapy is unlikely to be successful (28). An inquisitive exchange of questions usually guides the more productive therapy sessions (25). Even though weekly telephone calls from a therapist do not enhance the potency of internet treatment for depression (12), clients tend to drop out from internet based treatments because of the lack of face-to-face contact as well as other concerns (8, 17). Computerized treatments should be designed to extend, not replace, the role of the therapist (1, 29, 33). Computer therapy with support from a therapist has been found to be much more effective than computer therapy without personal support (3, 5, 31). Pre-scheduled telephone contacts can help to supplement the computerized interventions (19). In addition, clients tend to prefer working with therapists who self-disclose issues about their own life and concerns (18).

3. Conclusions

Even low-tech therapists can strengthen the treatment of depression using basic technology tools to replace, extend, or supplement traditional sessions. Computerized forms of treatment can provide many novel strategies for education, training, supervision and therapeutic change (4). The latest treatments can provide novel strategies, simple reminders, and vivid examples. Internet-based treatments are valued as convenient and anonymous (16), helpful, logical, and useful (7). Similar to weekly scheduled outpatient sessions, clients can be encouraged to complete one module each week (24).

There are many skilled therapists who were raised after the technology boom who may benefit from strategies for therapy that can be enhanced through simple technology tools. Some clients may need computer training (36). Ideally, computerized treatments should avoid becoming overly complicated in the technology sophistication needed (2). Research has found that internet-based treatments can be effective for adults over age 50 (32).

With the use of technology, it can become easier to provide treatment to clients in rural settings, as well as patients who have medical problems that might limit their mobility (23). Internet forms of therapy can be effective, convenient and affordable (14, 15). Computer assisted therapy is viewed as logical, useful, and acceptable by most clients. With adequate computer safety features, Internet therapies can be convenient and confidential (21).

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What is Positive Technology and its impact on CyberPsychology

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Abstract. The goal of this paper is to introduce and describe the "Positive Technology" approach - the scientific and applied approach to the use of technology for improving the quality of our personal experience through its structuring, augmentation and/or replacement - as a way of framing a suitable object of study in the field of cyberpsychology and human-computer interaction. Specifically, we suggest that it is possible to use technology to influence three specific features of our experience – affective quality, engagement/actualization and connectedness – that serve to promote adaptive behaviors and positive functioning. In this framework, positive technologies are classified according to their effects on a specific feature of personal experience. More, for each level we have identified critical variables that can be manipulated to guide the design and development of positive technologies.

Keywords: Positive Technology, Positive Psychology, Well-being, Flow, Optimal Experiences, Affective Quality, Engagement, Connectedness

Introduction

Positive Psychology is a nascent discipline whose broad goals are to understand human strengths and virtues, and to promote these strengths to allow individuals, communities, and societies to flourish [1-3]. Martin Seligman, considered the father of this movement, pointed out how subsequent to World War II, psychology became a science devoted to healing based on a disease model. However, it gradually became clearer to several scholars that this almost exclusive focus on pathology neglected the possibility of understanding normal and optimal functioning. This trend has resulted in a shift in emphasis towards the study of the factors that allow individuals and communities to thrive – the strengths' perspective [4].

Here we suggest that it is possible to combine the objectives of Positive Psychology with enhancements of Information and Communication Technologies (ICTs) towards a new paradigm: Positive Technology [5-7]. The final aim is to use technology to manipulate and enhance the features of our personal experience with the goal of increasing wellness, and generating strengths and resilience in individuals,

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organizations and society. Specifically, in the following paragraph we suggest an integrative framework of analysis based on the concept of "personal experience".

Seligman in his book "Authentic Happiness" identified "three pillars" of the good life [8]:

- *the pleasant life*: achieved through the presence of positive emotions;
- *the engaged life*: achieved through engagement in satisfying activities and utilization of one's strengths and talents;
- *the meaningful life*: achieved through serving a purpose larger than oneself.

Following a similar view, Keyes and Lopez argued that positive functioning is a combination of three types of well-being: 1) high emotional well-being; 2) high psychological well-being; and 3) high social well-being [9].

In other words, Positive Psychology identifies three characteristics of our personal experience – affective quality, engagement/actualization and connectedness – that serve to promote personal well-being. In the proposed framework, positive technologies will be classified according to their effects on these three features of personal experience [5-7]:

- *Hedonic*: technologies used to induce positive and pleasant experiences;
- *Eudaimonic*: technologies used to support individuals in reaching engaging and self-actualizing experiences;
- *Social/Interpersonal*: technologies used to support and improve social integration and/or connectedness between individuals, groups, and organizations.

For each level we will try to identify critical variables that can be manipulated and controlled to design and develop a Positive Technology.

1. Hedonic level: using technology to foster positive emotions

The first dimension of Positive Technology concerns how to use technology to foster positive emotional states.

According to the model of emotions developed by James Russell [10] it is possible to modify the affective quality of an experience through the manipulation of "core affect", a neurophysiological category corresponding to the combination of valence and arousal levels that endow the subjects with a kind of "core knowledge" about the emotional features of their experience. The "core affect" can be experienced as freefloating (mood) or attributed to some cause (and thereby begins an emotional episode). In this view, an emotional response is the attribution of a change in the core affect given to a specific object (affective quality). Simply put, a positive emotion is achieved by increasing the valence (positive) and arousal (high) of core affect (affect regulation) and by attributing this change to the contents of the proposed experience (object). Key arguments for the usefulness of positive emotions in increasing well-being have been recently provided by Fredrickson [11; 12] in what she called the "broaden-and-build model" of positive emotions. According to Fredrickson, positive emotions provide the organism with nonspecific action tendencies that can lead to adaptive behavior [11]. For example, in children, joy is associated with the urge to play, whereas interest sparks the urge to explore; in adults, positive emotions make them more likely to interact with others, provide help to others in need, and engage in creative challenges. The second proposition of Fredrickson's model concerns the consequences of the positive emotions: by broadening an individual's awareness and

thought–action repertoire, they build upon the resultant learning to create future physical, psychological and social resources [12].

2. Eudaimonic level: using technology to promote engagement and self-empowerment

As we have seen, the first level of Positive Technology - the hedonic one - is concerned with the use of technologies to induce positive and pleasant experiences. The second level is more concerned with the eudaimonic concept of well-being, and consists of investigating how technologies can be used to support individuals in reaching engaging and self-actualizing experiences.

The theory of flow, developed by Positive Psychology pioneer Mihaly Csikszentmihalyi [13], provides a useful framework for addressing this challenge. Flow, or optimal experience, is a positive and complex state of consciousness that is present when individuals act with total involvement. The basic feature of this experience is the perceived balance between high environmental opportunities for action (challenges) and adequate personal resources in facing them (skills). Additional characteristics are deep concentration, clear rules in and unambiguous feedback from the task at hand, loss of self-consciousness, control of one's actions and environment, positive affect and intrinsic motivation.

Some researchers have drawn parallels between the experience of flow in VR and the sense of presence, defined as the subjective perception of "being there" in a virtual environment [14-19]. From the phenomenological viewpoint, both experiences have been described as absorbing states, characterized by a merging of action and awareness, loss of self-consciousness, a feeling of being transported into another reality, and an altered perception of time [20]. Further, both presence and optimal experience are associated with high involvement, focused attention and high concentration on the ongoing activity [21; 22].

Starting from these theoretical premises, Riva and colleagues [23; 24] have suggested the possibility of using VR for a new breed of applications in positive mental health, based on a strategy defined as "transformation of flow", defined as a person's ability to draw upon an optimal experience induced by technology, and use it to promote new and unexpected psychological resources and sources of involvement.

3. Social and interpersonal level: using technology to promote social integration and connectedness

The final level of Positive Technology - the social and interpersonal one - is concerned with the use of technologies to support and improve the connectedness between individuals, groups, and organizations. However, an open challenge is to understand how to use technology to create a mutual sense of awareness, which is essential to the feeling that other participants are there, and to create a strong sense of community at a distance. Short et al., [25] define 'social presence' as the "degree of salience of the other person in a mediated communication and the consequent salience of their interpersonal interactions" (p. 65). Conventional computer-mediated communicative tools, such as email or text-based chat, are regarded as having lower social presence and social context cues when compared to face-to-face communication. However, different

authors have suggested that it is possible to manipulate the technological experience to enhance social presence and thereby improve different mediated activities [26] such as online learning [27], e-commerce [28] and health care [29].

Riva and colleagues [30] recently suggested that a subject is present within a virtual group if he is able to put his own intentions (presence) into practice and to understand the intentions of the other group members (social presence). This implies that, to sustain social optimal experiences (networked flow), the technology has to provide the virtual group with the possibility of expressing itself and of understanding what each individual member is doing [31]. More, Gaggioli and colleagues [32] argued that optimal group state is achieved when the team develops a "we-intention", in which the actions of the individuals and of the collective are merged, and the group acts as an autonomous, self-organizing entity.

Key arguments for the usefulness of connectedness in increasing well-being have been presented by Ryff and Singer [33]. The authors argued that interpersonal flourishing (the development of positive relations with other people) is a key dimension of well-being, which is stable across different cultures and across time. More, in a recent paper, Mauri and colleagues [34] used different physiological data - skin conductance, blood volume pulse, electroencephalogram, electromyography, respiratory activity, and pupil dilation – to evaluate the affective experience evoked by the use of Facebook. The biological signals revealed that Facebook use can evoke a psychophysiological state characterized by high positive valence and high arousal (Core Flow State). These findings support the hypothesis that the successful spread of social networks might be associated with a specific positive affective state experienced by users when they use their account.

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Human Computer Confluence Applied in Healthcare and Rehabilitation

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Abstract. Human computer confluence (HCC) is an ambitious research program studying how the emerging symbiotic relation between humans and computing devices can enable radically new forms of sensing, perception, interaction, and understanding. It is an interdisciplinary field, bringing together researches from horizons as various as pervasive computing, bio-signals processing, neuroscience, electronics, robotics, virtual & augmented reality, and provides an amazing potential for applications in medicine and rehabilitation.

Keywords. Perception, human body, cognitive neuroscience, embodiment, brain computer interface

Introduction

Human Computer Interface (HCI) research over three decades has shaped a wide spanning research area at the boundaries of computer science and behavioral science, with an impressive outreach to how humankind is experiencing information and communication technologies in literally every breath of an individuals life. The confluence of pervasive or ubiquitous computing and HCI through the Internet of Things, Smart Cities, AR and VR and mobile wearable devices is leading us to the disappearing interface.

Nowadays, technological improvements have changed the way that people communicate, sense and interact. Undoubtedly, these technological improvements have increased our capacities to understand the human brain and have provided new ways to envisage healthcare. The strong integration between humans and technology represents an incredible opportunity to investigate human behaviour and analyze all the potentialities and advantages when used in the field of healthcare and rehabilitation.

The horizontal character of HCC makes it a fascinating and fertile interdisciplinary field, with which new ways to improve the quality of life of the people can be envisaged, whether it is by providing new diagnostic tools or developing innovative therapeutic approaches, improving and accelerating the rehabilitation process of the patients. Under the umbrella of HCC there are several potentially interesting technologies for healthcare and rehabilitation.

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1. Brain Computer Interface & Computer Brain Interfaces

The field of Neuromodulation, including both neurofeedback and neuro-stimulation has seen a resurgence in the last 25 years or so. The Journal of Neurotherapy has been publishing mostly neurofeedback (NF) results since 1995. Much of this work has been based on Brain Computer Interfaces (BCI) studies carried out by both neuroscientists and HCI researchers trying to build new forms of communication for those that cannot use traditional channels. These insights have led to a better understanding of how NF can drive positive feedback loops with positive effects in the treatment of for example, ADHD and Autism.

More recent research (such as HIVE, http://hive-eu.org/) on using improved brain stimulation paradigms to explore fundamental neuroscience questions and applications, aims to design and test more powerful, controllable and safe non-invasive brain stimulation technologies. These technologies can be used for rehabilitation in stroke patients and have shown potential in the management of pain and depression.

In the next 50 years we will witness the coming of age of technologies for fluent brain-computer and computer-mediated brain-to-brain interaction. These systems will be *smart* and will adapt the NF protocol or stimulation to the needs of the individual based on real time decoding of brain state.

2. Mobile devices and the emergence of body computing

The explosive growth of networks and communications, and at the same time radical miniaturization of ICT electronics have reversed the principles of human computer interaction. One of the most advanced frontiers of this trend is the so-called "body computing", which refers to wearable or implantable wireless devices that can transmit real-time data to physicians, patients or caregivers. More specifically, the vision of body computing is achieved through the combination of portable communication systems (i.e. smart-phones) and body-sensors technologies, which are small piece of little or non-invasive equipment that measure specific bio-physical parameters (for example, heart beat rate or body temperature).

As body sensors are becoming available at accessible price, the interest towards the development of personal healthcare applications and services that integrate these devices is increasing. The research community on body computing is also expanding rapidly, as indicated by the growing number of conferences focused on this topic. As concerns applications, examples of areas where body computing could be effectively used include (but are not limited to) chronic diseases monitoring, monitoring patient's addiction recovery and long-term drug treatment, and daily assessment of generic health conditions of elderly patients. However, the successful development of body computing applications require not only cheap, reliable and non-invasive sensor technologies, but also appropriate data analysis approaches. Actually, the massive amounts of data collected via body sensors and stored in the databases must be integrated and processed in order to provide meaningful information about the patient's health status. The development of appropriate data mining, machine learning and signal processing techniques, as well as the definition of sound patho-physiological models, is a significant open challenge.

Beyond medical applications, body computing could prove useful in other fields, such as in human-computer interaction. For example, researchers at VIBE's

Computational User Experiences (CUE) group (http://research.microsoft.com/en-us/um/redmond/groups/cue/) are working on the idea of turning the body into the input device, in order to achieve the vision of "always-available computing". In one of their projects, Skinput (http://research.microsoft.com/en-us/um/redmond/groups/cue/skinput/), they are trying to develop a technology that appropriates the human body for acoustic transmission, allowing the skin to be used as an input surface.

In sum, body computing is an exciting field of research, which promises revolutionary applications in the fields of healthcare, personal wellness and beyond. However, the realization of this vision requires a careful analysis of the legal, ethical, societal, and privacy issues implicated by the use and manipulation of human data.

3. Virtual reality and body ownership

The neuroscience of body ownership has challenged the ideas about how humans interact with a virtual world, whether it is through a fully immersive display or a mobile display. The VERE project (Virtual Embodiment and Robotic re-Embodiment, http://www.vereproject.eu/), supported by the European Commission under the Future and Emerging Technologies program) in particular is studying the embodiment of people in surrogate bodies so that they have the illusion that the surrogate body is their own body – and that they can move and control it as if it were their own. Understanding and mastering embodiment in virtual reality would have implications in the context of rehabilitation settings.

How and whether the body is represented in a virtual environment have consequences that have been disregarded. Furthermore, the absence of body representation in a virtual environment have different implications according to the display setup used. For example, in a CAVE, the user is not dissociated from his/her actual body. But when using a head-mounted display, the user is completely detached from his/her body and the absence of visual representation of the body might have advantages but also drawbacks.

Virtual reality has long been neglecting body image and body schema topics, in spite of the pioneering work of Riva and colleagues who started to use virtual reality to improve body image in patients with eating disorders or obesity [1]. Paradoxically, what becomes of the body of a user immersed in a virtual world has been an inexistent topic until the neuroscience of body ownership made its coming out in the middle of the first decade of the XXIst century (see for example [2] for a feature article reviewing several of the recent illusions from Dr. Henrik Ehrsson lab). Today, virtual reality is one the favorite tools of neuroscientists studying body ownership, and the results of their study contribute a very important knowledge to the HCC community.

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A Brief Review of Positive Technology in Europe and the USA

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Abstract. The aim of this paper is to demonstrate the potential of positive technology to productively and positively transform the mental health of European and American citizens in the modern era. This work will describe three aspects – hedonic, eudaimonic, and social/interpersonal – of these technologies. We approach them with guarded optimism, as all of them seek to improve our lives through various techniques. After exploring the relevant technologies, this piece will then examine the future for research within this domain.

Keywords. Positive technology, positive psychology, hedonic, eudaimonic, social networking, virtual reality

Introduction

Positive technology (PT) may be described as a technological extension of existing therapy. PT is sought after for improving the quality of our personal thoughts, feelings, and emotions. In this account, we will outline the three primary ways in which PT can be communicated to citizens in order to improve their psychological well-being.

Positive technology may also be perceived as an offshoot of positive psychology (PP). PP may have had its official birth in 1998 [1], but its roots date back at least to the concept of "healthy mindedness" at the beginning of the 20th century [2]. The aim of PP is to evoke pleasure in people's experiences by taking their positive attributes and strengthening them, rather than focusing on the negative aspects of the individual and seeking to eliminate those negative attributes. By focusing on the positive attributes, not only does this improve and aid people's self-esteem, it also helps them to become better in something or become an expert in something they enjoyed doing previously. PT simply uses this framework and adds technological programming or devices to the equation to more swiftly advance the progress of the individual.

This account will demonstrate the effectiveness of PT by describing its three main forms: hedonic, eudaimonic, and social/interpersonal. It will show how these methods have been effective in improving people's mental health and well-being. Included is a set of precautions that we must take when embracing PT in the United States and Europe. Finally, this work will suggest a vision for the future of PT and its ability to improve the lives of citizens.

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1. Hedonic Technologies

The first dimension of PT concerns how to use technology to foster positive emotional states and pleasant experiences. The feeling of hedonism is associated with the mental states of excitement, relaxation, and happiness. Some European projects have already begun to capture this aspect of PT. The EMMA (Engaging Media for Mental Health Applications) Project called Emotional Parks, combines mood induction procedures (MIPs) with virtual reality (VR) to produce positive emotions [3]. Botella et al. developed a mood device called the Butler System, which is an online health system designed to improve the lives of elderly people – for example, one of its VR environments presents the image of a park and nature [4]. VR environments developed by the Wiederholds are being used in Iraq, Afghanistan, and U.S. military facilities to help service members practice combat breathing and reduce post-combat stress [5]. Most recently, Repetto et al. showed that use of a campfire, beach, or waterfall VR environment on a mobile phone could significantly reduce anxiety in individuals with generalized anxiety disorder [6].

Technology-assisted reminiscence uses media created from familiar voices, family photos, and detailed patient histories to create happy moments in the lives of people with dementia. "John had advanced dementia and was very withdrawn, which made it difficult to interact and connect with him. Researching his life, we discovered he played football for a Big Ten school in the 1940s. By showing him pictures of the school's team and playing the school's 'fight song,' John engaged in limited conversation and would sing part of the song. This made him happy, and it easier for others to relate to him." [7] The evidence suggests that these Hedonic technologies have the ability to project a positive effect on people's lives while simultaneously mitigating the negative effect.

As with all technological advances we must approach Hedonic approaches with an element of caution, as such approaches may not be suitable to every individual. Some individuals may need to focus on how they are to improve themselves. Our notions of self have a profound effect on the way in which we focus, both as individuals who are independent and as individuals who are interdependent and perceive themselves as functioning as part of a group.

2. Eudaimonic Technologies

The second dimension of PT is its eudaimonic aspect. Eudaimonic technologies concern the prospect of healing oneself in order to gain self-realization and self-actualization to reach a positive emotional state. In this section we will explore some of the technologies used to achieve this. Group therapy is a technique that has been practiced for a number of years; it can be empowering to some who are struggling to help themselves. Eudaimonic technologies fill the gap for those who are unable to reach positive estimations about themselves within a group environment. Some researchers believe that perhaps by constructing a system in which people can address their emotional turmoil or distress themselves, this can lead to a more individualized, progressive approach towards emotional recognition and stability.

Eudemonic technologies are used to support individuals in reaching self-actualizing experiences. Eudemonic technologies focus on self-well-being and the conclusions one can come to by oneself about one's mental stability, progress, and mood. Our internal feelings have a profound effect upon the ways in which we perceive ourselves as

persons, and some thinkers have discovered that by using these introverted technologies our external feelings and thought processes may benefit from progressive persistent improvement. Recent evidence has demonstrated that positive emotions and the erosion of negative feelings can potentially lead to a positive emotional state. What eudemonic technologies teach us is that we are sometimes able to achieve that state by ourselves, creating a liberating approach to psychotherapy in which one is able to reach positive emotional conclusions by oneself. Recent examples include the application called EARTH (Emotional Activities Related to Health), which within the framework of the MARS500 research project is designed to help astronauts in a future mission to Mars. This project includes VR MIPs and an application called the Book of Life, which includes several chapters that focus on significant events of one's life experiences and also one's future plans. Each chapter is designed to focus on people's psychological strengths. A range of media is used such as images, videos, and even personalized elements. After the user's positive ambitions have been recorded, the user is able to play them back and enjoy them at any time [1]. Additionally, Wiederhold and Wiederhold have been working with elite athletes and medical and military personnel in order to enhance and solidify their strong skill set [8]. Although it is crucial that the individual is able to understand the self, the self also needs to be understood in the context of other, which leads us to ponder the social and interpersonal level of PT.

3. Social and Interpersonal Level

Finally, the social and interpersonal level is concerned with using technology to improve what can be called the connectedness between individuals, groups, and organizations. The social and interpersonal level of PT concerns itself with the notion that individual happiness and positive notions may also need to be understood in the context of others. It is in this context that the term positive computing (PC) arises, as PC is the notion that the study and development of technologies are designed to support well-being, wisdom, and human development [9]. The reality is that we are living in an age of Facebook, Twitter, Tuenti, and other social networking sites, which are now used on a daily basis. Previously, we used computers out of necessity; in today's world through social networking sites we integrate and invite people and emotions into our lives and our homes through a computer. Therefore it is imperative that we examine the positive effect that such sites can have on our emotions.

Facebook currently has 901 million users worldwide. Although this may appear as a number; it is in fact a measure of its great popularity and power in affecting the emotions of others. Positive characteristics (such as gratitude, flexibility, and positive emotions) can uniquely predict disorder beyond the predictive power of the presence of negative characteristics, and buffer the impact of negative life events, potentially preventing the development of disorder. While individual decisions for using these websites vary, it is clear that they offer some kind of positive emotional stimulation to integrate into individuals' lives – something that can be classified as a positive technological measure to improve people's well-being. A study of 391 college students suggests that the number of Facebook friends and positive self-presentation may enhance users' subjective well-being. Furthermore, honest self-presentation may enhance happiness rooted in social support provided by Facebook friends [10]. An earlier study showed that 1,715 Texas college students joined Facebook Groups to obtain information about on- and off-campus activities, socialize with friends, seek self-status, and find entertainment. An important social result was that active Facebook

Group users were more likely to participate in offline civic and political activities [11].

   Although social media such as Facebook can create positive feelings and emotions, it is important to point out that, for example, being "unfriended" can have a devastating emotional impact on vulnerable people, while it may result in others repressing such emotions. Konrath and colleagues reported a 48 percent decrease in empathic concern and a 34 percent decrease in perspective taking amongst college students in the past 30 years, with implications that this is due in part to social media [12]. Facebook has a set of precautionary actions and guidelines to help prevent negative feelings while using the site. For example, Facebook states that:

1. You will not solicit login information or access an account belonging to someone else.
2. You will not bully, intimidate, or harass any user.
3. You will not post content that: is hate speech, threatening, or pornographic; incites violence; or contains nudity or graphic or gratuitous violence. [13]

To counteract some of the potentially negative effects of social media, researchers designed an anti-bullying virtual intervention called FEAR NOT to enhance the coping skills of victimized children or children at risk for victimization. In a randomized clinical trial of this intervention enrolling 1,029 nine-year-old children in the UK and Germany, the researchers found a dose-response between time spent in the virtual learning environment and ability to escape bullying. Subsample analysis found a significant effect for UK children [14].

4. The Future of Positive Technology (PT)

In sum, the future use of PT is essential to our understanding of the self, with the technological world we are involved in and the obvious role that the Internet plays in our daily lives – on our laptops, tablets, and phones. It is therefore very important that we continue our research in the field, as it is essential that we are constantly examining the obvious positive impacts that these technologies have on the lives of citizens in Europe. For example, a recent study showed that a large sample of adolescents and young adults who report higher positive affect or higher life satisfaction grow up to earn significantly higher levels of income [15]. This suggests a strong possibility for reverse causality between income and happiness, highlights the importance of an emotionally stable and positive upbringing for children, and suggests that policy makers' investment in promoting well-being may yield positive economic effects.

5. Conclusion

This paper has explored the essential aspects of positive technology: hedonic positive technology, eudemonic positive technology, and social and interpersonal positive technology. All three elements improve the quality of the lives of individuals in Europe and America. We conclude that it is imperative for us to advance our research in positive technologies to further the well-being of our citizens.

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Section II

Evaluations Studies

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Promotion of Emotional Wellbeing in Oncology Inpatients Using VR

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Abstract. *Introduction* In Psycho-oncology, VR has been utilized mainly to manage pain and distress associated to medical procedures and chemotherapy, with very few applications aimed at promotion of wellbeing in hospitalized patients. Considering this, it was implemented a psychological intervention that uses VR to induce positive emotions on adult oncology inpatients with the purpose of evaluating its utility to improve emotional wellbeing in this population.
Method Sample was composed of 33 patients (69.7% men, aged from 41 to 85 years old; X=62.1; SD=10.77). Intervention lasted 4 sessions of 30 minutes, along one week. In these sessions, two virtual environments designed to induce joy or relaxation were used. Symptoms of depression and anxiety (Hospital Anxiety and Depression Scale, HADS*)* and level of happiness (Fordyce Scale) were assessed before and after the VR intervention. Also, Visual Analogue Scales (VAS) were used to assess emotional state and physical discomfort before and after each session.
Results There were significant improvements in distress and level of happiness after the VR intervention. Also, it was detected an increment in positive emotions and a decrease in negative emotions after sessions.
Conclusions Results emphasize the potential of VR as a positive technology that can be used to promote wellbeing during hospitalization, especially considering the shortness of the intervention and the advanced state of disease of the participants. Despite the encouraging of these results, it is necessary to confirm them in studies with larger samples and control groups.

Keywords: Virtual Reality, Cancer, Hospital Setting, Positive Emotions

Introduction

VR has been utilized in health psychology with very good results. For example, it has been used to manage pain associated to medical procedures (burn care procedures, punctures, dental procedures) [1-3] and for assessment and rehabilitation of patients with strokes or dementia [4-5]. In Psycho-oncology, it has been used mainly to manage

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pain and anxiety associated to medical procedures (especially with children and adolescents) [6-11] as well as to handle distress during chemotherapy [12-16].

Studies that focused on painful medical procedures with children and adolescents indicates that VR helps them to manage anxiety, fear and pain during procedures [6-9], being considered by patients as a positive experience [10].

Moreover, VR has been utilized to handle distress during chemotherapy with very positive results. Studies show that VR alters time perception during chemotherapy sessions, so it became a more tolerable procedure [12-14]. Also, it was detected a significant decrease in anxiety, distress and fatigue immediately after chemotherapy sessions with VR [15, 16].

To our knowledge, there are very few applications focused on the promotion of wellbeing during hospitalization [17-19]. Considering that hospitalization is usually associated to stressing conditions (changes in health status, level of autonomy, intimacy and others) it is important to have therapeutic tools capable of respond to such conditions and needs.

Therefore, this study focuses on the promotion of emotional wellbeing – specifically, induction of positive emotions- through two virtual environments, in a group of patients little considered so far: hospitalized oncology patients. In particular, the objective was to increase positive emotions of joy and relax during their hospitalization period.

1. Method

1.1 Participants

Eligible patients were adult cancer patients with a Karnofsky functional state ≥ 50, indicators of adequate organ function, life expectancy ≥ 2 months and who were hospitalized for at least 1 week. Patients with serious psychopathology, legal incapacity or brain metastasis were excluded. All participants signed an informed consent before starting his/her participation in this study.

The sample was composed of 33 patients (69.7% men, aged from 41 to 85 years old; X=62.1; SD=10.77). Most of them had elementary educational level (75.8%). The main causes of hospitalization were acute crisis (33.3%) and specialized treatment (30.3%). The most frequent diagnoses were lung (18.2%) breast (15.2%) and bladder cancer (12.1%). The majority of patients had metastatic cancer (81.8%).

2. Measures

2.1. Hospital Anxiety and Depression Scale (HADS) (Zigmond & Snaith, 1983)
adapted version (Tejero, Guimerá, Farré & Peri, 1986).

This is a 14-item scale that has two subscales: anxiety and depression symptoms. Each item is scored on a 4-point Likert scale (0-3) [20].

2.2. Fordyce Questionnaire (1972, 1973).

It assesses the intensity of happiness experienced during the last week on a 0-10 scale (very unhappy, very happy) and its frequency [21].

2.3. Visual Analogical Scales (VAS): Mood.

It consisted of 7 items in a scale from 1 ("not at all") to 7 ("completely"). Five items assessed the intensity of several emotions (joy, sadness, anxiety, relax and vigor), 1 item assessed general mood state, and finally, a question assessed subjective mood change after session.

2.4. Visual Analogical Scales (VAS): Physical Discomfort.

It consisted of 3 items to assess the level of fatigue, pain and physical discomfort, using a 0 ("not at all") to 10 scale ("completely").

3. Intervention

Intervention lasted 4 sessions (two oriented to joy and two oriented to relaxation) of 30 minutes, administered along 1 week. To induce these positive emotions two virtual environments (park and forest) [22, 23] were used. Each virtual environment had specific formal characteristics (colors, lighting, music) and activity content depending on the objective to be achieved (induction of joy or relaxation). The activities included were: working with self statements and images, videos, slow breathing, mindfulness and autobiographical memories. Each session took place in the patient's room. To present each session a TV screen connected to a computer was used, both installed on a trolley that allowed movement from one room to another. Keyboard and mouse were used as interaction devices, and participants used headphones to listen to instructions and music.

4. Procedure

Before starting the program, participants were instructed about how to navigate inside the virtual environments. In the first two sessions, patients could choose the virtual environment they want to visit (Park or Forest). In the following sessions, participants visited the remaining environments. Sessions 1 and 3 were oriented to induction of joy, and sessions 2 and 4 were focused on relax. Symptoms of depression and anxiety (Hospital Anxiety and Depression Scale, HADS) and level of happiness (Fordyce Scale) were assessed before and after the VR intervention. Besides, mood and physical discomfort (VAS) were evaluated before and after each VR session. All procedures took place in the patient's room.

5. Results

Of the 33 patients, 21 completed the intervention (4 VR sessions). Twelve patients received fewer sessions due to discharge (n=10) and voluntary withdrawal (n=2).

There were significant reductions in anxiety and depression levels (depression scale, t=2,747; *p*=.012 and total HADS, t=2,440; *p*=.024) and significant increases in happiness levels after intervention (happiness intensity, t=-2,116; *p*=.047 and total happiness, t=-2,055; *p*=.05).

Also, there were significant improvements in emotional state and physical discomfort after each session. Positive emotions increased and negative emotions decreased after each VR session: In Session 1 (n=33) it was observed an improvement in mood (t= -2,002; *p*=.05) and vigor (t=-2,072; *p*=.046). In Session 2 (n=29), levels of mood (t=-3,360; *p*=.002), joy (t=-2,010; *p*=.05), sadness (t=3,144; *p*=.004), fatigue (t=2,183; *p*=.038) and physical discomfort (t=2,163; *p*=.039) improved significantly. In Session 3 (n=22) there was a significant improvement in anxiety (t=2,171; *p*=.042) and physical discomfort (t=2,027; *p*=.056). Finally, in Session 4 (n=21) there was a significant increment in joy (t=-2,253; *p*=.036).

6. Conclusions

These results emphasize the potential of VR as a positive technology that can be used to promote wellbeing during hospitalization, especially considering the shortness of the intervention and the advanced state of disease of the participants.

Given the limited number of VR applications oriented to hospitalized patients and even more, given de scant number of VR applications focused on promotion of wellbeing in this kind of population, this study contribute with important information about feasibility of this type of interventions in hospital setting (showing that it is possible), and also, valuable information about its possible benefits on emotional wellbeing. However, despite these results are promising, it is necessary to corroborate them in studies with larger samples and control groups.

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Mobilizing Bystanders of Cyberbullying: an Exploratory Study into Behavioural Determinants of Defending the Victim

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Abstract. This study explores behavioural determinants of defending behaviour in cyberbullying incidents. Three focus groups were conducted with youngsters aged 12-16y. Major themes that were found as important behavioural determinants to defend the victim were a low moral disengagement, that the victim is an in-group member and that the bystander is popular. Bystanders preferred to handle cyberbullying offline and in person, and comforting the victim was considered more feasible than facing the bully. With a high peer acceptance of passive bystanding and lack of parental support for defending behaviour, youngsters do not receive much encouragement from their environment to exhibit defending behaviour towards victims. These preliminary results suggest befriending and peer support interventions hold promise, as well as environmental interventions with parents and teachers. These first results will need to be confirmed in more in-depth analyses and in quantitative research.

Keywords. Adolescents, cyberbullying, bystanders, behavioural determinants, Social Cognitive Theory

Introduction

Cyberbullying is an upcoming social phenomenon amongst youngsters in which bullies intentionally and repeatedly send electronic messages with hurtful content, with the aim to cause harm or embarrassment to the victim [1, 2]. Between 20 to 40% of adolescents report having been cyberbullied [1] but large variations exist in prevalence figures depending on the definition used and the studied age group. Cyberbullying has a devastating impact on the quality-of-life of victims [3, 4] and as in traditional bullying may also influence a broader group of peers, by a mechanism of co-victimization [5] or by its negative impact on perceived safety at school [6]. It can thus be considered a public health issue warranting effective interventions.

Despite some differences between traditional bullying (involving face-to-face contact between bully and victim) and cyberbullying, such as its increased anonymity, there is a substantial overlap in participant roles and behavioural determinants for these types of bullying [7, 8]. Many interventions for traditional bullying have focused on

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mobilizing the bystanders to defend the victims since they have better problem-solving skills than either victim or bully and can break the chain of social reinforcement that the bully is looking for [9]. Research to date on bystanders of cyberbullying has mostly focused on prevalence rates, on reasons for not reporting [e.g. 10], and on their perceptions of cyberbullying [e.g. 11]. Others have viewed this group as mere outsiders.

To our knowledge, no study so far has examined theory-driven behavioural determinants among bystanders to defend the victim. This study aims to explore behavioural determinants of defending behaviour among adolescent bystanders in cyberbullying incidents.

1. Method

A qualitative study was conducted using a series of focus groups with adolescents.

1.1. Sample and procedures

The data were collected in May 2012 from one high school in Flanders that provides general, technical and vocational education and serves a low- to middle-class population. Three focus groups were held: one with first grade pupils (12-13y), one with second grade pupils (13-14y) and one with third grade pupils (14-15y). Both youngsters and parents provided written informed consent prior to participation. The study received ethics approval from the University Hospital of Ghent Ethics Committee.

In total, twenty-three youngsters participated. Two girls and 8 boys took part in the first grade group (mean age=12,6 y; SD=0,69). In the second grade group, 5 girls and 2 boys participated (mean age=14,0 y; SD=0,82); in the third group 4 girls and 2 boys participated (mean age=15,2 y; SD=0,98). Overall, 12 children were enrolled in general education, 11 received technical or vocational training. The focus groups took place during school hours and lasted between 50 and 60 minutes. All group conversations were audiotaped and transcribed.

1.2. Measures

The interview guide is inspired by social cognitive theory and the Reasoned Action Approach [12]. Participants were asked to only talk about experiences as bystanders or to imagine they were a bystander in a cyberbullying incident. The interview guide was pilot tested in a group of first-graders, to test for relevance and comprehensability. Minor modifications were made, to include more examples and prompting.

1.3. Analysis

Full results will later be analysed via Thematic Analysis using NVivo software. Presented here is the first step in this process, namely the detection of themes that will be used to design the codebook.

2. Results

2.1. Behaviour and behavioural intention

Quite unanimously adolescents would choose to defend the victim, but only when certain conditions are fulfilled. These conditions are summarized in Table 1.

Bullying is considered unfair when the bully picks on characteristics that are out of the victim's control (e.g. appearance, handicap), when the victim's family is dragged into it or when group norms are attacked (e.g. racist remarks). Exceptions to this are the loners: they behave strangely and are considered to be blamed for their own behaviour, which makes bullying seem fairer. This quote illustrates the differentiated behaviour:

"*When you're a foreigner or you're not pretty or something, and you are bullied, you can't do anything about that. But if you are not clean or act stupid towards other people, well, then it's your own fault*"

Table 1. Differentiated defending behaviour of cyberbullying bystanders

VICTIM		BULLY		CIRCUMSTANCES		
		Popular	*Not popular*	*Unclear*	*Fair*	*Unfair*
VICTIM	*Friend*	Always defend, regardless of the bully, regardless of circumstances				
	Not a friend	Learn more about the circum-stances	Defend, low risk that friends will support the bully	Do nothing (passive bystanding or ignore)	Do nothing (passive bystanding or ignore)	Defend, as everyone else will agree
	A loner	Never defend, do nothing				
	Popular	Defend, there is a high chance they are not the only defender in this case				

Defending can take several forms: talking to the bully (offline), giving the victim advice, comforting the victim, sticking around the victim at the playground, telling friends, telling the victim he or she can join their group, using humour, frightening the bully or physically retaliate. Behavioural options they would consider less are reacting online as this would publicly humiliate the bully and potentially make things worse; installing more internet safety for themselves as they would like to keep an eye on what goes on; and talking to teachers or parents, which takes too long, exposes them as a squealer, is not effective and because "*we are not in grammar school and need to stand up for ourselves*". Interestingly, reinforcing is not considered contradictory to defending by the participants. They would contribute to the bullying online by laughing or liking the bully-message, while also providing comfort to the victim offline.

2.2. Behavioural determinants

Knowledge

All participants seemed knowledgeable on what cyber-bullying is. They differentiated between teasing and bullying, with teasing being something that happens among friends, which is not meant to hurt or is considered funny by the 'victim'. Knowledge on consequences of cyberbullying for the victim was very limited and mostly negative consequences of physical bullying were discussed.

Attitudes
Cyberbullies are considered "*losers who don't have a real life*" or "*cowards who don't dare to say it to my face*". Peers who reinforce the bullying are considered hypocrites, fake, stupid, people who want to fit in or who think it is funny. Those who defend are considered "*popular*" or "*strong*". Passive bystanding is rather acceptable, some would not mind if their friends stood by and did nothing.

Subjective norm
Most participants said they thought their teachers expected the youngsters to tell them about the cyberbullying. Perceived expectations from parents were more diverse: some mentioned their parents expected them to stay out of it to avoid personal risk. Others said their parents would expect them to be able to handle it themselves, without involving an adult, and to defend their peers. They thought their peers expected them to support and comfort their friends, rather than defend them since everyone understands defending is difficult. Only one participant considered it his responsibility to also defend the weak. Being perceived as popular is an important facilitator in defending, in order not to get bullied himself.

Self-efficacy
The youngsters mentioned many different options to react as a bystander, but remained vague in the practical execution of their suggested coping strategies. Self-efficacy also differed by bystander response. Self-efficacy was high for giving the victim advice or consolation, but low for facing a bully alone in real-life (among girls) and for telling their parents. They felt that telling their parents "*is weird, he [the victim] should tell his own parents*" or thought parents would say "*well, that is your problem to deal with*".

Outcome Expectations and Expectancies
Most participants thought there was some risk of also getting bullied if they stood up for the victim. However, this risk did not seem to deter them in their defending if the victim is a friend. Several strategies were mentioned to lower the risk of being bullied as a defender: not embarrass the bully, address the bully offline, when he is alone, take friends along.

Outcome expectations for telling teachers were rather negative: it takes too long, teachers do not respect the bystander's wish to remain anonymous, and there is a risk that the teacher blames those who report the bullying.

Cues to action
Certain instances of cyberbullying were considered more severe and would encourage bystanders to take action by telling an adult: when the bullying occurred repeatedly, or when the bullying involved physical threats that should be taken seriously.

3. Discussion

This study explored determinants of bystander behaviour in cyberbullying, to provide insights for interventions. The first results confirm a connection between offline and online bullying: it often starts offline, continues online, but is preferably solved again offline. Similar factors play a role in cyberbullying bystander behaviour as in traditional bullying [13, 14]: social status and popularity increases defending behaviour,

moral disengagement decreases defending behaviour and defending is higher for in-group members than for others.

The repeated nature of cyberbullying appears to be important in the perception of youngsters, contrary to what previous studies on cyberbullying definitions found [1, 2].

Particular themes that emerged as individual behavioural determinants for defending a victim of cyberbullying were high self-efficacy for talking to the bully, but possibly limited knowledge on how to do this in an effective way. Self-efficacy for talking to parents and teachers was low. Knowledge on mental health problems caused by cyberbullying was lacking and increasing this may encourage adolescents to also defend for non-physical bullying types. The youngsters recognized the potential risk of defending the victim, but might consider the risk of being isolated when not defending a friend, and thereby making themselves a potential bully victim, as more threatening. Of all forms of defending, comforting is the most expected and considered easiest. Since comforting the victim has shown to be a buffer against the negative effects of victimization, this should be promoted as a first stepping stone. These preliminary results suggest that peer support interventions [15], coupled with environmental interventions with teachers and parents, can also hold promise for cyberbullying. This will need to be confirmed by in-depth analyses and further quantitative research.

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Influence of Parental Attitudes Towards Internet Use on the Employment of Online Safety Measures at Home

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Abstract. In this paper we present the results of a cross-sectional study of the entire adolescent student population aged 12-18 of the island of Kos and their parents, on Internet safety-related practices and attitudes towards the Internet. Total sample was 2017 students and 1214 parent responders. Research material included extended demographics and an Internet security questionnaire, the Internet Attitudes Scale (IAS) for parents and the Adolescent Computer Addiction Test (ACAT) for children and both parents. Both parents thus provided their views on their children's computer use and an estimate for their degree of computer addiction which was tested against their child's self-report. Results indicated that fathers and mothers who had negative views of the Internet, tended to encourage less their children to engage in online activities and worried more for the possibility that their child is addicted to computer use; their worries weren't correlated with their children's results. Parental views on the Internet had no effect on the level of security precautions they employed at home. Those parents who reported a low level of security knowledge and were unsure as to what their children were doing online, tended to consider their children more likely to be addicted to computer use; those views were confirmed by their children' self-reported results.

Keywords: Internet security, adolescents, computer addiction

Introduction

Large percentages of Internet and computer addiction have been repeatedly reported in related studies of Greek populations [1-4]. No studies however have investigated the link between parental beliefs on the Internet and their security practices as well as the impact of those beliefs on their children' behavior.

1. Method

This study was of a cross-sectional design with the inclusion of parents; all research material handed out to the students was given a single, random, non-identifying code and each student was tasked with handing out to his/her parents a questionnaire which was to be returned within a week's time. Those parent questionnaires had the same random code, thus ensuring that upon their return our researchers would be able to match each family's questionnaires without breaking confidentiality.

Our research sample consisted of 2017 teen students between 12 and 19 years of age. We received 1214 questionnaires back from the parents, corresponding to 640 children since there were 573 father/mother pair responders and 67 single parent responders. Research material included an extended demographics and Internet security questionnaire, the IAS questionnaire [5] for parents and the ACAT questionnaire[4] for children and both parents. Both parents thus provided their views on Internet use and an estimate for computer addiction, which was tested against their child's, own self-report. The demographics questionnaires included questions on sex, age, parental educational and occupational background, family's financial status, school performance and related goals. All Internet and PC activities were measured on a Likert scale for frequency during the last twelve months. The research material was distributed in schools and participation was voluntary and confidential during one school hour offered to the project by each school's director.

The twenty-question ACAT (Adolescent Computer Addiction Test) scale was created and validated for use in Greek populations [4] and has been employed successfully in related studies [3, 6]. This instrument was modeled after the 20-question Internet Addiction Test where the word 'Internet' was changed for 'Personal Computer (PC)' in order to create an instrument suitable for use in cases where the subject was heavily involved with PC activities without necessarily using the Internet. A version for parents was also employed with the same set of questions modified in order to present the parent's opinion for their child's use of the PC. This instrument is more practical for parental use than an instrument for Internet use because the parent does not necessarily know when his/her child is online but rather how much time he/she spends in front of a computer monitor. Cronbach's alphas in our survey were high, .931 for the children, .943 for the fathers' and .945 for the mothers' version of the questionnaire.

The Internet Attitude Scale (IAS) is a 20-item self-report inventory, used to measure attitudes toward the Internet [5]. It is rated on a five point Likert type scale. Total scores on IAS ranges from 20, indicating an extremely negative attitude toward the Internet, to a score of 100, which would imply an extremely positive attitude toward the Internet. Two factors are defined, the perceived negative Internet impact and the perceived positive Internet impact, related to the perceived impact of the Internet in our lives and the future. Cronbach's alphas in our survey were moderate, .826 and .76 for the father's first and second factor, and .851 and .771 for the mother's respective factors.

We created one composite index for each parent by the total sum of a set of ten yes/no questions regarding Internet security measures that the parents should take in order to make the web browsing experience secure for their adolescents. The questions queried on the use of parental control and content filtering programs, creating a fair Internet use 'contract', actively participating in the initial introduction to the Internet and creating a list with appropriate web pages and search engines, periodically

checking bookmarks and browsing history, placing the PC in plain view while teaching the adolescents to avoid uploading personal data online and meeting in-person online acquaintances.

Finally, questions on outcomes with regards to the children's relationship with the Internet were included in the parental questionnaires. Those questions referred to whether the Internet had a negative impact on the child's social life and interests, limited the time the parents spent with their child, disrupts sleep, is a cause of conflict that disrupts family life and whether the child uses the Internet excessively.

2. Results

Sample demographics for the adolescents and their parents are presented in Tables 1 and 2. There were a high percentage of teenagers who reported having addictive PC use (17,3% of respondents). Parents reported a high rate of Internet 'illiteracy', more than two thirds reported 'minimal' or 'next to none' when questioned on their level of Internet expertise. Their median score on the composite security index was above average, but there wide discrepancies between parents denoted by the non-normal distribution of the variable and the large standard deviation value. Internet-related attitudes were mostly positive.

Comparing the results on Internet security and attitudes between parental pairs (father/mother) showed that there was a statistically significant correlation (p<.001), with large effect sizes (r = .726 and .687 respectively). This denotes that parents tend to share general views on the Internet and Internet security-related knowledge. However, there were statistically significant differences between each parental pair (Table 3). Fathers within a particular family were most likely to have positive views of the Internet and a better knowledge of Internet security than mothers did.

Table 1 – Demographics of adolescent responders to the survey

Variable	Frequency	Percentage
Sex		
Boys	1046	51.8%
Girls	971	48.2%
Age		
12	74	3.7%
13	347	17.2%
14	405	20.1%
15	385	19.1%
16	373	18.5%
17	278	13.8%
18	123	6.1%
19	13	0.6%
Ethnicity		
Greek	1557	77.2%
Foreign	116	5.8%
Greek immigrant (Albania)	128	6.3%
Greek immigrant (former USSR)	124	6.3%
Other	64	3.1%

Group classification on computer addictive use		
Typical use	787	39%
		(45.6%*)
At risk	641	31.8%
		(37.1%*)
Possibly addicted	299	14.8%
		(17.3%*)
Did not answer	290	14.4%

*valid percentage among those who answered the test

Table 2 – Demographics of parent responders to the survey

Variable	Frequency	Percentage
Sex		
Male	593	51.8%
Female	621	48.2%
Mean age (SE)		
Male	46.02 (0.262)	
Female	40.74 (0.215)	
Self-reported knowledge on Internet-related issues		
	Father	Mother
Next to nothing	194 (33.3%)	176 (32.8%)
Minimal knowledge	178 (30.5%)	192 (35.8%)
Adequate knowledge	137 (23.5%)	129 (24%)
Good level of knowledge	74 (12.7%)	40 (7.4%)
Parental supervision on the Internet		
	Father	Mother
Yes	342 (59.5%)	356 (66.2%)
No	233 (40.5%)	182 (33.8%)
Self-reported knowledge on Internet security		
	Father	Mother
Yes	348 (59.9%)	333 (61.9%)
No	233 (40.1%)	205 (38.1%)
Composite security index median score (SD)		
	Father	Mother
	6 (2.31)	6 (2.26)
Mean IAS score (S.E)		
	Father	Mother
	63.27 (.43)	62.8 (.43)

Table 3 – Paired differences for the parents on Internet views and security measures

Paired Differences		Mean	s.d	Mean difference	95% Confidence Interval of the Difference		t (df)	Sig. (2-tailed)
					Lower	Upper		
Pair 2 (N=402)	Paternal IAS score	63.38	9.6	1.07	.32	1.82	2.8 (401)	.005
	Maternal IAS score	62.3	9.82					
Pair 3 (N=452)	Paternal Security index	5.77	2.33	-.205	-.36353	-.04798	-2.563 (451)	.011
	Maternal Security index	5.97	2.28					

Table 4 – Differences between those parents whose children show negative impact of Internet use to those who don't with regards to general views of the Internet and Internet security measures employed at home

Question	Mean differences between no/yes answer to the question	Mean difference	95% Confidence Interval of the Difference		t	df	Sig. (2-tailed)
			Lower	Upper			
Does your child use the Internet excessively?	Paternal IAS score	2.239	.002	4.477	1.966	472	.050
	Maternal IAS score	2.848	.345	5.352	2.236	439	.026
	Paternal Security index	.866	.352	1.380	3.310	510	.001
	Maternal Security index	.806	.257	1.355	2.886	461	.004
Does your child's Internet use have a negative impact on its social life?	Paternal IAS score	3.381	1.539	5.223	3.606	473	<.001
	Maternal IAS score	2.936	.957	4.916	2.915	438	.004
	Paternal Security index	.831	.402	1.261	3.804	510	<.001
	Maternal Security index	.910	.471	1.349	4.072	460	<.001
Does your child's Internet use have a negative impact on its general interests and occupations?	Paternal IAS score	3.637	1.802	5.473	3.894	468	<.001
	Maternal IAS score	3.809	1.835	5.783	3.793	436	<.001
	Paternal Security index	.713	.279	1.147	3.229	506	.001
	Maternal Security index	1.026	.594	1.457	4.668	459	<.001
Has the Internet limited the time you spend with your child?	Paternal IAS score	3.926	2.195	5.657	4.457	471	<.001
	Maternal IAS score	4.001	2.129	5.874	4.200	435	<.001
	Paternal Security index	.543	.131	.954	2.591	507	.010
	Maternal Security index	.865	.451	1.279	4.108	457	<.001
Hoes your child's Internet use become a cause of conflict that disrupts your family's life?	Paternal IAS score	5.069	2.948	7.191	4.695	468	<.001
	Maternal IAS score	5.616	3.381	7.850	4.939	434	<.001
	Paternal Security index	.758	.262	1.254	3.002	506	.003
	Maternal Security index	.578	.067	1.088	2.225	458	.027

Comparative results indicated that there were no measurable differences between those parents who enforced security measures at home and those who did not with regards to their general views on the Internet. The same was not true however when those groups were queried as to possible negative impact of the Internet on their children' lives; those parents who claimed that using the Internet has limited their children' social lives, their activities and interests, the time they spend with their children and has become a reason of intra-family conflict have reported a higher level of negative views of the Internet (Table 4). It would appear in our sample (which is mostly uneducated on Internet use) that views of the Internet are greatly affected by their living experience in the family, and the perceived impact it has on their children. This was also apparent when we examined the correlates of the parental attitudes towards the Internet and the values of the ACAT test; the higher the parental estimate of computer addiction for their children the less favorably they were inclined towards the Internet (Table 5). A related finding was that those parents who reported a low level of security knowledge and were unsure as to what their children were doing online tended to consider their children more likely to be computer-addicted; those views were confirmed by their children' results (p<.001). Those parents who reported adverse outcomes with regards to their children's relationship with the Internet tended to employ less online safety precautions than those who did not.

Table 5 – Correlates of attitudes towards the Internet with estimates of PC addiction

	Paternal IAS score	Maternal IAS score	Child's ACAT score	Paternal ACAT score	Maternal ACAT score
Paternal IAS score	1	,687**	-,024	-,206**	-,204**
Maternal IAS score	,687**	1	-,070	-,227**	-,254**
Child's ACAT score	-,024	-,070	1	,473**	,486**
Paternal ACAT score	-,206**	-,227**	,473**	1	,812**
Maternal ACAT score	-,204**	-,254**	,486**	,812**	1

**. Correlation is significant at the 0.01 level (2-tailed).

3. Conclusion

Our results show parents while being generally positive about Internet-related views, their views may be hampered on an individual basis by their personal level of knowledge when called upon to provide safety measures while online. Parents in our sample, who were mostly uneducated with regards to Internet use, have had their views shaped by their experiences at home; when a child demonstrated Internet-related behavioral problems, parents tended to hold less positive views of the Internet. The presence of those problems typically occurred in homes where the parents did not employ basic safety precautions. It is thus important to educate parents on Internet safety procedures, which may assist in limit-setting while online for the children and result in fewer chances of the children developing addictive tendencies to personal computing and the Internet. Parents may be open-minded and generally positive on the adoption of new technologies but proper education is critical in helping keep those attitudes positive. Being knowledgeable on the Internet as a parent may however lead

to an underestimation of the actual danger of adolescent addictive tendencies. Parallel education on those dangers should thus be a target.

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Outcomes from a Pilot Study using Computer-Based Rehabilitative Tools in a Military Population

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Abstract. Novel therapeutic approaches and outcome data are needed for cognitive rehabilitation for patients with a traumatic brain injury; computer-based programs may play a critical role in filling existing knowledge gaps. Brain-fitness computer programs can complement existing therapies, maximize neuroplasticity, provide treatment beyond the clinic, and deliver objective efficacy data. However, these approaches have not been extensively studied in the military and traumatic brain injury population. Walter Reed National Military Medical Center established its Brain Fitness Center (BFC) in 2008 as an adjunct to traditional cognitive therapies for wounded warriors. The BFC offers commercially available "brain-training" products for military Service Members to use in a supportive, structured environment. Over 250 Service Members have utilized this therapeutic intervention. Each patient receives subjective assessments pre and post BFC participation including the Mayo-Portland Adaptability Inventory-4 (MPAI-4), the Neurobehavioral Symptom Inventory (NBSI), and the Satisfaction with Life Scale (SWLS). A review of the first 29 BFC participants, who finished initial and repeat measures, was completed to determine the effectiveness of the BFC program. Two of the three questionnaires of self-reported symptom change completed before and after participation in the BFC revealed a statistically significant reduction in symptom severity based on MPAI and NBSI total scores ($p < .05$). There were no significant differences in the SWLS score. Despite the typical limitations of a retrospective chart review, such as variation in treatment procedures, preliminary results reveal a trend towards improved self-reported cognitive and functional symptoms.

Keywords. Neurorehabilitation, Cognitive Rehabilitation & Therapy, Traumatic Brain Injury, Military Medicine

Introduction

A total of 229,206 United States military Service Members were diagnosed with a traumatic brain injury (TBI) between 2000 and 2011 [1]. These individuals often report cognitive dysfunction related to their injuries that interferes with their ability to reintegrate into society. In some cases, these reported difficulties are related to objectively measured impairments in attention, memory, or other cognitive domains due to the effects of brain injury, side effects of therapeutic interventions, or extra-

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cranial injuries. In other cases, the complaints reflect emotional distress, including mood disorders or combat-induced stress symptoms. Regardless of the etiology, the long-term impact of chronic cognitive symptoms following TBI for active military personnel, veterans and their families is just beginning to be appreciated.

Traditional cognitive rehabilitation is provided for Service Members based on evidence-based literature. However, the factors involved in the apparent success of these remediation strategies are not clear and may depend on both the time post injury and the dosing levels [2]. Computer-based brain-training programs have become increasingly more available in the commercial market. Evidence of the effectiveness of computer-based programs for mild cognitive impairments comes from studies demonstrating that intense and long-term use can slow down the continuous progression of cognitive decline in the aging population. In one study, this population demonstrated significant improvements in attention, memory, and other cognitive domains following a structured computer-training program [3]. Studies of brain fitness programs for the aging population have shown improvements in daily activities for up to 5 years post-training [4]. Additional studies are needed to determine the short and long-term effects of computer-based training in disordered populations such as TBI.

Computer-based programs could enhance traditional cognitive rehabilitation approaches by maximizing neuroplasticity and providing a means for treatment beyond the clinic. However, this method has not been extensively studied in the military population. In November of 2008, a Brain Fitness Center (BFC) was created at Walter Reed Army Medical Center (WRAMC, and later transferred to Walter Reed National Military Medical Center (WRNMMC)) as a resource for patients with subjective cognitive complaints. The BFC provides access to a variety of "brain-training" tools for Service Members to use as either an adjunct to their current care or as a stand-alone service for those discharged from cognitive rehabilitation or preparing for discharge home. The BFC has seen over 250 patients with an average of 110 patient visits per month. While the majority of patients have been diagnosed with a TBI, the BFC also sees patients without a TBI diagnosis. These patients have various other medical conditions, psychiatric conditions such as Post-Traumatic Stress Disorder (PTSD), or subjective complaints of cognitive dysfunction following deployment.

Objective cognitive assessments and self-report questionnaires are utilized at the time of the intake evaluation, at approximately 6-8 weeks, and at the time of discharge or discontinuation. These data are collected as normal standard of care for internal review as well as for a means of providing feedback to patients. The results of the questionnaires are used to determine whether there are changes in symptom reporting after participating in the Brain Fitness Center. The goal of our study was to determine if there was a decrease in symptom severity as measured by the Mayo-Portland Adaptability Inventory-4 (MPAI-4), the Neurobehavioral Symptom Inventory (NBSI), and the Satisfaction with Life Scale (SWLS).

1. Methods

The Institution Review Board at WRNMMC approved a retrospective chart review. The chart review was completed for the first 96 patients who participated in the Brain Fitness Center (November 2008 through February 2011). Of those 96, 29 patients had completed the initial and repeat self-report questionnaires. Results of the MPAI-4, NBSI, and SWLS for those 29 patients were used to determine subjective reports of symptom change.

2. Participants

The average age of the 29 patients was 39 years, with the majority male. About half of the patients began participation in the BFC less than a year post-onset of cognitive symptoms, and half began more than a year post-onset. Most participants suffered a TBI, with the most common method of injury being an Improvised Explosive Device (IED) blast while in a combat environment. The five patients without a TBI diagnosis had various other medical conditions such as PTSD, or some other type of acquired brain injury. Most of the 29 BFC patients were also engaged in other therapies at WRAMC that were providing concomitant services to address cognitive complaints. Table 1 summarizes the participants' demographics.

Table 1. Patient Demographics.

Characteristic	N	%	Characteristic	N	%
Sex			**TBI Severity (*N*=24)**		
Male	26	89.7	Mild	12	50.0
Female	3	10.3	Moderate	6	25.0
Age			Severe	3	12.5
20-29	6	20.7	Penetrating	3	12.5
30-39	9	31.0	**Method of Injury (*N*=24)**		
40-49	8	27.6	Blast	11	45.9
50-59	5	17.2	Fall	2	8.3
60+	1	3.4	MVA	3	12.5
Military Status			Hit/Assault	3	12.5
Active Duty	22	75.9	Gunshot Wound	1	4.2
Active Duty Reserve	3	10.3	Multiple	3	12.5
Retired	1	3.4	Unknown	1	4.2
National Guard	2	6.9	**Site of Injury (*N*= 24)**		
Civilian	1	3.4	Combat	18	75.0
Education			Stateside	6	25.0
High School	5	17.2	**Amputation**		
Some College	8	27.6	None	26	89.7
College Degree	5	17.2	≥ 1 limb	3	10.3
Advanced Degree	9	31.0	**Non-TBI Etiology (*N*= 5)**		
Unknown	2	6.9	PTSD	1	20.0
Time Post Onset			Acquired Brain Injury	3	60.0
< 1 year	13	44.8	Unknown	1	20.0
> 1 year	15	51.7	**Concomitant Therapies**		
Unknown	1	3.4	Speech-Language Pathology	12	41.4
TBI Diagnosis			Occupational Therapy	16	55.2
Positive	24	82.8	Physical Therapy	10	34.5
Negative	5	17.2			

The BFC offers patients a variety of computer-based brain-fitness programs for in-clinic and at-home use. In this study, each patient selected a combination of the computer-based cognitive training tools that met their needs. Two of the programs were available to use in the BFC and patients could access a third program online using a computer of their choice.

Figure 1 shows the distribution of patient visits to the BFC. On average, patients completed computer sessions 29 times with a range of 3-137 visits (SD = 29.46, Median = 21). However, eight patients were also using an at-home cognitive program. Data on how often they were completing these home-based sessions is not available.
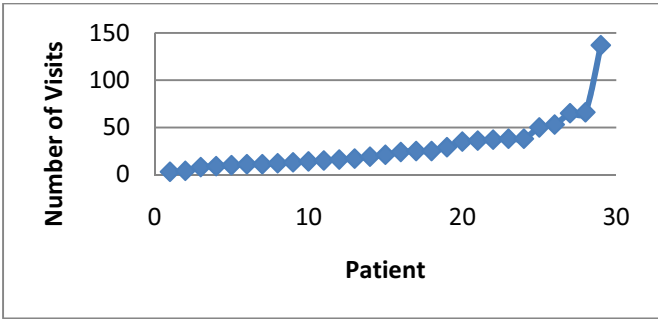
Figure 1. Distribution of Patient Visits.

3. Materials

The BFC offers a variety of commercially-available brain-training products for Service Members to use either in the Center or at home. Each patient used the three programs described below either exclusively or in some combination. The design of each program is different; however, all of the programs are structured to adjust the level of difficulty based on the patient's performance. The programs allow users to track their progress and provide feedback through end-of-session scores.

Dakim Brain Fitness is designed to present a series of interactive cognitive exercises that span six cognitive domains: long-term memory, short-term memory, critical thinking, calculation, language, and visuospatial. The program is structured to increase the level of difficulty based on the patient's performance in each cognitive domain, presenting novel and entertaining subject material via touch-screen [5]

Posit Science Brain Fitness Classic (auditory processing program) targets auditory-processing to increase the speed and efficiency with which patients take in and process information to improve their overall thinking skills. Additional cognitive areas trained include memory and concentration/attention. Research has shown that the Posit Science program provides a mental exercise that is statistically superior to general mental activity, as measured by the extent to which older adults have shown cognitive improvements following training [6].

Lumosity is an online program designed to provide individualized training in a variety of cognitive domains at adjustable levels of difficulty. Lumosity exercises target processing speed, attention, memory, flexibility, and problem solving. A 2006 study of 23 normal, healthy adults who used Lumosity 20 minutes a day for 5 weeks revealed significant improvements in working memory, visual attention, and executive function following training [7]. Results suggest that Lumosity training can generalize to improvements in untrained tasks such as real-world activities.

4. Outcome Measures

The MPAI-4 is a clinical evaluation tool consisting of 35 items measuring the cognitive, behavioral, social, psychological, and physical outcomes in individuals with brain injury [8]. The NBSI is a 22-item self-report Likert scale assessing a number of neurobehavioral symptoms covering the somatic, emotional, and cognitive domains. This instrument has been adopted as a standard-of-care measure for TBI in the

Department of Defense (DoD) and Veterans Affairs (VA) [9]. The SWLS is a five-item instrument designed to measure global life satisfaction using a seven-point scale ("strongly agree" to "strongly disagree") [10]. Instruments were drawn from the Federal Common Data Elements projects for TBI outcomes research [11].

5. Statistical Analyses

The demographic characteristics of this patient population were summarized with means or percentages. The measure of self-reported symptom severity before and after Brain Fitness Center participation was compared using t-tests.

6. Results

An initial review of the first 29 patients who completed the questionnaires before and after their participation in the Brain Fitness Center revealed a statistically significant reduction in symptom severity based on MPAI and NBSI total scores (*p < .05). There was no significant difference in the SWLS score (see Figure 2). However, there was a slight trend towards increased satisfaction with life.
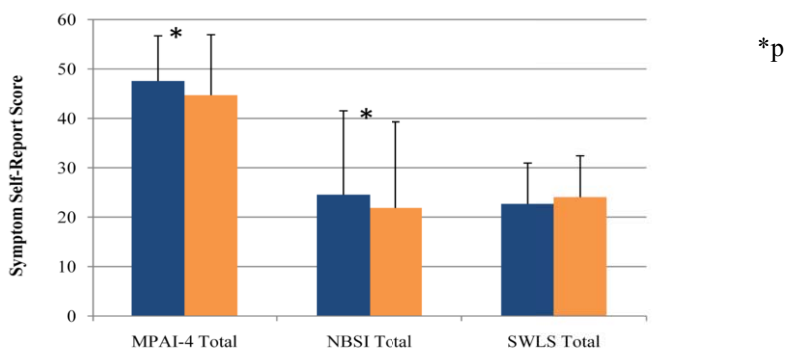
Figure 2. Symptom Self-Report Scores.

7. Discussion

The three self-report questionnaires used in this study have high face validity for the Service Members. The measures assess the impact of training beyond the cognitive domain, to include behavioral, social, physical, and emotional functioning. The significant reduction in symptom severity following BFC retraining using a brain-fitness program suggests that improvements are generalized to a broad range of domains applicable to everyday functioning.

Due to the variations in our patient population and participation, other factors beyond the brain-training intent of the computer program(s) may play a role in real or perceived self-betterment. Coming to the BFC provides additional face-to-face time with staff and real-time feedback with computer-driven scores. Service Members are

given the control to self-pace their care in the BFC, making it one of the few therapeutic interventions that allow patients to determine the intensity of their participation.   The inconsistency in dosing makes standardization and research difficult; however, empowering the patient to have control over an aspect of their care may play an important clinical role.

This study has the typical limitations of a retrospective chart review. For example, the population was highly heterogeneous and procedures varied widely. There is no control data in this study and many patients were visiting the BFC during a time in their recovery when spontaneous and natural improvements occur. The majority of patients were engaged in at least one form of traditional rehabilitation therapy while participating in the BFC. Patient involvement in additional therapies may have contributed to the recovery process and influenced symptom reporting. Patient data is continuing to be collected to capture a larger sample size, which will increase the power of study results and may help identify which specific products, intensity of use, and patient characteristics yield the best response to the BFC program.

8. Conclusion

If shown to be feasible and effective in our population, computer-based remediation as an adjunct to traditional rehabilitation and later for patients in remote locations could fill an unmet clinical need for Service Members and veterans. Future studies will explore differences in symptom reporting based on other factors including the program of use, patient diagnosis, patient self-esteem, timeframe (dosing and duration) in the BFC, time post onset, and/or specific cognitive complaints.

9. Acknowledgments

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Nicotine Craving: ERPs correlates after VR exposure to smoking cues

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Abstract. Even though it is diminishing in Europe, smoking is still a serious health problem. The craving of Nicotine is one of the hardest behaviours to tackle when a smoking cessation programme is implemented. Following on previous work [1], which aimed at evaluating the possibility of inducing smoking craving in smokers using a VR platform, the present study was devised to assess the role of craving in cognitive processing through event related potentials (ERP). From an initial sample of 89 university students (smokers and non-smokers), which was randomly exposed to VR smoking cues and VR non-smoking cue scenarios, a subsample of 13 smokers and non-smokers was drawn. This subsample (M = 23.08; SD = 4.39), which had previously been immersed in the VR smoking cues environment, was presented to a rapid (1 sec) serial of smoking and neutral images. Data on brain activity was recorded through an EEG during this task to further estimate ERPs. When compared to non-smokers, smokers showed higher frontal activation when watching smoking related images.

Keywords. Nicotine, craving, VR cues, ERPs, SCL.

1. Introduction

Smoking affects around one third of the world population it plays the leading role in premature death and is one of the propellers of several types of cancer [2]. The smoking craving is one of the most intense patterns of compulsive behaviour; nicotine addicts can be characterized by feeling an urge to consume tobacco [3, 4]. Even though common sense tends to ignore it, smokers experience acute craving episodes just like any other addict [5]. Emotional distress, alcohol consumption and social events are usually identified as situational and as exogenous factors, by acting like triggers in the smoking craving [6; 7].

Within the individual treatment scope of action, smoking cessation programmes that are based on behavioural therapy (many times in combination with pharmacology) are considered to be the best approach. These programs rely upon craving elicitation as a vehicle to disrupt conditioned behaviours.

Exposure therapy (ET) is a leading paradigm in CBT (Cognitive Behavioural Therapy) based psychotherapeutic approach and is essential to confront patients with distressful events associated with their consumption behaviours. Since ET looks to improve the patient's control on their reactive behaviour triggered by some distressful

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events, stimuli or memory, it aims to achieve emotional detachment between them and the associated disruptive behaviour.

Several studies have suggested that ET based on VR cues may be an option to elicit craving on nicotine addicts [1; 8] and on alcoholics [11]. For example, [12; 13] compared the effect of exposing nicotine addicts to VR environments and to pictures, founding higher levels of craving after exposure to a VR bar with smoking cues than after watching images smoking content behaviours. On this and other studies focused on nicotine dependence the results are similar to the ones found on other types of addictions.

More recently, and on the track of the work of several other authors [14; 15], Choi and colleagues [16] presented results that evidenced the relevance of VR applications as an alternative method for traditional smoking cessation programs. Moreover, this study highlights the importance of using autonomic reactivity, assessed through psychophysiological measures, to investigate the impact of VR exposure on nicotine addicts. This suggestion adds on the claim that VR exposure is, possibly, a path to follow to elicit craving in smokers.

The above mentioned autonomic reactivity can be monitored by physiological indexes such as skin conductance level, heart rate, and respiratory rate (and, as described in this paper, by evoked related potentials), which may act as indicators of craving, since these measures are sensitive to emotional states [9, 10].

In fact, previous research has also showed that drug cues may engage motivational processes in addicted individuals. For instance, [17] drug cues capture more attention when compared to other salient stimuli in heroin addicts. These authors found that the stimuli modulate cognitive brain potentials (e.g., P300), suggesting that addicts show greater cortical processing specially for drug-related stimuli. Other studies, [18, 19] claim that motivated attention to drug-related cues might enhance late cognitive components, such as the late positive potential (LPP). The LPP is considered to be sensitive to the allocation of attentional resources and to the motivational salience of visual stimuli [20].

In line with these studies, this paper reports on a study to investigate the relation between craving elicitation of nicotine addicts and the underlying cognitive brain activity. In order to achieve this goal, the participants were exposed first to a VR environment with smoking cues to enhance craving levels, similar to the design of Gamito and colleagues [1]. After this preliminary task, the participants engaged in a rapid visual presentation with smoking and neutral pictures. ERP were registered during this task and were computed differentially to smoking and neutral stimuli. Given the previous findings reported in the literature, we expected that enhanced craving levels in smokers prompted modulation of late brain potentials to motivational stimuli.

2. Method

2.1. Sample

The sample consisted of 89 undergraduate students (45 male and 44 female) with an average age of 27.13 years old (SD = 10.78). The participants were randomly collected from a university campus, in which, 46 (51.7%) were smokers and 43 (48.3%) were non-smokers. All the participants were Portuguese with normal or corrected-to-normal vision and did not have any clinical demonstrable neurological or psychiatric impairment. A subsample of 13 participants was drawn for ERPs analysis purposes, in which, 7 of them were smokers and 6 were non-smokers.

2.2. Procedures

The experiment started off with self-reports for nicotine craving assessment. Their cravings were assessed by a brief 10-item form of the Questionnaire of Smoking Urges – QSU [21], whereas nicotine levels were estimated by the Fagerstrom Test for Nicotine Dependence - FTND [22]. The participants were presented to a VR environment in order to elicit craving, with skin conductance level (SCL) assessment during the VR exposure. The VR environment was designed using Unity 2.5 (Unity Technologies) and consisted of a three room virtual apartment with smoking-related cues, such as cigarettes, smoke, drinks or people smoking and interacting in social event (see [1], for more details). The intent of this task was to enhance craving levels in smokers to allow the study of neural mechanisms underlying impulsive responses in smokers and their urge to smoke.

For that, other sixty undergraduate students participated on the validation of smoking and neutral pictures. From an initial set of 138 of these images, 48 neutral and 48 smoking related pictures were selected. Cortical activity of thirteen post-VR exposure participants was recorded during the presentation of neutral and smoking pictures. EEG recording was carried out during the experiment for 19 Ag/AgCl active electrodes (BrainAmp Standard from Brain Products, GmbH) in accordance with the 10-20 International System with mastoid reference and a sampling rate of 250Hz. The channels used are illustrated in Figure 1.

Data was band pass filtered (0.05 - 50Hz) and signals above 75 µV were automatically rejected. The data was also corrected for electrooculography movements. ERP averages were calculated for each participant in a time window from -100 to 1000 ms at stimulus onset. The LPP was estimated in a time window between 350 to 750 ms.

3. Results

The results suggest an increase in craving levels during the VR exposure to smoking cues. The SCL data revealed an increase in autonomic activity in smokers, in comparison to non-smokers, when performing the VR tasks (t (88) = 2.057; p < 0.05). These data are in agreement with previous findings [1] and suggest that virtual exposure to arousal cues allocate attentional resources in smokers and enhance craving in those participants. The results also motivate the use of VR exposure as a tool for the conventional smoking cessation protocols.

Moreover, smokers showed enhanced frontal activity (F3 channel) during the presentation of smoking related pictures, specifically through the late positive

component - LPP (t (12) = 3.006; p < 0.05). The Figure 1 illustrates the ERP and respective topographic maps.

These data demonstrate the engagement of frontal activity during the processing of smoking stimuli, providing evidence for greater cortical processing in smokers when exposed to smoking cues and probably indicating that smokers attend more often to smoking cues than other environmental stimuli.
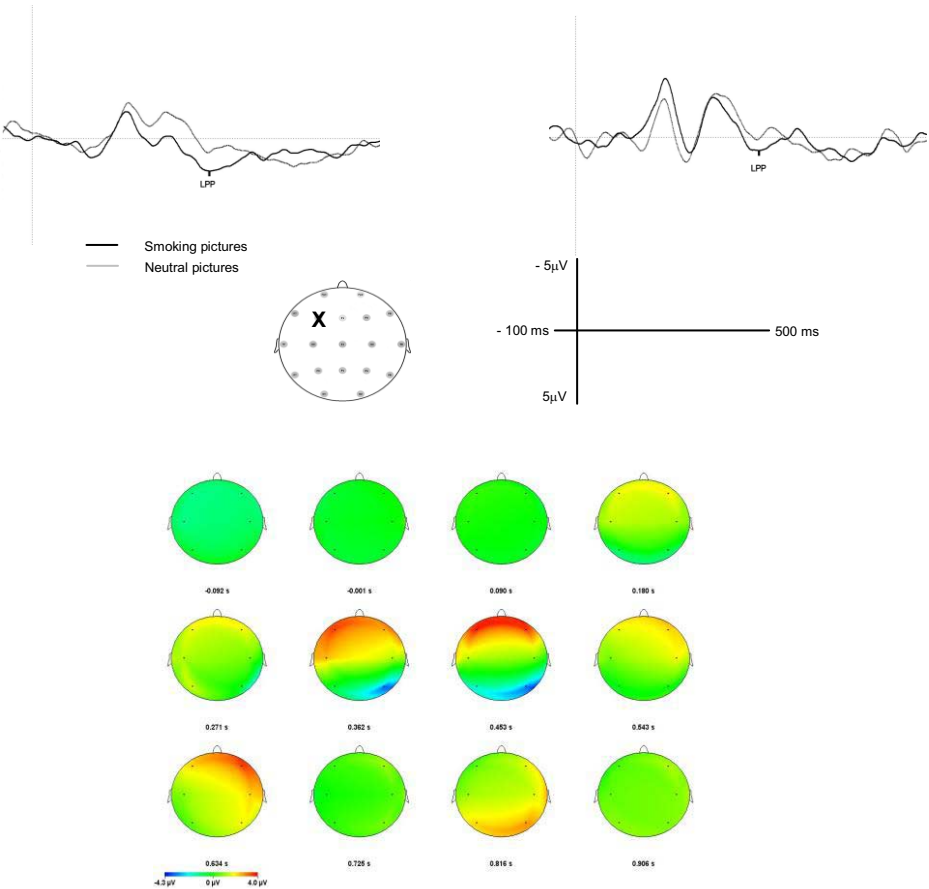
Figure 1. ERP grand averages in smokers (top left panel) and non-smokers (top right panel) to smoking and neutral pictures. Negative is plotted up. The topographic maps for the differences waves to cue exposure (smokers minus non-smokers) are presented in the bottom panel.

4. Conclusion

The results are in line with previous studies showing that the LPP is sensitive to smoking related images in nicotine addicts, which may reflect the allocation of

attentional resources to relevant stimuli [17; 18; 19]. Overall data may put on evidence the contribution of the cortical frontal areas to the process of craving. Being true, this may give stronger support to the behavioural strategies of smoking cessation programmes.

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Reliability and Validity of TIPS Wireless ECG Prototypes

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Abstract. The aims of the present study are to examine the reliability and validity of the Heart Rate signal registered using two self-made wireless ECG systems, R-Tips and TipsShirt, and to compare them with another commercial ECG device typically used in psychophysiology studies. An ECG simulator was used to artificially generate signals corresponding to different cardiac frequencies. Results of the reliability study showed that the signal acquisition, signal processing and signal transmission were reliable and valid for R-Tips and TipsShirt. Consequently, these wireless ECG prototypes could be used for studies where the freedom of movements of the participants is fundamental without any loss of quality in the registered signals.

Keywords. ECG wireless, R-Tips, TipShirt, ECG100C, Biopac, Heart rate, Cronbach's alpha

Introduction

Ambient Intelligence (AmI) refers to electronic environments that are sensitive and responsive to the presence of people. Users must notice that the surrounding is redesigned in an intelligent way to adapt to their needs.

The new technological advances are allowing the implementation of wireless intelligent sensor networks to acquire and select the necessary variables for the decision making of the motor of inference in each case [1-2].

Regarding the specific fields of therapy and the clinical treatment, a sensorial structure is required to contribute to design activities that interact with the physiological response of the patient.

Referring to the patient´s monitoring in free-living conditions, there is a need of translating determined physiological and contextual information variables about the physical and/or mental status of the patient without altering his perception of the environment [3-4]. One approach to obtain non-invasive monitoring technologies has been the use of smart fabrics, which allow the monitoring of patients over extended

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periods of time, in a natural context, in biomedicine, as well as in several health-focused disciplines [5].

One of the most important parameters to detect in these situations could be instantaneous Heart Rate, which can be applied for the measurement of energy expenditure, physical activity and exercise, emotional states and cardiac monitoring between others purposes [6-8]. Regarding emotional and psychological detection, heart rate variability (HRV), which is calculated from the ECG, can be used as an indicator [9]. In a continuous electrocardiographic (ECG) record, each QRS complex is detected, and the so-called normal-to-normal (NN) intervals (that is, all intervals between adjacent QRS complexes resulting from sinus node depolarizations), or the instantaneous heart rate is determined. A cardiac signal could be acquired from the current smart fabric sensors with a quality similar to standard 12 lead ECG.

The aim of this study is to test the feasibility and validity of a new platform called TIPS (Therapy Intelligent Personal Sensor). For this reason, two different versions of TIPS, R-Tips (RT) and TipsShirt (TSh, Nuubo Wearable Medical Technologies), will be evaluated and compared with a clinical validated sensor (ECG100C; Biopac System, Inc.) using for this purpose a cardiac waveform simulator (Fluke Biomedical, medSim 300B).

1. Methods

The different TIPS platforms were designed to capture ECG information of the subject in real time. The main components of the TIPS platforms are an acquisition and transmission system of the ECG signal (hardware part) and a processor of the received signal (software part). Different sensors, depending of the version of TIPS that is being used, capture the ECG signal. The captured signals are pre-processed to remove noise and are transmitted to a PC with TIPs property software using a Bluetooth transmitter. The HR is calculated with the property software in real time.

1.1. R-Tips

RT (Figure 1a) is one of the first versions of TIPS platform. This system allows monitoring of the cardiac signal remotely and wirelessly [10]. The sensors used are in the same way as in any commercial ECG. The sensors are connected to the transmitter system through several cables. This system can only transmit the data using Bluetooth wireless technology.

1.2. TipsShirt

TSh (Figure 1b) is a new version of TIPS, smaller and more portable than RT. This device allows monitoring the heart signal remotely and wirelessly, through a system based in biomedical textiles [11]. This system can transmit the data using Bluetooth wireless technology or save it in an internal memory.

Figure 1. a) R-Tips; b) TipsShirt c) ECG100C Biopac

1.3. Protocol of study

RT, TSh and ECG100C (Figure 1c) were tested [12] with simulated R-waves, Fluke Biomedical, medSim 300B (Figure2) with and without noise for different frequencies, for 1 minute and 30 seconds at each frequency, so no subjects were required for the experiment.

Figure 2 Fluke Biomedical, medSim 300B

The frequencies and conditions that were simulated and programmed in the simulated R-waves were 30 bpm, 30 bpm with 50Hz noise, 60 bpm, 60 bpm with muscular noise, 80 bpm, 80 bpm with 60 Hz noise, 120 bpm, 120 bpm with baseline noise, 160 bpm, 160 bpm with 50Hz noise and 200 bpm with muscular noise. This study lasted 16 minutes and 30 seconds for each device.

1.4. Statistical Analysis

Statistical Package for the Social Sciences (SPSS v.17.0) was used to conduct the statistical analysis.

Coefficients of variations and reliability analysis were applied to analyse the differences between real value and the calculated value by our systems. Cronbach's alpha Intraclass correlation coefficients (ICC) of reliability between the real values and the values obtained for each device were calculated.

2. Results

The descriptive statistics of coefficients of variations, with respect to the original signal, for the different apparatus are shown in Table1. In this table, small mean values

in coefficients of variation can be observed in all devices. The commercial system, ECG100C, has the lowest coefficient of variation, 0.0307(0.330), but similar values are obtained for all the systems.

Table 1. Mean (standard error of the mean) values of coefficients of variation with respect to the original signal (ECG simulator)

Rtips	TipsShirt	ECG100C
0.0367(0.477)	0.0428(0.510)	0.0307(0.330)

Cronbach's alpha Intraclass correlation coefficients (ICC) of reliability, with respect to the original signal generated by the ECG simulator, were also calculated (Table 2). In this statistical study, the most reliable device was the ECG100C, 0.998, followed by RT, 0.997, and TSh, 0.996, with similar values as can be observed. All results were significant ($p<0.001$).

Table 2. Cronbach's alpha Intraclass correlation coefficients of reliability with respect to the original signal (ECG simulator)

Apparatus	Cronbach's Alpha	Significance
Rtips	0.997	p<0.001
TipsShirt	0.996	p<0.001
ECG100C	0.998	p<0.001

3. Discussion

This paper presents the feasibility and validity of two different versions of a new non-invasive platform of cardiac monitoring called TIPS. The main conclusions and their implications for future studies are discussed below.

The obtained results show that both RT and TSh are a technically reliable and valid system for ECG measurement, 0.997 ($p<0.001$) and 0.996 ($p<0.001$) respectively. In fact, if we compare these results with results obtained by the commercial system (ECG100C), 0.998 ($p<0.001$), we can appreciate that the difference between the results is very small. This shows that signal acquisition and signal transmission is reliable and valid in our wireless ECG prototypes.

In our opinion, the results confirm that our TIPS systems can register correctly the cardiac output of any subject and in any situation. For this reason, we think that TIPS systems can be used in studies where the subject has to execute physical activities to record data from every day, for example, in a study with virtual reality where the subject is introduced in a CAVE system or a study of emotional engineering. These studies will need to have a system less invasive and more comfortable that traditional or clinical apparatus. Moreover, in these studies it is especially important to have reliable and feasible recorders. All these, our systems would be able to offer them.

The next step is to validate the TIPS version with human subjects in different daily situations. In this way, we will check that the systems remain robust and reliable in extreme conditions. For this, the recorders ECG data will be compared with other obtained through a commercial system in future studies.

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Associations Between Facial Emotion Recognition, Cognition and Alexithymia in Patients with Schizophrenia: Comparison of Photographic and Virtual Reality Presentations

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Abstract. Emotion recognition is known to be impaired in schizophrenia patients. Although cognitive deficits and symptomatology have been associated with this impairment there are other patient characteristics, such as alexithymia, which have not been widely explored. Emotion recognition is normally assessed by means of photographs, although they do not reproduce the dynamism of human expressions. Our group has designed and validated a virtual reality (VR) task to assess and subsequently train schizophrenia patients. The present study uses this VR task to evaluate the impaired recognition of facial affect in patients with schizophrenia and to examine its association with cognitive deficit and the patients' inability to express feelings. Thirty clinically stabilized outpatients with a well-established diagnosis of schizophrenia or schizoaffective disorder were assessed in neuropsychological, symptomatic and affective domains. They then performed the facial emotion recognition task. Statistical analyses revealed no significant differences between the two presentation conditions (photographs and VR) in terms of overall errors made. However, anger and fear were easier to recognize in VR than in photographs. Moreover, strong correlations were found between psychopathology and the errors made.

Keywords: emotion recognition, virtual reality, schizophrenia, alexithymia.

Introduction

Facial emotion recognition is a core feature of social cognition and interpersonal communication. Deficits in this capability have mostly been studied in schizophrenia [1], and both cognitive deficits and symptom intensity have been associated with this impairment [2]. In a recent meta-analysis Chan et al. [3] concluded that in most studies negative symptoms were strongly associated with facial emotion perception. Regarding cognitive variables, research has shown that affect recognition is correlated with attention, vigilance [4], concentration and cognitive flexibility [3]. However, other patient characteristics, such as alexithymia, have not been widely explored.

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Alexithymia refers to the inability to recognize and verbalize emotions [5], and some researchers, such as Campbell and McKeen [6], have claimed that individuals with high levels of alexithymia might have difficulty recognizing and interpreting the affective associations linked with face processing. Recently, van't Wout et al. [7] found that patients with schizophrenia, and notably males, had difficulty verbalizing and identifying emotions. However, the association between alexithymia, cognitive deficits and the ability to recognize facial emotions has not been thoroughly studied in patients with schizophrenia.

To date, photographs or static images have been the most common way of presenting experimental stimuli to subjects who are asked to recognize expressions of emotion. Although this format has been shown to be valid, it is limited by the fact that it cannot reproduce the dynamic aspect of human expressions. Virtual reality (VR) may help to overcome this problem, as it generates realistic and active faces as well as characters [8]. Gur et al. [9] proposed a method to obtain three-dimensional facial expressions using photographs. More recently, Dyck et al. [8] reported positive results about the validity of virtual faces for assessing facial emotion recognition.

Our group has validated a new virtual reality facial emotion recognition task using a set of faces, which also include an animation that reproduces naturalistic human movement. This paper reports the first results obtained when applying this validated VR task to patients with schizophrenia. The aim of the study was to evaluate the impairment in facial affect recognition shown by schizophrenia patients and to examine its association with cognitive deficits and the patients' inability to express feelings.

1. Methods

1.1. Participants

Thirty clinically stabilized outpatients with a diagnosis of schizophrenia or schizoaffective disorder were recruited from a mental health centre in Igualada (Spain), and they all completed the entire task designed for the study.

1.2. Measures

- Cognitive measures: SCIP (Screen for Cognitive Impairment in Psychiatry [10]) and CPT (Continuous Performance Test [11])
- Symptomatology: PANSS (Positive and Negative Syndrome Scale [12])
- Alexithymia: TAS-20 (Toronto Alexithymia Scale [13])

1.3 The Facial Emotion Recognition Task

The facial emotion recognition task includes two blocks of facial stimuli (photographs and virtual reality faces) that are presented in counterbalanced order and which represent the five basic emotions: happiness, sadness, fear, disgust and anger, plus a neutral emotion (no emotion).

Natural Faces: forty-four photographs were selected from the Penn Emotion Recognition Test - 96 Faces version (PERT96) [1]. This is a computer-based test containing 96 colour photographs of facial expressions of emotions, which include both high- and middle-intensity angry, fearful, happy, sad, disgusted and neutral faces.

Virtual Faces: Forty-four avatars were created to display the abovementioned basic emotions. This was done using the facial surface changes proposed by Ekman in his Facial Action Coding System (FACS) [14], which were matched to the intensity parameters of the PERT96 photographs. The faces were first morphed according to the action units (AUs) in the FACS, using 3ds Max® (Autodesk, Inc., USA). Every parameter for each emotion was controlled in order to make the faces as realistic as possible, and in order to match them to the intensity of the photographs used. Further modelling and animations were also applied using 3ds Max. To make the images more realistic, textures were included with the help of Photoshop 6.0®. Finally, 3DVIA Virtools® was used to correctly display each emotion during the final presentation.

Figure 1. Examples of virtual reality faces.

2. Results

Although there were no significant differences in the overall rate of correct responses for the two presentation conditions, a repeated measures ANOVA revealed that participants made fewer errors in the case of fear and anger in the VR condition than in the photograph condition. By contrast, disgust was easier to recognize when it was presented in photographs.

Table 1. The rate of correct answers for each emotion and the significance of differences between rates for the two conditions. *p<0.05, **p<0.01

	Photographs	VR	F	Sig
Total	58.11	59.78	0.71	0.640
s Happiness	89.17	91.25	0.75	0.393
Sadness	48.75	55	4.06	0.085
Fear	54.17	66.67	5.57	0.025*
Disgust	49.59	38.75	4.97	0.034*
Anger	38.34	65	34.29	0.00**
Neutral	72.5	70.84	0.18	0.677

Patients with high alexithymia made more errors (Ph: M=19.78; VR: M=19.22) than did patients with low alexithymia (Ph: M=16.86; VR: M=16.36) in both conditions of presentation, although this difference was not statistically significant.

Positive symptoms (r=0.379, p<0.05; r=0.368, p<0.05) and general psychopathology (PANSS) (r=0.329, p<0.05; r=0.410, p<0.05) were strongly correlated with the errors made on the facial recognition task.

No significant relationship was found between the cognitive measures and the ability to recognize emotions.

3. Conclusions

Virtual reality is a useful tool for assessing schizophrenia patients' ability to recognize emotions. Its dynamic nature can help to improve the accuracy of recognition for some basic emotions, as compared to what can be achieved when using static facial expressions [15]. Disgust was the only emotion for which the correct recognition rate was significantly worse in the virtual reality as opposed to the photograph condition. This finding may be explained by the difficulty of authentically recreating the naso-labial area [3], even though special attention was paid to this aspect when creating the virtual avatars.

The cognitive measures analysed in this study do not seem to be associated with individuals' ability to recognize emotions. Since these data are not consistent with previous reports, further research is needed on this topic. Although the presence of alexithymia did seem to impede the ability to recognize emotions, its influence did not reach statistical significance. By contrast, positive symptoms and general psychopathology were strongly correlated with the ability to recognize emotions, both in photographs and in virtual reality.

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Postural Control of Elderly: Moving to Predictable and Unpredictable Targets

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Abstract. Impaired postural control with muscle weakness is an important predictor of falls within the elderly population.Particular daily activities that require weight shifting in order to be able to reach a specific target (a cup on a table) require continuous adjustments to keep the body's center of mass balanced. In the present study postural control was examined in healthy elderly and young subjects during a task in which subjects had to move the body's center of mass towards a virtual target on a screen that appeared at predictable and unpredictable locations. Postural control decreased with unpredictable targets, e.g. movement time was larger, trajectories more irregular. The results indicate that even though older individuals clearly benefitted from the early release of target location information, young individuals improved even more when target information became available.This indicates thatthe young were better able to use this information prospectively for executing the target directed movement quickly and accurately.

Keywords.postural control, elderly, visuo-motor declines, exergaming

Introduction

The expanding ageing population has ignited a growing interest in how to preserve postural control skills to reduce the risk of falling as falling can result in loss of independence, significant morbidity or death. Thirty percent of seniors over 65 and fifty percent of seniors over 80 experience at least one fall each year. Even in the absence of overt pathology, postural control deteriorates due to a progressive loss of sensorimotor functioning associated with normal ageing. With ageing the dynamics of the postural control system is affected, requiring more corrective responses making it more difficult to adapt to unexpected situations that require postural adjustments[1,2]. Consequently the attentional demands for postural control are increased, making elderly more vulnerable to distractions, thereby increasing the risk of falls[3]. In order to limit fall rates in populations at risk, exercise interventions are often applied[4.]

Common interventions usually solely focus on the physical aspects of training like muscle strength and endurance, while overlooking the specific training of motor control aspects such as planning, online guidance, monitoring and switching behavior. New technology-based techniques, such as interactive video games, appear quite

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promising for balance training. Especially because these systems include enriched environments that provide physical activities with motor control training and decision-making opportunities that also motivates people to practice.

The present study explores a self-initiated weight-shifting task in older adults. The ability to quickly transfer weight within the base of support without losing balance is essential for many activities during daily living. Particularly weight-shifting tasks have been widely used in physical therapy to counteract balance declines. The use of a virtual reality environment for exercise has the potential to increase exercise but also to assess motor control strategies. The exergame used did not only require controlled weight shifts but also perceptual-cognitive abilities, such as observing the environment to anticipate the next target and making quick adjustments. It, therefore, may reflect problems that occur during daily living and may provide insight in the motor control difficulties experienced by older people.

1. Methods

1.1. Participants

Nine healthy elderly (70.3 ± 6.9 year) and elevenyoung subjects (20.9 ± 0.5 year) participated in the study. All participants had normal or corrected to normal vision, walked without aids and did not experience any falls in the previous two years.

1.2. Procedure and Design

The experiment was performed in the CAREN (computer Assisted Rehabilitation Environment; Motek medical™). CAREN combines a motion platform, a three-dimensional large-screen video projection, a real-time motion capture system, 2 force plates and a graphics workstation. The position of a dot ($\varnothing$ 11.5 cm) projected on a screen 2 m in front was controlled through movement of the centre of foot pressure (CoP) on the force platforms.By shifting weight (moving the CoP quickly but accurately) the subjects had to position the dot on the screen from the centre target to a projected goal target (Fig. 1A). After reaching the target for 0.5 s, the goal target disappeared and the subject moved back to the centre target. In the predictable condition a new goal target appeared on the screen before the subjects moved back, allowing longer movement preparation. In the unpredictable condition the new goal target appeared unexpectedly when the subject arrived on the centre target. The force platforms registered with 1000Hz and this frequency was reduced to 100Hz for the visualizations.

A new goal target (36 x 36 cm) could appear in one of five different wind directions (N, NE, E, NW, W) and was positioned 72 cm from the centre target (about 65% of max excursion for the elderly). In both the predictable and unpredictable condition five blocks of five different target locations were presented (total of 50 targets). Before the experiment started participants were allowed to practice.

Outcome parameters
1 = ideal path
2 = performed path
3 = maximal deviation
4 = number of peaks
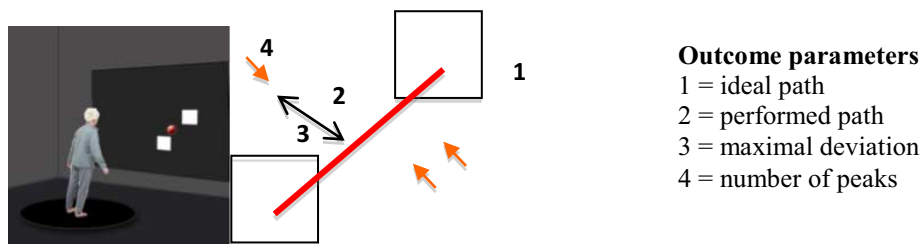
Figure 1 A: setup   B: outcome measures

1.3. Data analysis

CoP data were low-pass filtered at 5 Hz with a 4thorder Butterworth filter.Goal-directed movements from the centre target to the goal targets were analyzed. The following measures were calculated (Fig. 1B): movement time – time between appearance of two subsequent targets;dwell time – time between appearance of a new target and last exit from the centre target area, unsteadiness - number of velocity peaks, wandering - path length; deviation – maximal deviation perpendicular to the ideal path and standard deviation. The individual means of these variables were submitted to a RM-ANOVA with Task (predictable versus unpredictable) as a within factor and Age (young versus old) as a between factor.

2. Results

Figure 2 represents typical trajectories from a young and older participant for CoP movements from the centre location to each of the five goal locationsand back in the predictable and unpredictable target condition. Table 1 displays the means and standard deviations of all outcome measures averaged across individuals for both target conditions and age groups.
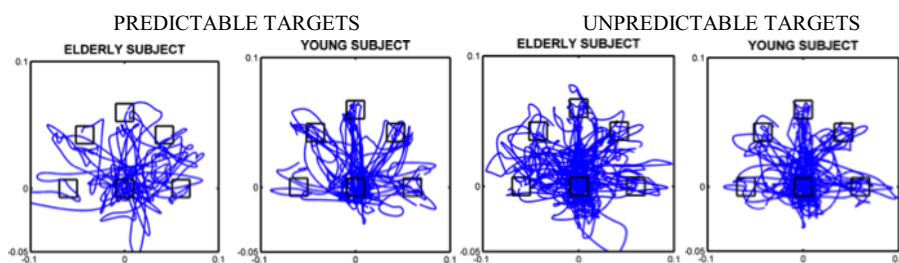
Figure 2. trajectories of individual subjects

2.1. Predictable versus unpredictable targets - task effects

Significant differences between the two tasks were observed for all outcome measures.When the next goal target was already visible before moving back to the center location (i.e. in the predictable condition) young and older participants spend

less time dwelling around the center target (F(1,18)=98.84, P<.001), they moved to the goal with less peaks (F(1,18)=55.25, P<.01), a shorter path (F(1,18)=30.71, P<.001), a smaller maximumdeviation (F(1,18)=9.8, P<.01) and less variation around the ideal path (F(1,18)=4.13, P=.06).

2.2. Age effects

On most outcome variables significant differences between the age groups were observed. Older adults moved slower (F(1,18)=14.18, P<.005), with a longer path (F(1,18)=14.18, P<.005), larger deviation (F(1,18)=11.82, P<.005) and variation around the ideal path (F(1,18)=9.89, P<.01) and with more peaks (F(1,18)=19.69, P<.01) than the young. Young people benefitted more from the predictability of the target as indicated by a significant interaction effect of Age x Task for maximum deviation (F(1,18) = 5.02, P<.05) and variation (F(1,18) = 6.28, P<.05) around the ideal path and a near significant interaction effect for dwelling time around the center target (F(1,18) =3.07, P=.097).

Table 1. Means (and standard deviations) of the outcome measures for both task conditions (unpredictable and predictable goal-target) and participant groups (young and old).

	Unpredictable target		Predictable target	
	Young	**Old**	**Young**	**Old**
MT (s)	1.59 (0.18)	2.01 (0.36)	1.26 (0.14)	1.64 (0.31)
center dwell time (s)	0.74 (0.16)	0.80 (0.18)	0.43 (0.09)	0.58 (0.19)
nr. Peaks	4.25 (0.74)	6.02 (1.35)	3.02 (0.52)	4.85 (1.18)
path length (cm)*	14.79 (2.00)	18.12 (4.84)	12.64 (2.47)	15.56 (3.75)
max. deviation (cm)*	1.81 (0.20)	2.22 (0.45)	1.56 (0.21)	2.18 (0.50)
path variation (cm)*	0.44 (0.06)	0.62 (0.15)	0.51 (0.05)	0.61 (0.12)

* = for scaling on the screen a multiplication factor of 12 was applied

3. Discussion

With this study we furthered the understanding of age-related changes on a challenging postural control task thatrequired targeted CoP movements. The participants had to rapidly and purposefully change direction and speed while maintaining balance to meet the task demands. We especially examined the beneficial effects of target predictability on the spatiotemporal characteristics of the movement. The main observation was that older subjects benefitted from an early release of target location information to compensate for the age-related declines in the planning and execution of the targeted CoP movements. Yet, they were less efficient in using target information prospectively than young subjects.

Typical age-effects observed on this postural control task are the increased dwelling time around the centre target and wandering of the target-directed movement as indicated by the larger maximal deviation and standard deviation around the ideal path for the older compared to the younger subjects. These observations indicate that the older participants showed greater variability and instability in their postural controland are more vulnerable to perturbations.Generally, movement duration was observed to increase whereas steadiness of the movement decreased in older participants. These findings are consistent with performing target-directed movements with the upper

extremity, showing increased movement time and number of sub-movements with age[5]This result suggestsage-induced delays in the use of visual information for online control of targeted movements, which have also been reported for precision stepping[6]. To compensate for such delays,older adults require more time looking at a target in order to plan and execute accurate movements. Indeed, our study showed that older adults benefitted from the early release of target location information. In the predictable condition there was less dwelling around the centre target, less wandering when moving towards the target location and movement trajectory was less peaked. Correspondingly, movement time and path length were decreased in the predictable compared to the unpredictable condition.

The improved performance in the predictable target condition compared to the unpredictable target condition was larger for the young than the older participants. This indicates that even though older participants benefitted from the longer presentation time of the goal target, the young were better able to use this information prospectively for executing the target directed movement quickly and accurately. A possible reason might be that the young were better able to integrate aspects of the later goal movementwhen moving to the centretarget. One explanation for this more segmented control by the older adults might be their greater reliance on visual information about the target locations, not only when moving to the goal targetwhich can appear in different locations,but also when moving back to the centretarget which is always in the same location. Another explanation, which doesn't preclude the first, resides in the greater variability and instability of the older adult's postural control system. When a person experiences more motor noise when executing a target-directed movement it is perhaps less efficient to implement acontrol strategy that takes into account multiple segments. Future work is needed to better understand this information-based regulation of CoP movement sequences in elderly.

Theobserved age-related changes in accuracy constrained volitional weight shifts are particularly relevant in everyday activities such as turning and bending to reach out and might be a contributing factor to the increased risk of falling in older adults. Exergames that require rapid and accurate weight shifts might be helpful in fall prevention programs and motivate people to practice[7].

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Assessment of Executive Functions in Patients with Obsessive Compulsive Disorder by NeuroVR

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Abstract. Executive functions are often impaired in obsessive-compulsive disorder (OCD). We used a Virtual Reality version of the Multiple Errand Test (VMET) - developed dusing the free NeuroVR software (http://www.neurovr.org) - to evaluate the executive functions in daily life in 10 OCD patients and 10 controls. It is performed in a shopping setting where there are items to be bought and information to be obtained. The execution time for the whole task was higher in patients with OCD compared to controls, suggesting that patients with OCD need more time in planning than controls. The same difference was found in the partial errors during the task. Furthermore, the mean rank for and for interpretation failures is higher for controls, while the values of divided attention and the of self correction seems to be lower in controls. We think that obsessive patients tend to work with greater diligence and observance of rules than controls. In conclusion, these results provide initial support for the feasibility of VMET as assessment tool of executive functions. Specifically, the significant correlation found between the VMET and the neuropsychological battery support the ecological validity of VMET as an instrument for the evaluation of executive functions in patients with OCD.

Keywords. Virtual Reality, Multiple Errands Test (MET), Executive functions, Obsessive-compulsive Disorder

Introduction

The executive functions are a set of mental processes, which include problem solving, planning, working memory, inhibition, mental flexibility, initiation and monitoring of actions. Deficits in these functions are called "dysexecutive syndrome" and they are common in neurological patients with frontal lobe damage due to traumatic brain injury or stroke [1]. Individuals who have an impairment of executive functions show problems of starting and stopping activities, a difficulty in mental and behavioral shifts, an increased distractibility and difficulties in learning new tasks [2]. This syndrome

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may be present in different clinical disorders, such as dementia, attention and hyperactivity disorder, schizophrenia [3] and obsessive-compulsive disorder.

Obsessive compulsive disorder is a psychiatric condition which is characterized by recurrent, intrusive thoughts, impulses and images, often associated with compulsive behaviors that are repetitive, time consuming and often ritualized [4].

From the neuropsychological point of view, patients with obsessive compulsive disorder (OCD) show deficit of executive functions, which are characterized by the impairment of several skills such as attention, planning, problem-solving and behavioral control [5]. Further, OCD is often associated with impairments of visuospatial skills [6], and of memory functioning, including visual, verbal, and numerical [7].

According a recent review [8], the executive functions, which seem to be representative of the perseverative and repetitive behaviours observed in patients with OCD, are set-shifting and response inhibition. Set-shifting refers to the ability to shift attention among different features of a stimulus in response to a changing feedback.

The assessment and the rehabilitation of executive functions under typical clinical or laboratory conditions are unsatisfactory for several reasons. In such settings, planning, multi-tasking or problem solving are usually assessed by pen and paper tasks rather than being presented in an actual or simulated way [9]. Increasing the ecological validity of neuropsychological assessment is important since this will increase the likelihood that patient's cognitive and behavioural responses will replicate the response that would occur in real-life situation [10].

The Multiple Errands Test (MET) developed by Shallice & Burgess [2], is instruments used to assess executive functions in real life settings; it consists of tasks abide by certain rules. It is performed in an actual shopping mall-like setting where there are items to be bought and information to be obtained.

Recent research shows that Virtual Reality can offer new possibilities for the assessment of executive functions providing an additional support to the traditional paper and pencil tasks [11, 12].

The present study is aimed at analyzing the executive functions in patients affected by obsessive compulsive disorder through a neuropsychological battery and a Virtual Reality (VR) version of the Multiple Errands Test (MET) [13, 2] based on the free NeuroVR software (http://www.neurovr.org) , developed by the Applied Technology for Neuropsychology laboratory, Istituto Auxologico Italiano of Milan [14-16].

1. Methods

We recruited 10 patients suffering from obsessive-compulsive disorder diagnosed according to DSM IV-TR criteria (M=6, F=4; mean age=32,8 years, std.dev.=10,8) and 10 healthy controls (M=6, F=4; mean age=37,2 years, std.dev.=8,3) (table 1). Patients were randomly selected from the outpatient Unit of Psychiatry of Palermo University Hospital.

Patients were excluded from the study if they had a severe cognitive impairment (MMSE<19), a severe motor impairment which did not allow subjects to perform the procedure, auditory language comprehension difficulties (Token Test<26,5), object recognition impairments (Street Completion Test<2,25), excessive state and trait anxiety (STAI>40) and excessive depression state (Beck Depression Inventory>16).

The control group consisted of subjects without motor and cognitive impairments. In particular, exclusion criteria were: cognitive deficit evaluated by MMSE (cut off: 24); motor impairment which does not allow subjects to perform the virtual procedure; sensory deficits.

Table 1: Population characteristics

	Experimental group	**Control group**
	$n = 10$	$n = 10$
Age (Mean ± SD)	32,80 ± 10,779	37,20 ± 8,324
(range)	19 ± 53	28 ± 53
Gender (M, F)	6, 4	6, 4

We used a complete neuropsychological battery for the assessment of executive functions, in the experimental group, including: Frontal Assessment Battery-FAB, to assess the presence and the severity of a dysexecutive syndrome affecting both cognition and motor behavior; Trail Making Test (form A and B), to investigate the visual attention and task switching; Phonemic and Semantic Fluencies, for object denomination; Tower of London, for the capacity of planning, and Corsi's memory span and supra-span, Digit span, Short Story recall and word recall tests, for memory evaluation.

After a neuropsychological evaluation, we used the Virtual Multiple Errands Test (V-MET), both in cases and in controls. In this version, after a training session, the subjects were requested to select and to buy various products presented on shelves with the aid of a joy-pad.

In particular, subjects were invited to buy some items following a defined shopping list (e.g. a chocolate bar or a product in sale) and to obtain some information (e.g. the closing time of the supermarket) following specific rules:

- you must complete all tasks but you can choose any order;
- you are not allowed to enter any aisle unless you need items to complete part of your task;
- you are not allowed to go into the same aisle more than once;
- you are not allowed to buy more than two items for item category;
- take as little time as possible to complete this exercise without rushing excessively;
- do not speak to the person observing you unless this is part of the exercise.

While completing the multiple errands test procedure, time of execution, total errors, partial tasks failures, inefficiencies, rule breaks, strategies and interpretation failures were measured.

2. Results

We applied the *Mann-Whitney Test* to evaluate the performance differences at the virtual test (V-MET) among cases and controls. The execution time for the whole task was higher in patients with OCD compared to controls, suggesting that patients with

OCD need more time in planning than controls. The same difference was found in the partial errors during the task; in particular, there was a significant difference in the mean rank of the partial errors for the sub-tests 6 (buying two products from the refrigerated products aisle, Asym. Sig. = 0.025) and partial errors 7 (going to the beverage aisle and asking about what to buy, Asym. Sig. = 0.024). Furthermore, the mean rank for inefficiency (Asym. Sig. = 0.08) and for interpretation failures is higher for controls (Asym. Sig.=0.01), while the values of divided attention (Asym. Sig.=0.02) and the of self correction (Asym. Sig. =0.07) seems to be lower in controls. We think that obsessive patients tend to work with greater diligence and observance of rules than controls.

Among patients, Spearman correlation coefficients were used to examine the relationship between the neuropsychology tests and the scores of virtual version MET for each group (table 2).

Table 2. Correlations between neuropsychological tests and the variables of the virtual MET

	Errors 5		Inefficiencies		Sustained Attention		Maintained Sequence		No Perseveration	
	r	p	r	p	r	p	r	p	r	p
FAB			.628	.05						
TMT (B)	-.645	.04			.817	.00				
TMT (BA)	-.674	.03			.820	.00				
Phonemic Fluencies									.671	.03
ToL			.736	.01			-.772	.00		
Digit Span									.688	.02
Corsi's mem.span			.789	.00						
Corsi's supra-span			.859	.00						

The Frontal Assessment Battery correlates with the inefficiencies variable (Sig.=0.05); the Trail Making Test significantly correlates with some VMET's variables: sustained attention, partial errors in performing of task n. 5 (buying a product on sale); the Fluency Phonemic correlates with the absence of perseveration; the Tower of London correlates with inefficiency and with maintenance of the tasks sequence; the Digit span correlates with the absence of perseveration; the Corsi's memory span and the Corsi's supra span correlates with the inefficiencies.

3. Conclusions

Our results provide initial support for the feasibility of using the VMET as an assessment tool of executive functions.
Further, the significant correlation found between the VMET and the neuropsychological battery support the ecological validity of VMET as an instrument for the evaluation of executive functions in patients with OCD.
The results of the present study are limited by the small sample size. Further studies are needed to clarify the relationship between traditional tests and the emerging tools based on virtual environment. For these purposes, analyses of comparable samples of OCD

subtypes (e.g. washers, checkers, gamblers) could be relevant because the heterogeneity of the disorder can lead to different results for each subtype.

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Exergaming for Elderly: Effects of Different Types of Game Feedback on Performance of a Balance Task

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Abstract. Balance training to improve postural control in elderly can contribute to the prevention of falls. Video games that require body movements have the potential to improve balance. However, research about the effects of type of visual feedback (i.e. the exergame) on the quality of movement and experienced workout intensity is scarce. In this study twelve healthy older and younger subjects performed anterior-posterior or mediolateral oscillations on a wobble board, in three conditions: no feedback, real-time visual feedback, and real-time visual feedback with a competitive game element. The Elderly moved slower, less accurately and more irregularly than younger people. Both feedback conditions ensured a more controlled movement technique on the wobble-board and increased experienced workout intensity. The participants enjoyed the attention demanding competitive game element, but this game did not improve balance performance more than interacting with a game that incorporated visual feedback. These results show the potential of exergames with visual feedback to enhance postural control.

Keywords: Exergaming, balance training, feedback, motivation, elderly

Introduction

Impaired postural control with muscle weakness is an important predictor of falls within the elderly population. Postural control relies on neuromuscular control integrating sensory information from various sources like the vestibular, muscle and visual system. Appropriate control of posture underlies many motor skills and is an absolute pre-requisite for activities of daily living. Ageing yields an undeniable deterioration of postural control [1]. Existing balance training programs for elderly can contribute to fall prevention and maintaining physical activity [2,3] but these programs however, typically have a clinical focus on secondary prevention in recurrent fallers. For elderly, who have never fallen conventional exercise therapy is difficult to adhere to since this requires high levels of intrinsic motivation [4]. In contrast, exergaming can engage and motivate this group by making the physically demanding exercises more enjoyable and challenging [4,5].

A growing number of studies examined the benefits of off-the-shelf exergames (video-games that require body movements for game play) for balance and mobility training of the elderly. In a previous study we found that a six-week exergaming

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intervention, improved balance. In addition elderly reported being highly motivated to exercise [5,6]. Providing individuals with augmented visual information about their own motion, i.e. (bio) feedback, during training may optimize movement performance [7,8]. However, scarce information is available about the effects of the type of visual feedback (i.e. the exergame) on balance performance and experienced task difficulty. Therefore the objective of the present study was to examine the effects of no feedback, real-time visual feedback with and without a competitive game element on balance performance on a wobble board. In addition, levels of intrinsic motivation, perceived performance, perceived degree of control and experienced physical and mental effort, while performing the three balance tasks were assessed.

1. Methods

Twelve healthy elderly (61-77 year) and young subjects (19-26 year) performed a balance task when standing on a wobble board that integrates video gaming with balance control (Miniboard; Sensamove®, Utrecht, The Netherlands). A three-dimensional accelerometer and gyroscope registered tilts of the board with a sample frequency of 100 Hz, and was used to interact with the video game. The balance tasks required oscillating movements of the board in anterior-posterior or mediolateral direction. Three tasks were performed: 1) without feedback or game element; 2) with a game element in the form of real-time visual feedback by visualization of the travelled path on a screen; 3) with visual feedback in the form of a moving balloon and a competitive game element that required transporting as many balloons from one side to the other as possible. Tasks were randomized. The instruction was to oscillate the board as smooth as possible. *Outcome measures*: 1) mean Hilbert amplitude; 2) number of oscillations; 3) fluency of the movement indexed by dividing the power spectral density of the fundamental oscillatory frequency by that of the entire signal. A value of 1 of this harmonicity index represents a smooth movement; 4) trajectory length; 5) % error: the number of samples deviating from the ideal trajectory normalized by trajectory length.

To examine the subjective experience, participants ranked 12 statements about the tasks in terms of difficulty and enjoyment and visual analogue scales were administered to assess experienced mental and physical fatigue. The statements were categorized into three components, namely motivation, perceived degree of control and perceived performance. *Statistics.* A repeated measurement analysis of variance was applied with TASK (no feedback, visual-feedback, visual feedback and game) as within factor and AGE (young adults vs. elderly) as between factor ($p < 0.05$). When significant main effects were observed post-hoc analyses were performed.

2. Results

2.1. Task effects on postural control

Significant effects of task were observed for all outcome measures ($p<0.01$) in both directions except for the harmonicity index of mediolateral movements (see table 1). Post-hoc analyses revealed significant higher amplitude for both directions when performing the task without feedback compared to both other condition ($p<0.01$). The harmonicity index was significantly higher for both feedback tasks compared to the no feedback task while moving anterior-posterior direction ($p<0.001$). The number of

oscillations, as well as the trajectory length and the % of error were significantly lower ($p<0.001$) for both directions while performing both feedback tasks compared to the no feedback task. The feedback task did not differ significantly form the competitive game task with feedback on any of the outcome measures.

2.2. Age effects on postural control

Post-hoc analyses of the main AGE effects showed a significant larger amplitude ($p<0.005$), higher harmonicity index ($p<0.001$) and lower % of error ($p<0.005$) for young adults then elderly for both movement directions (Figure 1).
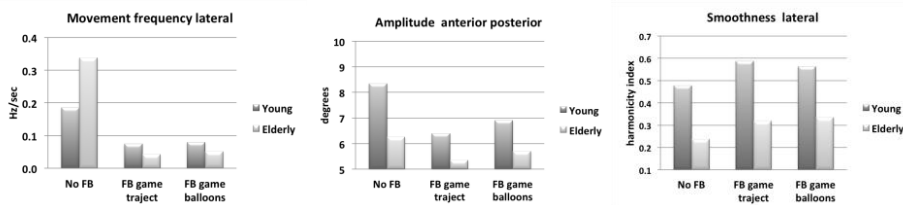
Figure 1. Movement frequency, amplitude (max = 10°) and smoothness of movement (max = 1)

Significant interaction effects of AGE by TASK were found for number of oscillations, trajectory length and % error (Table 1). In both movement directions, the number of oscillations was higher for elderly than young adults for the no feedback task ($p<0.05$), and higher for the young than the elderly adults for the feedback and game feedback tasks ($p<0.01$). Trajectory length was larger for the young adults during the no feedback task ($p<0.05$), whereas for the elderly trajectory length was larger in the other two tasks ($p<0.05$). The young adults deviate more from the ideal trajectory during the no feedback task in mediolateral direction, compared to the elderly ($p<0.05$). However, the elderly show a significantly higher % of error during the other two tasks in both directions ($p<0.01$).

Table 1. Main effects of task (without feedback, with feedback, with feedback and competitive game element), and AGE (young adults vs. elderly) and interaction effects of TASK*AGE on anterior-posterior (AP) and medio-lateral (ML) movements. NS = not significant

	Direction	TASK		AGE		TASK*AGE	
		F(2,56)	p	F(2,56)	p	F(2,56)	p
Amplitude (degrees)	AP	14.51	< 0.001	11.79	0.002	1.39	NS
	ML	12.59	< 0.001	12.29	0.002	3.44	NS
Harmonicity index	AP	22.87	< 0.001	34.39	< 0.001	0.16	NS
	ML	3.03	NS	55.96	< 0.001	0.18	NS
Oscillations (Hz/s)	AP	43.29	< 0.001	1.98	NS	10.69	0.003
	ML	50.66	< 0.001	3.63	NS	15.00	< 0.001
Trajectory length	AP	35.32	< 0.001	1.15	NS	7.37	0.005
	ML	35.45	< 0.001	1.40	NS	15.15	< 0.001
Error (% of ideal traject)	AP	188.81	< 0.001	13.23	0.001	16.00	< 0.001
	ML	84.12	< 0.001*	13.93	0.001	18.09	< 0.001

## 2.3. Experienced physical and mental fatigue and task experiences

Elderly experienced more mental and physical fatigue during both feedback tasks than in the no feedback task ($P<0.01$) and their fatigue scores were higher compared to the

young subjects. Figure 2 shows the results for the young adults and the elderly of the ranking of the 12 different statements. The first component represented the questions addressing motivation. Participants indicated that the condition without feedback was most boring and over 70% of the young adults found this balance task to be most long lasting, even though all tasks lasted two minutes. In addition, the young adults indicate the balloon game as most motivating (88%) 70.8 % of the subjects rated the game balloon task as the most motivating and the task without feedback as the most boring task. The latter was also rated as the most difficult task, but the game balloon task required the most attention in both groups.

Table 2 Mean scores of the experienced physical and mental effort while executing the balance tasks. Values are mean ± standard deviations. Range VAS score: 0-100. Higher score indicates higher experienced physical or mental effort.

Visual Analogue Scales (mm)	Young adults (n=18)	Elderly (n=12)
Task: No feedback		
Physical effort	38.49 ± 18.79	57.67 ± 23.37
Mental effort	45.68 ± 26.18	38.88 ± 20.15
Task: Visual feedback		
Physical effort	38.47 ± 21.50	64.75 ± 29.32
Mental effort	43.48 ± 29.72	51.00 ± 28.55
Task: Visual feedback and competitive game		
Physical effort	38.65 ± 21.11	72.38 ± 21.55
Mental effort	45.98 ± 26.60	51.42 ± 36.20

Evaluating the results of the component of perceived degree of control, over 70% of the young adults and elderly stated that they were most stimulated to move on the wobble board, during the execution of the balloon game task. Over 80% of the young adults felt that their movements were more goal-directed during the execution of the feedback game. The component of perceived performance show that performing the balloon game required more concentration for all participants compared to the other two tasks. In line, all participants reported that the task without feedback required the least effort.
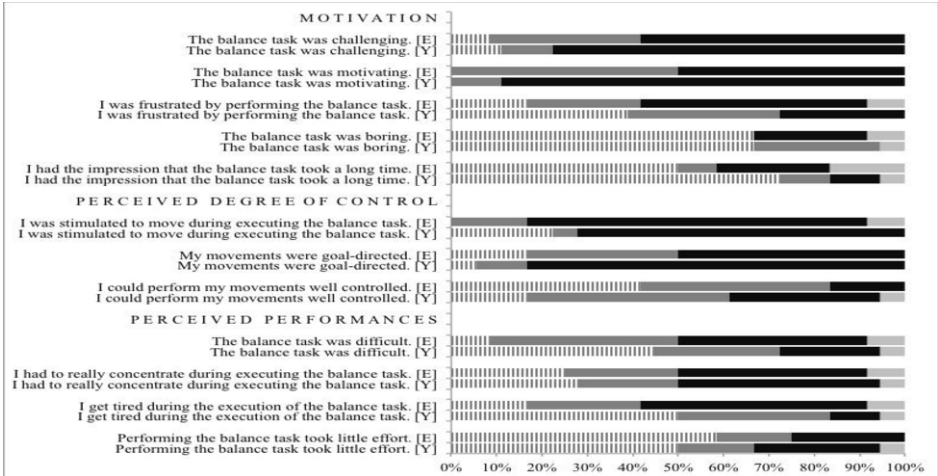
Figure 2. Relative frequency distribution of the extent to which each statement is true for each of the three conditions (without feedback = stripes; with feedback = grey; FB with balloon game = black; missing values = light grey). Y = young adults, E = elderly.

3. Discussion and Conclusion

The main objective of the study was to examine whether the performance of young adults and elderly on a balance task using a wobble board was influenced differently by adding real-time visual feedback about performance. We especially examined the beneficial effects of adding an exergame component to the feedback in the form a competitive game element. In addition differences in participants' experiences of the three different tasks in terms of motivation, perceived control and performance, and experienced mental and physical fatigue were assessed.

General age-effects were observed on this balance task; movements of elderly were performed slower, more irregular with larger deviations form the ideal path as indicated by a lower harmonicity index and larger % error than young adults. In contrast to elderly, young adults performed more well-controlled, goal-directed and rhythmic movements on the wobble board in all tasks. The task without feedback was always performed worst. The high number of oscillation in the no feedback task and the low harmonicity index implies fast, uncontrolled attempts to shift the board in mediolateral or in anterior-posterior direction, particularly in the elderly participants. The feedback task with a competitive game element, however, did not improve balance performance more than interacting with a game that incorporated only real-time visual feedback about balance performance. This may be due to the fact that the balance task was very difficult for the elderly. The game required continuous corrective balance reactions to maintain balance when standing on the unstable wobble board and required additional attention to pick up as much balloons as possible.

The secondary aim was to compare levels of intrinsic motivation, perceived performance, perceived degree of control and experienced physical and mental effort, while performing the different balance tasks with and without an added game element. The main observation was that the feedback with the competitive balloon task was perceived as the most motivating and challenging task. This finding provide further support for the notion that exergaming provides a motivational factor for exercising [4,5,6]. Contrary to the young adults, the elderly often reported to get tired during the execution of the balloon game, suggesting that the elderly needed more effort to perform the feedback balloon game. The video game used was designed for the present objective. A more sophisticated virtual-reality based video game might improve the player's feeling of presence and immersion, reducing attentional load.

To conclude, the results of the present study indicate that for balance training of elderly a feedback exergaming task may have the largest training effect compared to exercising without feedback of with solely visual real-time feedback. It facilitates, accuracy and goal directedness of postural control. Correspondingly, perceived workout intensity was higher and participants enjoyed the competitive game element of the feedback game task.

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Balance Recovery Through Virtual Stepping Exercises Using Kinect Skeleton Tracking: A Follow-Up Study With Chronic Stroke Patients

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Abstract. Stroke patients often suffer from hemiparesis, which affects their balance condition and consequently their self-dependency and quality of life. Balance rehabilitation can be a long and tedious process. Virtual rehabilitation systems have been reported to provide therapeutic benefits to the balance recovery of stroke patients while increasing their motivation. This paper presents a follow-up study involving chronic stroke patients to evaluate the clinical effectiveness of a virtual stepping exercise using skeleton tracking through a low-cost Kinect depth sensor.

Keywords. Balance recovery, virtual rehabilitation, skeleton tracking, acquired brain injury, BioTrak system

Introduction

Balance complications are common amongst patients with hemiparetic acquired brain injury (ABI) patients. The balance disorders are among the most disabling dysfunctions since they can affect and even prevent the performance of the activities of daily living. The balance recovery requires the hierarchical recovery of multiple deficits including perceptive, musculoskeletal, and cognitive components of posture in order to achieve maximum functionality in terms of the patient's self-dependency. For this reason, traditional neurorehabilitation programs focus on the balance recovery since the initial stages of the rehabilitation process. There is proven clinical evidence that the recovery of this skill has been associated with a favorable functional outcome [1]. However, the balance recovery process can last for years and can become tedious and meaningless.

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In the last years some studies have reported the clinical benefits of virtual reality (VR)-based systems in the balance recovery of ABI patients, from chroma-key systems [2] to force platforms [3]. At present, the off-the-shelf depth sensors, such as the Microsoft® Kinect [4], provide therapists with a low cost and non-invasive body tracking that can easily fit in the clinical setting. We have integrated the Kinect skeleton tracking in the BioTrak system [5] and in this paper we present a follow-up study involving stroke patients to evaluate the clinical effectiveness of a reaching exercise in standing position that uses VR technology and skeleton tracking.

1. Methods

1.1. Participants

89 patients that were attending a holistic rehabilitation program in a large metropolitan hospital were potential candidates to take part in the study. Inclusion criteria were: 1) age ≥ 18 and ≤ 75 years; 2) chronicity > 6 months; 3) Brunel Balance Assessment [6]: section 3, levels 7-12; 4) Mini-Mental State Examination [7] > 23. Exclusion criteria were: patients with 1) severe dementia or aphasia; 2) cerebellar symptoms. After inclusion/exclusion criteria 15 chronic stroke patients (Table 1) were recruited from the total pool.

Table 1. Characteristics of the participants

Scale	Initial assessment
Gender (n)	
Male	8
Female	7
Age (years)	51.87±15.57
Etiology (n)	
Ischemic stroke	10
Hemorrhagic stroke	5
Hemiparesis side (n)	
Left	7
Right	8
Chronicity (days)	483.47±241.59

1.2. Instrumentation

BioTrak is a modular VR system that provides, among others, exercises for the balance rehabilitation in both standing and sitting position. For this study the BioTrak setting consisted of a 42" LCD screen, a standard computer, and a depth sensor (DS). Only the stepping exercise in standing position was evaluated. This exercise immerses the participants in a virtual scenario and represents their feet by means of two virtual shoes. The positions of the participants' feet are estimated by the DS and then transferred to the virtual scenario. During the training sessions, different items rise from the floor around a central circle. The participants are required to step on the items with one foot before they disappear while maintaining the other foot inside the circle. After that, the participants have to return the extended foot within the circle before they can step on a new item. Specifically, the reaching exercises in standing position train the one-leg standing strategies and the balance control in the swing phase of the gait cycle and in the step strategies (Figure 1).
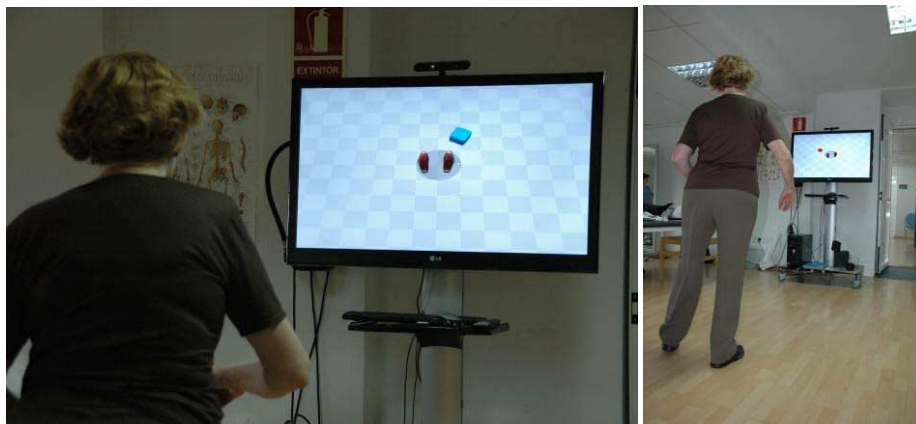
Figure 1. Photograph of a patient testing the system. The patient's feet are estimated by the skeleton tracking and transferred to the virtual world, where two shoes represent them. The objective of the exercise is to step on the items that randomly rise from the floor around the patient.

1.3. Intervention

Each participant underwent 20 sessions of 45 minutes each, which consisted of 6 6-minute repetitions with 1-minute break among them, from 3 to 5 sessions per week. All the participants were assessed with the Berg balance scale (BBS) [8], the balance subscale of the Tinetti performance oriented mobility assessment (POMAb) [9] and the Brunnel balance assessment (BBA) [10] at the beginning (initial assessment), at the end (final assessment), and 1 month after treatment (follow-up assessment).

2. Results

Statistical analyses of the within-subject (time) effect showed significant differences between the initial and final assessment in the BBS ($p < 0.01$) but not in the POMAb ($p = 0.08$). A post-hoc analysis of the BBS scores showed significant improvement during the treatment ($p < 0.01$) but not during the follow-up ($p = 0.162$). Regarding the BBA a chi-square test also showed statistical significance in the percentage of participants (26.6%) that increased their score during the treatment (chi-square=2.5, $p < 0.01$) but no further increases were detected during the follow-up.

Table 2. Results of both scales expressed in number of participants

Scale	Initial assessment (A_i)	Final assessment (A_f)	Follow-up assessment (A_{fu})	Significance
BBS	49.00±6.12	51.73±3.99	52.13±3.60	$A_i<A_f$ (p<0.01)
POMAb	14.60±2.56	15.40±0.74	15.53±0.74	NS
BBA				$A_i<A_f$ (p<0.01)
Level=7	1	0	0	
Level=8	1	1	1	
Level=9	0	0	0	
Level=10	0	0	0	
Level=11	2	1	1	
Level=12	11	13	13	

3. Conclusions

The experimental results showed that the virtual training had a significant time effect in the balance recovery of stroke patients, which is coherent with our previous studies [5]. With regards to the BBS and the BBA, the participants improved significantly between the initial and the final assessment. The improvement in the BBS is especially interesting since it is greater than the minimum detectable change established for chronicity ranging from 6 months to 17 years [11]. However, no significant differences were detected in the POMAb, even though a slight tendency towards significance was detected (p=0.08). Although these results must be taken into account considering the limitations of the study (non-controlled) and the characteristics of the final sample, the chronicity values support the potential benefits of the training even in chronic stages, similarly to recent evidence [12]. The skeleton tracking using a low-cost DS provided similar accuracy to other more expensive tracking systems and made the patients' interaction, and consequently their rehabilitation, possible. The therapists highlighted its easy and speed of use. Future studies will include usability questionnaires to deeply evaluate these aspects.

Acknowledgements

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Effectiveness Evaluation for Short-Term Group Pre-Deployment VR Computer-Assisted Stress Inoculation Training Provided to Polish ISAF Soldiers

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Abstract. The goal of this study was to assess effectiveness of a short collective stress inoculation training (SIT) conducted according to the methodology of the Virtual Reality Medical Center of San Diego (Training of Physiological Control Exposure to Virtual Stressor while Maintaining Physiological Control). The results obtained indicate a short-term effectiveness of the training as a method of tension reduction. However, in the long-term perspective these results are ambiguous and they suggest a need of further research. In order to extend the analysis effects of temperamental factors on training effectiveness was presented.

Keywords. Stress Inoculation Training (SIT), military psychiatry, Polish Military Contingent ISAF Afghanistan

Introduction

A review of the references shows that one of effective methods of both prevention and treatment of PTSD developed as a result of participation in military deployments is use of virtual reality. Especially a combination of SIT with a VR exposure improves skills in coping with difficult situations in military conditions, providing a possibility of gradual and controlled exercising of techniques needed in conditions similar to a battlefield situation. The Stress Inoculation Training method, developed by the Virtual Reality Medical Center (San Diego) allows for a simultaneous exposure in virtual environment and observing physiological indicators. This provides immediate feedback on stress control skills to the participants of the training. Due to conditions similar to those encountered during real military service they are able to cope with stress better and this prevents an occurrence of the above-mentioned mental disorders [1-2].

The goal of the research conducted by us was an assessment of the Stress Inoculation Training (SIT) effect on anxiety measured by means of the Self-Evaluation

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Questionnaire (STAI) as a state and trait in soldiers deployed to Afghanistan (within the ISAF) as well as an effect of additional factors modifying training effectiveness such as temperament, personality or style of coping with stress.

1.   Materials and Method

1.1. Participants

The participants were 118 soldiers, selected randomly from the 1500-strong Polish Military Contingent in Afghanistan and split into two groups of 60 - the experimental group (E) and the control one (C). The age range of the participants was from 21 to 44 years, 112 males and 6 females, who served in the armed forces from 8 to 231 months. Ninety-five soldiers have not been deployed before outside of Poland, 16 were deployed once, 5 - twice and one participant was deployed three times. After their return back home from deployment, 19 months after provision of the training and one year after completion of the deployment, the soldiers were re-examined. This re-examination covered 84 participants - 80 males and 4 females, aged from 23 to 46 years. Forty-five of them were from the experimental group while 39 were from the control one. The soldiers participating in the experiment have been previously qualified for deployment by the Military Medical Commission that has not identified any mental disorders in them.

1.2. Procedure

First both the experimental and the control group listened to a 90-minute lecture on the nature and symptoms of stress as well as ways of coping with it (Introduction to Operational Stress Control). Having listened to the lecture both groups filled test questionnaire: the State-Trait Anxiety Inventory (STAi-2), PTSD Checklist - Military Version (PCL-M), Beck Depression Inventory (BDI-2), Coping Inventory for Stressful Situations (CISS), The Formal Characteristics of Behavior-Temperament Inventory (FCB-TI), NEO-Personality Inventory-Revised (NEO-PI-R) and Tellegen Absorption Scale (TAS). In addition to this participants from the experimental group filled before the training also the Immersive Tendencies Questionnaire (ITQ). Participants in the experimental group, split into 15-strong subgroups, participated for 5 days in a row in ten SIT sessions run according to the methodology developed by the Virtual Reality Medical Center of San Diego (Training of Physiological Control and Exposure to Virtual Stressor while Maintaining Physiological Control). In each of the experimental subgroups one participant participated actively in the training and could move in the virtual reality. The remaining 14 participants were taking part in the training without monitoring of their physiological indicators and they were not able to control the virtual reality, observing the scenario on the monitor screen. The Behavioral Avoidance Test (measurement of physiological parameters: breathing, heart rate, skin conductance and finger temperature) was conducted in the beginning and in the end of the training. The measurements were conducted during 5-minute „baseline" and „recovery" sessions. A 3-minute virtual reality exposure to stimuli occurring during military missions was provided between these sessions. In that time soldiers from the K group were participating in scheduled training activities in the barracks area. After completion of the SIT both groups filled the STAI questionnaire, and in addition to this the experimental group filled the following questionnaires: Immersion Scale (IS),

Simulator Sickness Questionnaire (SSQ), Presence Questionnaire Revised (PQR). Having completed their deployment to Afghanistan and coming back to Poland - 19 months after the stress inoculation training - the soldiers underwent the self-report examination again, filling the STAI and PCL-M questionnaires and answering to questions of a standardized interview. All participants were informed by a psychologist about conditions and goals of the SIT and expressed their consent for participation in the training.

1.3. Equipment

Three computers and software allowing for audio-video presentation of both Afghanistan's war settings and monitoring of physiological variables were used for the training.

1.4. State-Trait Anxiety Inventory (STAI)

The STAI questionnaire was used in the study. STAI is a tool designed for examination of anxiety understood as a temporal and situation-determined state of an individual as well as anxiety understood as a relatively constant personality trait. STAI consists of two subscales. One of them (X-1) is used to measure anxiety-state while the other (X-2) - to measure anxiety-trait [3].

1.5. The Formal Characteristics of Behavior - Temperament Inventory (FCB-TI)

The FCB-TI questionnaire was used in the study. It is designed for diagnosing the basic, primarily biologically determined dimensions of personality named temperament [4,5].

1.6 The Coping Inventory in Stressful Situations (CISS) questionnaire

Also the CISS questionnaire, used to determine behaviour patterns of an individual in stressful situations, was used in the study. This questionnaire consists of 48 simple statements referring to various patterns of behaviour used by people in stressful situations [6].

1.7 PTSD Checklist- military (PCL-M)

The PTSD Checklist – military (PCL-M) was used in the study. The PCL is self-report measure of the 17 DSM-IV symptoms of PTSD. The PCL has a variety of purposes, including: screening individuals for PTSD, diagnosing PTSD and monitoring symptom change during and after treatment [7].

2. Effects of the Experiment

Basing upon results of the experiment it may be found out that in a short period of time the training delivered reduced tension in its participants. However, in a longer perspective no differences have been observed between the experimental and control group. In both groups a drop in anxiety-state was observed, indicating other factors than the training provided (a long time between successive phases of the research or their circumstances). Similarly a drop in anxiety-trait, the one declared by the author of

the questionnaire as relatively constant and resistant to easy change, was observed in both groups. The drop in anxiety-trait intensity can be explained referring to the latest research on the Spanish version of the questionnaire that has shown it measures rather an intensity of negative affect than anxiety-trait. [8]. With this understanding of that theoretical construct next hypotheses on importance of the psycho-education provided to both groups (experimental and control group) in the first phase of the research can be set forth to consider it as the cause of the negative affect reduction and effect of a safe return to Poland on intensity of the negative affect in the second phase of the research [9].

Moreover, a detailed analysis of the experimental group was conducted in terms of individual predispositions in order to identify factors that modify effectiveness of stress inoculation training. The training situation can be considered as one of a high intensity of stress connected with a social exposure and assessment of stress resistance in conditions similar to a battlefield situation, and thus this is a situation where temperamental traits become visible to the largest possible extent. So it may be supposed that the experimental group participants mobilised their additional energetic resources and due to this the relationship between anxiety and temperament structure turned out to be clearer in them than in the control group. In the experimental group, both after the training and after coming back home from deployment, the anxiety-state level was positively correlated with emotional reactivity. These results seem to be understandable given the fact that highly reactive persons with high emotional sensitivity and low resistance, respond more intensively to stimuli [10]. On top of this an analysis of individual results for the active participants of the training demonstrated that the participants featuring a more balanced temperament structure had achieved better training effects (near the end of the training they were able to reduce tension level in a more effective way). Therefore it may be expected that the temperamental background is the factor modifying the training effectiveness and that it may facilitate acquisition of arousal reduction skills during the VR SIT [11].

Also the post-deployment intensity level of post-traumatic stress symptoms was examined. In the experimental group they were related more to the emotions-oriented style as well as emotional reactivity and endurance. The results obtained should be treated with cautiousness because of a multitude of factors that may affect the correlation that occurred. [10]

In order to learn to what extent the training provided was useful for the deployed soldiers in their subjective assessment standardized interviews were conducted with the SIT trainees after their return from Afghanistan. They were asked whether they had benefited at the deployment from the skills acquired during the training. Every tenth of them answered, he was training breathing and that this helped him in difficult moments". Also every tenth participant responded, at lower stress levels breathing control was helping slightly but at higher levels it was difficult to focus on breathing". Eight of ten responded that they did not remember much from the training and they were using their own, previously learnt ways of coping with stress". Conditions in which the training was conducted may be responsible for such results. Lack of possibilities of individual training and limited training duration have not allowed to create a belief in the participants on a superiority of the stress coping method proposed to them over their own ways. [9]

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Using Virtual Week To Assess Prospective Memory In Younger And Older Adults

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Abstract. Prospective memory (PM) is the ability to perform future intention. Older adults often present dysfunctions in PM tasks and investigating the nature of their difficulties have critical implication for their indipendent living. Virtual Week is a computer based program that simulate real week activities. Participants also performed executive functions tasks to investigate which abilities are involved in PM. Virtual Week has shown to be suitable instrument to evaluate PM performance with important implications on assessment and rehabilitation of PM dysfunctions.

Keywords. Prospective Memory, Aging, Virtual Week, Executive Functions, Working Memory, Ecological Validity.

1. Introduction

The capacity to direct our future behaviour has fundamental importance to develop and maintain an independent and autonomous lifestyle. Particularly important is the ability to remember to perform an action in a specific future time; this ability is called prospective memory (PM) [1]. The variety of PM situation has been categorized into event-based and time-based PM tasks, depending on whether the intended action is trigged by an external cue that guide the remembering (event-based PM tasks) or guided by temporal event (time-based PM tasks) [2]. Studies on PM are relevant because successful performances in real life PM activities (i.e. remembering to turn off the oven or remembering to buy soap at the grocery store) are important features of whether a person is able to lead an independent life. This is particularly true for older adults, who often have health-related PM needs (remembering to take medication after lunch or remembering the appointment at 4 pm with the doctor); problems in PM could threaten independent living [3, 4]. Therefore, it is important to fully understand PM performance in older adults as it has social and clinical implication to improve their independence and normal living.

Despite the growing of studies on PM with older adults, most of them are laboratory-based and suffer from the limitation of being not representative of daily life [3, 4]. Virtual Week [5] was developed as a laboratory PM task that would more closely represent PM tasks in everyday life. Virtual Week simulates daily life activities in a board game, in which participants move around the board with the roll of a dice.

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As participants move around the board, they are required to make choices about plausible daily activities and remember to carry out lifelike activities. The full version includes seven days (from Monday to Sunday) but the number of days can be reduced as well as the task difficulty that can be modified according to the experimental design without affecting the reliability [4, 5]. Strength of Virtual Week is to include within the same virtual day, both event- and time-based tasks and also regular and irregular activities that give information about possible learning effect on regular tasks. Regular activities refer to routine and recurring activities whereas irregular activities are to refer to tasks rather than change every day.

Virtual Week has been widely employed with normal and clinical population [4] and our study is the first study conducted with Italian population. We have invested this task considering the experimental and clinical potentiality. Virtual Week has strong psychometric properties [4, 5] and it is also particularly intuitive for users, which are important features when working with older adults or clinical populations.

Specifically in this study, we investigate PM performance in younger and older adults and we expected that time-based and irregular activities would increase age-related differences in PM performance. This is consistent with the notion that PM cues, which are guided by a self-initiated process and which occur less regularly, may be less likely to be spontaneously retrieved. Moreover, we included neuropsychological tasks (Stroop, N-back and SART) to investigate the involvement of high executive functions on PM performance. We expected that differences in executive abilities would be related to differences in PM performance: participants with lower executive abilities would show less efficient PM performance.

2. Method

2.1 Procedure

Older adults were recruited thought the community of Padova (Italy) and tested in their own home. Younger adults were University students and tested at Department of General Psychology of Padova (Italy). Participants were tested in two sessions that lasted approximately 50 minutes. In the first session participants performed Virtual Week and in the second session executive functions tasks: Stroop, N-back task and Sustained Attention to Response Task (SART). All tasks were presented on a 15-inch computer monitor and participants were seated approximately 60 cm away from the computer screen. E-prime 2.0 was used to program and present executive functions tasks. Informed consents were signed at the first session.

2.2 Participants

Twenty-four older adults (mean age = 66.14 SD = 5.43) and 42 younger adults (mean age = 23.05, SD = 2.14) were involved in the study [t(64)=41.67, p<.001, d=10.44]. Mean education for older adults was 12.42 year (SD=3.98; range=5-18) whereas for younger adults was 15.76 year (DS=1.85; range=13-18) [t(64)=4.64, p<.001, d=1.07]. For older adults a score over 24 on Mini-Mental State Examination (MMSE) was required to exclude cognitive impairment (mean score of 27.4; SD=1.67).

2.3 Materials

2.3.1 Prospective memory task

Virtual Week is a computer board game that simulates real life activities (Figure 1). Participants move around the board by pressing the dice at the center of the board, above and below the dice are placed two clocks: the virtual clock which increases 15 min every 2 squares and the stop clock which shows the real time. Along the board are 10 places of green squares labeled with "E"; every time the token lands or passes through the green square, participants are required to select an event card. The event cards described specific activities relevant for the game. Participants performed 5 virtual days (from Monday to Friday) in which were required to execute future activity assigned by computer program. Every day participants were required to perform 4 regular activities (i.e. remembering to take medications) and 4 irregular activities (i.e. remembering to pick up the dry cleaning); half of the regular and irregular activities were event-based (triggered by the event card; i.e. taking medication at breakfast) or time-based (triggered by the virtual clock; i.e. calling the doctor at 1 pm) tasks.
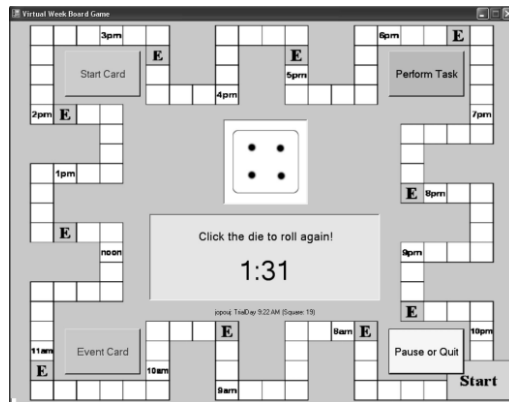
Figure 1 Screen of the Virtual Week game.

2.3.2 Executive functions tasks

The *Stroop task* was administrated to tap inhibition. Each trial contained three of four words (RED, YELLOW, GREEN, or BLUE) the central word was colored in red, yellow, green, or blue and was the target stimulus, whereas the two lateral words were always black. Participants were instructed to identify the color of the central word by pressing a key on the keyboard marked with an arrow pointing either right (←) or left (→), depending on the position of the correct response word (in black). Forty-eight stimuli were presented in the congruent and in the incongruent conditions (for a total of 96 stimuli), and an equal number of correct responses were presented in the right or left side. The *N-bask task* was administrated to tap working memory. Common bi-syllabic words were presented centrally on the computer screen. Participants were instructed to press the left mouse key to indicate when they recognized a word that was the same as one of the 3 words back. The *SART task* was included to tap sustain attention and included the presentation of numbers (from 1 to 9) one at the time at the center of the

computer screen. Participants required pressing a designed key every time a number was presented except for the number 3.

3. Results and Discussion

Participants took between 5 and 12 min to complete each virtual day; younger adults were faster than older adults (mean time to perform one day 10.84 vs. 5.68 min; $p<.001$); overall, all participants became faster as they played the game showing that also older adults became more practiced with the game (Older adults: 12.67, 11.20, 10.27, 10.23 and 9.23; Younger adults; 6.69, 5.75, 5.34, 5.30 and 5.30; $p<.001$).

Participants' PM responses were judged to be correct if they were made before the next dice roll following the target time or event and percentage of accurate responses were included in the analysis. Data were subjected to a 2×2×2 mixed ANOVA that included the between-subject group (older vs. younger) and within factors type of activity (regular vs. irregular) and type of task (event vs. time). The data revealed significant effect of group [$F(1,64)=96.12$, $p<.001$; 52% vs. 87%], type of activity [$F(1,128)=33.18$, $p<.001$; 74% vs. 65%] and type of task [$F(2,128)=239.60$, $p<.001$; 85% vs. 54%]. Significant interaction group and type of task was also found [$F(2,128)=77.01$, $p<.001$] (Figure 2a). Younger adults equally performed event- and time-based tasks; older adults were generally less accurate in particular when performed time-based tasks.
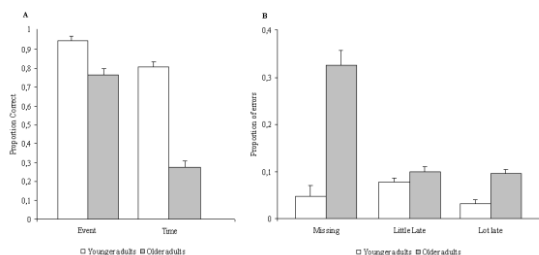
Figure 2 (A) Mean proportions of correct responses by each group for the two types of PM tasks (event vs. time). (B) Mean proportions of errors by each group for the three types of errors.

We also analysed the characteristics of the errors separately for the number of missing, somewhat late and very late responses taking into consideration when the response occurred after the expected event or time (somewhat late or very late) or if the participants completely forgot to perform the activity (missing). A 2×3 mixed ANOVA was conducted with the between variable of group (TBI, controls) and within variable of type of error (missing, somewhat, very late responses). Significant effect of type of error was found [$F(2,128)=23.92$, $p<.001$; 18%, 8% and 6%] likewise significant interaction with group [$F(2,128)=27.19$, $p<.001$](Figure 2b). Older adults made more missing compare to little late or lot late errors indicating that older participants were not able to retrieve the target information even after some time. On the other hand, younger participants made more little late errors indicating that younger participants were able to retrieve the target.

Analysis of executive functions tasks showed general impairment in older adults compared to younger participants; older adults were less able to inhibit irrelevant information calculated as difference between reaction time (RT) in incongruent condition with RT in congruent condition (Stroop task: 243 vs. 168 ms; *p*<.001), made more errors in the n-back task calculated as sum of false alarm and omission (17 vs. 12; *p*<.001) and presented lower sustained attention abilities calculated as number of false alarm in the SART task (6.29 vs. 2.51; *p*<.001). Correlation analysis was conducted between PM accuracy and executive functions tasks. Working memory and sustained attention abilities seem to be the best predictor of PM performance (r=-.612 and r=-.616).

Taken together, our data confirmed PM dysfunctions in older adults and gave additional information on PM performance with virtual based tasks. Older adults were particularly affected by performing time-based tasks and could benefit from task regularity indicating that repeating the same activity regularly every day may reduce their PM impairment. Moreover, we showed significant involvement of executive functions in PM performance. In particular, working memory and sustaining attention are required to accurately perform Virtual Week and presumably are also involved in real life PM activity in which people are required to maintain active in memory the PM activity for a long time.

Virtual Week seems to be a promising task to evaluate PM dysfunctions and it has been successfully employed with different clinical populations [4] and this was the first study that employed Virtual Week with Italian population. The task is a useful tool from experimental and clinical prospective in the way of creating PM tasks that maintain statistical power and similarity with real life. In fact, strength of Virtual Week as a measure of PM is the inclusion of PM tasks that vary in their relative task demands without affecting the psychometric properties. In the context of clinical practice, a differentiated profile of PM impairment is shown with Virtual Week, not only with regard to degree of PM impairment per se, but also the particular circumstances (event- or time-based; regular or irregular activities) in which PM impairment are more likely to arise. Future studies need to be conducted in particular to test ecological validity. All participants gave positive feedback after performing the task and older adults found the program reliable to their daily activities.

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Smiling is Fun: A Coping with Stress and Emotion Regulation Program

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Abstract. Emotional disorders (Anxiety disorders and Mood disorders) are one of the most common health problems worldwide, and their economic costs are very high. People suffering from emotional disorders often use maladaptive emotion regulation strategies and have low coping behaviour that contributes to the presence of clinical symptoms. For this reason, it is important to develop strategies to monitor coping and promote emotion regulation in people exposed to high levels of stress. Information and Communication Technologies (ICT) can help us in this task. Recent systematic reviews of literature on evidence-based CBT treatments delivered via the Internet show that these approaches are effective. We have developed an intervention program ICT based: *Coping with Stress and Emotion Regulation Program (Smiling is Fun)*, a self-applied program via the Internet. *Smiling is Fun* follows a transdiagnostic perspective, and it is based on CBT techniques. However, it also includes other psychological strategies to improve positive mood. The aim of the present work is to describe *Smiling is Fun* and the study designed to test its efficacy.

Keywords. cognitive-behavioural treatment, Internet based therapy, emotional disorders, transdiagnostic approach, emotion regulation, positive mood, behavioural activation.

Introduction

Emotional disorders are one of the most common health problems worldwide, and their economic costs are very high. It is known that 25% of all human beings will suffer from a depression at any moment over their lives [1] and, according to the World Health Organization [2], depression will become the second most important cause of disability in 2020. These data underscore the importance of designing tools to identify people at risk. There is a significant relationship between depression, stress, and coping

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[3]. Also, people with emotional disorders often use maladaptive emotion regulation strategies and have low coping behaviour that contribute to the presence of clinical symptoms [4]. For this reason, it is important to develop strategies to monitor coping and promote emotion regulation in people exposed to high levels of stress. Recent systematic reviews of literature on evidence-based CBT treatments delivered via the Internet show that these approaches are effective [5], [6]. Taking all this into consideration, within the framework of the OPTIMI project *(Online Predictive Tools for Intervention in Mental Illness),* financed by the 7th Framework of the European Union, we have designed tools based on the new Information and Communication Technologies (ICT) for early detection and prevention of depression. The central hypothesis of the OPTIMI project is that there is a significant relationship between depression, stress, and the person's coping ability. Some cognitive, behavioral, and physiological monitoring tools have been developed using heart rate sensors, activity, EEG, etc. Furthermore, we have developed an assessment and treatment protocol ICT based: *Coping with Stress and Emotion Regulation Program (Smiling is Fun),* a self-applied program via the Internet that tries to help people in the prevention of depression and anxiety symptoms, and in the promotion of emotion regulation. *Smiling is Fun* follows a transdiagnostic perspective [4] and is based on classical CBT techniques, and behavioural activation [7]. However, it also includes other psychological strategies to improve positive mood [8]. The aim of the present work is to describe the *Smiling is Fun* system and the study that is being conducted to test its efficacy and efficiency.

1. Method

1.1. Participants

Out of the 205 people who called, 60 met the inclusion criteria and were included in this study. Participants considered for inclusion are unemployed men who are suffering stress due to their financial concerns, family burden, and lack of employment. They had to be aged 18–65 years, willing to participate in the study, able to understand the goals of the study and to give informed consent, and able to use a computer and the Internet in order to access the Program. Exclusion criteria includes proneness to skin allergies that might be exacerbated by wearing stick-on sensors, personal history of depression/psychosis (acute BDI II ≥ 19, history of depression/psychosis in any first-degree relative (i.e. parents or children of the participant), heart conditions (could interfere with ECG measurement), epilepsy, daily intake of recreational drugs (cannabis, etc), regular intake of any sleep medication, regular intake of any medication for heart conditions or that might interfere with cardiovascular function (antihypertensives, etc).

1.2. Assessment protocol

- *Socio-demographic variables*. Gender, age, marital status, education, occupation and economical level.

- *Beck Depression Inventory II*. This is one of the most widely questionnaires used to evaluate severity of depression in pharmacological and psychotherapy trials. Furthermore the participants answered a Suicidal Ideation Question.

- *Mini-International Neuropsychiatric Interview (MINI).* This is a short structured diagnostic psychiatric interview that yields key DSM-IV and ICD-10 diagnoses.

- *Overall Depression Severity and Impairment Scale.* OASIS consists of 5 items that measure the frequency and severity of anxiety, as well as level of avoidance, work/ school/home interference, and social interference associated with anxiety.

- *Overall Depression Severity and Impairment Scale.* ODSIS is a self-report measure consists of 5 items. In this case, evaluating experiences related to depression. ODSIS measure the frequency and severity of depression, as well as level of avoidance, work/ school/home interference, and social interference associated with depression.

- *Positive and Negative Affect Scale.* PANAS consists of 20 items that evaluate two independent dimensions: *positive affect* (PA) and *negative affect* (NA). The range for each scale (10 items on each) is 10 to 50.

- *Brief Cope.* Ii is a self-report questionnaire used to assess a number of different coping behaviors and thoughts a person may have in response to a specific situation.

- *Multicultural Quality of Life Index.* It is a self-administered questionnaire that uses 10 items to assess global perception of quality of life in addition to physical and emotional well-being, self-care, occupational and interpersonal functioning, community and services support and personal and spiritual fulfillment.

- *Perceived Stress Scale.* The PSS is a 14-item self-report questionnaire that assesses the degree to which recent life situations are appraised as stressful.

1.3. Design and treatment

The present work is a between-group design with three experimental conditions: 1) Intervention program plus sensors. Participants in this condition have access to the CCBT Intervention Program and use the sensors (IP+S: CCBT, N=20), 2) Intervention program. Participants in this condition have access to the CCBT Intervention Program only (IP: CCBT, N=20), and 3) Waiting list control condition. Participants in this condition do not have access to the sensors nor the CCBT Intervention Program (C, N=20). There are five assessment moments: Pre treatment, Post treatment, three, six, and twelve month follow-ups.

The treatment program (*Smiling is Fun*) is an internet-delivered, multimedia, interactive, self-help program for emotional disorders, which will allow the individual to learn and practice adaptive ways to cope with depression and daily problems. Each module includes exercises to practice such techniques. The program includes a **Home module,** which contains a number of elements to explain very simply what *Smiling is Fun* is, and its goal, who can benefit from this, use conditions acceptance and who we are; A **Welcome module** which provides the user with information about the content of the modules that are included in the program, and recommendations for the user to benefit maximally from it; and eight treatment modules: (1) **Motivation for change,**

whose aim is to analyze the advantages and disadvantages of changing, emphasizing the importance of being motivated, (2) **Understanding emotional problems,** that provides information to recognize and understand the emotional problems, (3) **Learning to move on,** that focuses on behaviour activation by teaching the importance of "moving on" to acquire a proper level of activity and involvement in life, (4) **Learning to be flexible,** which aims to teach a more flexible way of thinking and to interpret situations and learning to think about different alternatives, (5) **Learning to enjoy.** This module focuses on the importance that generate positive emotions, promoting the involvement in pleasant and significant activities, and contact with other people, (6) **Learning to live,** that focuses on understanding the importance of identifying the individual's own psychological strengths and selecting and carrying out meaningful activities linked to values and goals in life, (7) **Living and learning:** This module focuses on developing an action plan to boost the individual psychological strengths, (8) **From now on, what else…?,** which aims to go on and strengthen what has been learnt during the program.

The program emphasizes on 'what you know can help you', and uses two essential tools: 1) **Activity report** (see Figure 1) for self-monitoring, its aim is to provide feedback to the user and help him see that his mood is related to the activities performed and also the benefits of being active are greater to the extent that activities are meaningful to him. So the user is encouraged to come every day in the program and complete it. 2) **"How am I?"** This tool offers a set of graphs and feedbacks to chart the user's progress.

Figure 1. Activity report.

1.4. Procedure

First, participants were recruited via announcements to the University community, advertisements in the media, Internet, and direct contact with local Job Centres. All volunteers who contacted us had to answer an online questionnaire which assessed whether they met the minimum requirements to join the study (unemployed men). Next, we called 205 men (pre-screening by phone) to filter the most important exclusion criteria. The participants who went through the pre screening by phone were asked to attend an initial interview. In this interview the Diagnosis of major depression was carried out with MINI International Neuropsychiatric Interview and scoring of

depression using Beck Depression Inventory II. Furthermore, the participants completed the self-report questionnaires, and a screening questionnaire to determine eligibility that is based on the exclusion criteria listed above; a research assistant explained what participation involves and took the participant through the consent procedure. Finally the participants meeting the inclusion criteria (N=60) were randomized to the control group, the intervention group, or the intervention plus sensors group.

Participants from both intervention groups received a weekly phone support call (5 minutes) where they were reminded of the importance of carrying out the activity report, the tasks that are proposed in the different modules, and about the convenience of doing one module per week.

2. Results

At the present moment the work is in progress. Participants keep on doing the treatment program, receiving the clinician support every week over the phone.

3. Discussion

This treatment programme tries to provide an effective help to the people who need it, and it also contributes to the dissemination of evidence-based CBT and practice, according to Kazdin and Blaze's view [9]. We hope to provide data regarding efficacy of this programme and the role developed by the modules designed to promote positive affect. Also, future research should study other important issues such as: why do some users drop out before completing the program? What amount and type of support by the clinician is needed?

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The Effectiveness of VR Exposure Therapy for PTSD in Returning Warfighters

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Abstract. In the decade following the attack on the World Trade Center, over 2.3 million American military personnel were deployed to Iraq and Afghanistan. Lengthy tours of duty and multiple re-deployments were characteristic of these operations. Research findings demonstrate that prolonged exposure to combat increases the risk of developing posttraumatic stress disorder (PTSD). The current study was a randomized controlled clinical trial designed to assess the effectiveness of a novel intervention to treat combat-related PTSD in returning Operation Iraqi Freedom (OIF) and Operation Enduring Freedom (OEF) warfighters. A cognitive behavior treatment approach augmented with virtual reality exposure therapy (VRE) was developed, and administered for 10 treatment sessions over 5 weeks. Comparisons with a control group receiving minimal attention (MA) for 5 weeks revealed that the VRE group had significant reductions in the avoidance/numbing symptoms on the Clinician Administered PTSD Scale (CAPS). The VRE group also had significant reductions in guilt at post-treatment compared to the control group.

Keywords. Virtual reality, PTSD, exposure therapy, combat

Introduction

The recent conflicts in Iraq (OIF), and Afghanistan (OEF), have been among the most protracted military campaigns in United States history. More than 2.3 million American men and women service members have served in Iraq, Afghanistan, or both since 2001.[1] Prolonged exposure to the stressors of combat due to lengthy tours of duty and multiple re-deployments places the warfighter at high risk of developing posttraumatic stress disorder (PTSD). An estimated 12%-18% of returning OIF and OEF warfighters were assessed to have had probable PTSD at post-deployment.[2] Moreover, this rate was maintained or increased over time.

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Treatment of PTSD in OIF and OEF warfighters is particularly challenging, because of the high co-morbidity with other mental and physical health conditions and their PTSD. Avoidance of the memories of the traumatic event, hyperarousal, nightmares, flashbacks, irritability, and guilt are common symptoms of PTSD. Research findings support the effectiveness of exposure-based cognitive behavior therapy (CBT) in reducing PTSD symptoms.[3]

Investigations of the use of virtual reality (VR) exposure as an augmentation to the treatment of combat-related PTSD have yielded promising results. A recent randomized controlled study reported a significant decrease in PTSD symptom severity in active duty military personnel with graded VR exposure treatment compared to treatment as usual.[4] Similar findings were reported in a study of returning OIF and OEF soldiers who were treated with VR exposure therapy. PTSD symptoms at post-treatment were significantly reduced compared to pre-treatment symptoms.[5] While these and other research support the effectiveness of VRE treatment for combat-related PTSD more randomized controlled trials with larger samples are needed.

This randomized controlled study assessed the effectiveness of CBT with immersive VR exposure in reducing combat-related PTSD symptoms in OIF and OEF service members compared to a non-treatment control group of OIF and OEF service members with PTSD.

1. Methods

1.1. Sample

Male (n=94) and female (n=5) active duty service members with PTSD symptoms who participated in military operations in Iraq or Afghanistan volunteered for this study. After the initial screening, 64 OIF and OEF warfighters met the eligibility criteria for enrollment, and underwent further assessment, Forty-two participants met the criteria for random assignment to one of two study conditions, the Virtual Reality Exposure (VRE) treatment condition (n=29) or the Minimal Attention (MA) control condition (n=13). A total of 22 participants completed the study (VRE=12 and MA=10).

1.2. Measures

Multiple measures were used to assess treatment outcomes. These included the Clinician Administered PTSD Scale (CAPS), PTSD Diagnostic Scale (PDS), Beck Depression Inventory II (BDI-II), Quality of Life Inventory (QOLI), and the Trauma-Related Guilt Inventory (TRGI). All measures were administered before and after the VRE treatment, and the MA control procedures.

1.3. Procedures

A two-group, pre-post experimental design was used for this randomized controlled clinical trial. Eligible participants who were randomly assigned to the VRE condition received 10 treatment sessions (2 sessions per week for 5 weeks) with VR exposure in

Sessions 2-10. Information about the treatment program, description of the traumatic event, and breathing exercise training were the focus of Session 1. MA control group participants received minimal attention, i.e., brief telephone contacts, every 2 weeks for 5 weeks to assess safety and to affirm their continued interest in study participation. Prior to enrollment participants in the MA condition were informed that VRE treatment would be available to them after completing the MA procedures, if desired.

During the VRE treatment sessions participants viewed a 3D computer-generated combat environment through a high resolution stereoscopic helmet with a head tracker, which enabled them to "look around" in the VR environment. Study therapists who received training on a manualized CBT treatment protocol with VRE exposure guided the VRE participants through the treatment procedures. A computer keyboard interface enabled the therapists to select the type of stimuli participants were exposed to, and to control the intensity and duration of the visual, auditory, and kinesthetic stimuli that participants experienced. Participant levels of distress were assessed regularly throughout each VR session.

The study protocol was approved by the Human Use Committee at Tripler Army Medical Center and the Institutional Review Board at the Veterans Affairs Pacific Islands Healthcare System. Investigators adhered to the policies for protection of human subjects as prescribed in 45 U.S. Code of Federal Regulations 46.

2. Results

There was a high attrition rate, 47.6%, among the randomized participants, which limited data analysis. The pre- and post-test mean scores and standard deviations for the VRE and MA groups on the study outcome measures are shown in Table 1.

**Table 1.** VRE and MA Groups Pre-Post Score Means and Standard Deviations on All Outcome Measures

Outcome Measure	VRE (n=10)		MA (n=12)	
	Pre (Mean/SD)	Post (Mean/SD)	Pre (Mean/SD)	Post (Mean/SD)
CAPS (total)	72.2 (17.07)	58.9 (23.29)	75.0 (19.29)	71.17 (25.41)
PDS (sxs severity)	33.4 (9.88)	27.3 (13.29)	30.75 (10.38)	25.25 (12.02)
BDI-II	25.5 (13.34)	23.7 (11.72)	24.58 (11.74)	22.67 (10.83)
QOLI (overall)	2.10 (1.20)	1.80 (1.03)	1.83 (1.27)	2.08 (1.31)
TRGI	51.40 (23.04)	37.30 (21.21)	52.25 (20.58)	52.25 (23.54)

A repeated measures analysis of variance (ANOVA) was conducted to compare the effect of VRE and MA on the outcome measures. No significant difference was found between groups on the pre-post CAPS total score, $F(1, 20) = 1.214$, $p = 0.284$. However, there was a significant decrease over time on the CAPS Criterion C (avoidance/numbing symptoms) in the VRE group ($F(1,20) = 6.03$, $p=.02$). A significant interaction effect was found between the VRE (treatment) and MA (control) groups on avoidance/numbing symptoms over time. The VRE group scored significantly lower on the CAPS Criterion C compared to the MA group at post-procedures ($F(1, 20) = 8.705$, $p = 0.008$).

Similarly, a repeated measures ANOVA revealed a significant decrease of trauma-related guilt (TRGI total score) in the VRE group at post-condition, and a significant interaction effect of VRE treatment on TRGI total score over time ($F(1, 20) = 4.858$, $p=.04$). The VRE group scored significantly lower on TRGI total score at post-condition compared to the MA group (see Figure 1).

No significant differences were found on the PDS, BDI-II, and QOLI outcome measures.
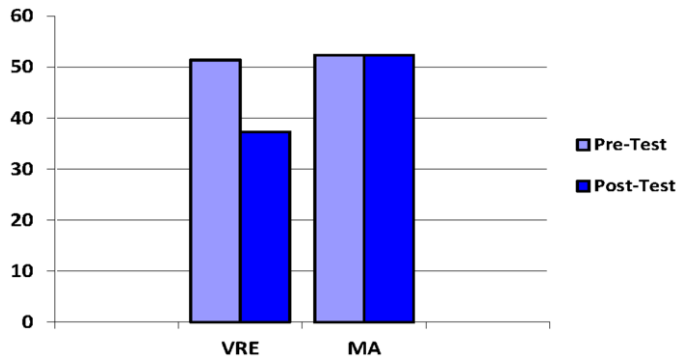
Figure 1. VRE and MA Groups Mean Pre-Post TRGI Total Scores

3. Discussion

The results of this study suggest that the augmentation of CBT with VR exposure may be effective in reducing some PTSD symptoms in active duty service members returning from combat theaters. OIF and OEF warfighters in the VRE group reported significant reductions in avoidance and numbing symptoms that are characteristic of PTSD. Suppression of unwanted thoughts and intense emotions associated with the traumatic event are frequently used as coping strategies, which tend to become less effective over time. Graded exposure to immersive VR environments of commonly experienced combat situations during CBT appeared to facilitate cognitive restructuring of maladaptive interpretations of visual, auditory and kinesthetic stimuli, which decreased anxiety and avoidant behaviors.

Additional support for the effectiveness of VRE in treating combat PTSD was revealed by the significant reduction in trauma-related guilt in the VRE treatment group compared to the MA control group. It is not uncommon for returning warfighters to be burdened by feelings of guilt for having survived the challenges of war. With repeated exposure to the simulated combat events while guided by a trained therapist, VRE treatment allowed warfighters with PTSD to discuss their combat memories in a safe, therapeutic setting where new and more adaptive feelings and thoughts about the traumatic events encountered during combat could be developed.

The study outcomes provide further evidence for the use of VRE to treat PTSD, but the small sample size of study completers, and high attrition rate from enrollment to completion make it difficult to determine how these limitations may have impacted the study findings. Further research, particularly randomized controlled trials with larger samples, is needed to substantiate the effectiveness of CBT augmented by VR exposure on the treatment of combat-related PTSD.

Acknowledgements and Disclaimer

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Bottom-Up and Top-Down Influences of Beliefs on Emotional Responses: Fear of Heights in a Virtual Environment

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Abstract. According to cognitive approaches in emotion research, emotions hinge on beliefs that can be true or false. We suggest that emotionally relevant beliefs can be influenced bottom-up e.g. by the depth cues of a virtual environment or top-down e.g. by reappraisal strategies. Our research question is if bottom-up and top-down processes influence the same belief structure or if different belief structures are responsible for bottom-up and top-down influences on emotions. To test these assumptions we exposed participants to a virtual environment that is able to elicit fear of heights and manipulated reappraisal for half of the participants. Moreover, we presented virtual scenes of heights in a monoscopic (less depth cues) and stereoscopic (more depth cues) mode in order to influence the confirmatory processes that are associated with beliefs. Subjective intensity of discomfort and the bending angle as a behavioural response were measured. We observed that although the depth cues and the reappraisal strategy were both effective in reducing the feeling of discomfort, reappraisal and the mode of presentation exert independent effects. Thus, beliefs that are triggered by bottom-up processes (depth cues) change emotions independent of the beliefs triggered by top-down processes (reappraisal).

Keywords. Virtual Reality, height phobia, reappraisal

Introduction

An exciting feature of emotions eliciting events is that they can have the potential to automatically draw attention so that one gets immersed in the emotional eliciting event [1, 2]. However, it is suggested that emotional responses are based on beliefs and are influenced by both top-down and bottom-up processes [3]. But how are beliefs influenced by bottom-up processes? If medias such as pictures, movies or narratives elicit emotions a decisive factor is whether the perceptual input is similar to the natural environment or not. Based on these assumptions, we think that a stereoscopically presented virtual environment is more similar to our natural environment than a monoscopic one of the same sensory input. On the other hand, beliefs are not only

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influenced by the perceptual input but by the knowledge a person has. In the current research we will test the idea that perceptual bottom-up processes and conceptual top-down processes exert a joint influence on beliefs, which in turn determines the emotional response.

1. Methods

1.1 Participants

Participants were 56 paid (10€) volunteers (34 women, mean age: 35.5 years, *SD* = 11.1) recruited through newspaper articles informing about a research project on height phobia at the University of Würzburg, Germany. At the time of recruitment each respondent was screened for DSM IV [4] criteria of specific phobia (height).

1.2 Procedure

After obtaining informed consent, participants received written information about the simulation. This information also stressed that they would get further important information before the first height situation; this was done to already increase attentiveness to the particular instruction of emotion regulation. Then the Acrophobia Questionnaire (AQ) was assessed [5], and the Head Mounted Display (HMD) and the earphones were explained and adjusted. Having controlled and adjusted the image, the light was switched off and a short test followed to verify that the stereoscopic picture was perceived correctly. Then the simulation was started. Halfway through there was a short break of about five minutes, in which participants could take a short rest. The mode of stereoscopy was switched before the second part started. Having completed the experiment, participants were asked if they had realized a difference in the simulation between the two parts; this was done to assess whether they had been aware of the variation in the impression of spatial depth. After the experiment, participants were informed about the background of the study and received a brochure about fear of heights and possible treatment (available on request). Finally, participants received 10 € for their participation. The duration was about 90 minutes.

1.3 Simulation

First, a street scene was presented to get participants accustomed to the virtual environment and to moving with the HMD (30 seconds). The scene consisted of a street with houses on each side, and participants were instructed to look around in all directions. This was followed by the first baseline scene, in which they were also situated on a street. Scheduling and instructions were the same as in the height scenes.
After the assessment of the baseline, a black screen emerged (10 seconds), followed by the written instructions for the respective emotion regulation strategy, which were simultaneously presented over the earphones (see below for instructions). Following verification that participants were able to comprehend the instructions, the first height scene was presented: participants found themselves on a roof (approx. 15 meters high) at a distance of 10 cm from the edge. One could see buildings of the same height across the street. On the same side of the street were trees to the viewer's left and right sides, from which branches loomed into the field of vision. Participants were first asked to

look around to the left and to the right side (10 seconds). This was meant to make them more aware of their position and the height. Then they were asked to look at a cross that was placed on the opposite street at the approximate height of a building's first floor (distance: approx. 15 meters). They were asked to keep the cross in the middle of their perceptual field, which required looking down at an angle of 25 degrees (50 seconds). After that, participants were asked for their subjective rating of their present fear. Subsequently, the Behavioural Avoidance Test was assessed: participants were asked to bend forward following an acoustic signal and to look at a second cross as long as possible (max. 10 seconds). The cross was located on the same side of the street directly below them (76° downwards). The total duration of this trial was 85 seconds.

Following the completion of the presentation of the first scene, the next scene was presented after a short break (black display). Each scene started with a repetition of the emotion regulation instruction.

1.4 Manipulations (Dependent variables)

Emotion Regulation was manipulated between subjects. The two independent groups received the following instructions. For Acceptance*:* "Please let the following situations just have their effect on you and just allow feelings to emerge!" and for Reappraisal: "Please keep in mind that you are situated only in a virtual environment in the following scenes. Everything you can see is generated by a computer program." These instructions were repeated for each scene.

Stereoscopy was used to manipulate the degree of the impression of spatial depth. In this technique, a pair of 2-D images that slightly deviate laterally according to the parallax are presented to the eyes. This corresponds to the perspective that both eyes naturally receive: because of the eye base, two slightly different pictures are represented on the retina. Parallax and the processing of these two different pictures contribute largely to the formation of three-dimensional pictures. In our experiment the stereoscopic presentation could be switched off, so that the same picture was presented to both eyes (monoscopic mode), which resulted in a lower impression of spatial depth.

1.5 Dependent measures

Rating of Discomfort: In each of the twelve scenes, participants were asked to rate their present level of fear on a scale ranging from 0 (no fear) to 100 (maximum fear). They were asked after having looked at the first cross for 50 seconds.

Behavioural Measure: After the acoustic signal, participants were required to bend down in order to see the second cross. The continuously recorded bending angle was averaged across a time interval of 10 seconds after the acoustic signal.

1.6 Laboratory and apparatus

The experiment was conducted in a laboratory of the Psychology Department at the University of Würzburg. A Z800 HMD (eMagin, Bellevue, Washington, USA) was used to present the virtual scenes. The head motion data measurement used for adaptation of the presented picture was done by the Fast-track tracking device (Polhemus, Colchester, Vermont, USA). The process of the simulation was controlled by an in house virtual reality interface, the rendering by the Source Engine (Valve, Bellevue, Washington, USA).

2. Results

Ratings of Discomfort: The rating of each height situation was subtracted from the rating of the first baseline situation. A 2 x 2 x 2 ANOVA of the ratings included *Emotion Regulation* (acceptance vs. reappraisal) and *Order of Spatial Depth* (mono-first vs. stereoscopic first) as between-subjects factors and *Spatial Depth* (mono- vs. stereoscopic) as within-subjects factor. This analysis revealed that participants in the acceptance condition ($M = 23.3$) reported more discomfort than those in the reappraisal condition ($M = 12.6$), $F(1,53) = 6.83$, $p < .01$. Moreover, participants in the stereoscopic condition reported marginally significant more discomfort ($M = 18.7$) than those in the monoscopic condition ($M = 16.9$), $F(1,53) = 3.0$, $p = .08$. *Order of Spatial Depth* had no reliable effect on the ratings, $F < 1.7$. No interaction of *Emotion Regulation* x *Spatial Depth* was obtained $F < 1$. This indicates that *Emotion Regulation* and *Spatial Depth* trigger independent mechanisms.

Table 1: *Ratings of Discomfort and Behavioural Responses as a Function of Spatial Depth and Reappraisal.*

	Ratings of Discomfort		Behavioural Responses	
	Monoscopic	Stereoscopic	Monoscopic	Stereoscopic
Acceptance	22.5 (16.5)	23.8 (17.6)	57.7 (9.48)	56.7 (8.46)
Reappraisal	11.6 (12.1)	13.9 (15.8)	60.6 (6.39)	60.5 (7.51)

Note. Ratings of Discomfort are baseline corrected and indicate the increase of discomfort on a scale between 0 and 100. Behavioural Response refers to the bending angle (in degrees). We present Means (*SD*).

Behavioural Responses: The 2 x 2 ANOVA of the Bending Angle, including *Emotion Regulation* (acceptance vs. reappraisal) and *Spatial Depth* (mono- vs. stereoscopic) as independent variable, revealed a marginally significant main effect of *Emotion Regulation*, $F(1,53) = 3.05$, $p = .08$, indicating that the bending angle during Reappraisal was larger ($M = 60.5$) than during Acceptance ($M = 57.3$). No reliable effect was obtained for *Spatial Depth* or the Interaction of *Spatial Depth* x *Emotion Regulation*, all $F < 1$. Moreover, the interaction of *Order of Spatial Depth* and *Spatial Depth* was significant, $F(1,53) = 23$, $p < .001$. This effect is due to a smaller bending angle in the monoscopic ($M = 57.9$) than in the stereoscopic condition ($M = 61.5$) in the setup where participants started with the monoscopic condition. By contrast, when they started with the stereoscopic condition the bending angle in the monoscopic condition ($M = 60.4$) was larger than in the stereoscopic condition ($M = 55.8$). This indicates that with increasing practice participants increased the bending angle. No other reliable interaction effect was obtained, all $F < 1.3$.

3. Conclusions

We proposed that emotionally relevant beliefs can be influenced bottom-up by depth cues of a virtual environment or top-down by reappraisal strategies. Our research question was if depth cues and reappraisal influence the same belief structures. We found that the stereoscopic presentation of the height situation elicited stronger feelings of discomfort than the monoscopic condition. Moreover, keeping in mind that the virtual abysms are not real also decreased the feelings of discomfort. However, we did not find any evidence for an interaction of top-down and bottom-up processing on

feelings of discomfort. This suggests that different beliefs are responsible for the impact of bottom-up and top-down influences on emotional responses. From an evolutionary point of view, it makes sense that bottom-up processes vary independent of top-down processes. Otherwise it would be easy to change the perceptual input according to the current concerns, which might have serious consequences.

The behavioural responses to the virtual precipitates were exclusively influenced by reappraisal but not by the spatial depth. Thus, participants bended more into the precipitate in the reappraisal condition than in the acceptance condition.

Participants in the reappraisal condition experienced less discomfort and bent down more to the virtual precipitate than those who accepted their emotional response. Thus, in line with previous research, reappraisal was successful in down regulating negative emotions [6]. The fact that behavioural tendencies are influenced by reappraisal in addition to the subjective response suggests that the obtained effects are not only due to demand effects. Interestingly, our manipulation of spatial depth had an influence on the subjective ratings, but not on the behavioural measure. One possibility is that the manipulation of the spatial depth was too subtle to influence behaviour and other factors such as field of view and sensory qualities have an additional impact. Another interesting possibility is that different processes contribute to the subjective response and to the behavioural tendency. Such dissociations between components of emotions have been repeatedly shown [7]. Thus, the often-obtained dissociation between different components of emotion might be due to the parallel activation of associative and inferential processes that trigger these responses.

Acknowledgements

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Implicit Theory Manipulations Affecting Efficacy of a Smartphone Application Aiding Speech Therapy for Parkinson's Patients

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Abstract. A Smartphone speech-therapy application (STA) is being developed, intended for people with Parkinson's disease (PD) with reduced implicit volume cues. The STA offers visual volume feedback, addressing diminished auditory cues. Users are typically older adults, less familiar with new technology. Domain-specific implicit theories (ITs) have been shown to result in mastery or helpless behaviors. Studies manipulating participants' implicit theories of 'technology' (Study One), and 'ability to affect one's voice' (Study Two), were coordinated with iterative STA test-stages, using patients with PD with prior speech-therapist referrals. Across studies, findings suggest it is possible to manipulate patients' ITs related to engaging with a Smartphone STA. This potentially impacts initial application approach and overall effort using a technology-based therapy.

Keywords. implicit theories, speech therapy, apps, manipulations, Parkinson's

Introduction

Speech impairments affect approximately 70% of people with Parkinson's disease (PD) [1]. Speech volume has been cited within NICE guidelines as treatable with therapy, and that consideration should be given to "ensuring an effective means of communication is maintained throughout the course of the disease, including use of assistive technologies" [2 (p8)]. The Lombard effect is the automatic process whereby speech volume increases in competition with increased background noise [3]. People with PD with impaired speech show deficits incorporating implicit cues to automatically regulate speech volume. Using hypophonic patients with PD, 'over-constancy' of speech volume was found, and failure responding to implicit cues [4]. Speech volume regulation was possible when explicit volume instructions were provided. This main effect of instruction-provision suggests normal volume is possible when conscious attention is paid to speaking loudly. In response to this, a speech-therapy application (STA) has been developed, aiming to provide a visual volume cue.

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With the STA being developed on Smartphone platforms there was an initial concern, due to a stereotype of older adults being less comfortable with technology [5], that uptake of a potentially useful application might be poor.

Implicit theories (ITs), held by an individual, influence their judgements [6]. Having an entity or an incremental theory predisposes individuals to performance or learning goals which, depending on perceived skill level, can result in stronger (mastery) or weaker (helpless) behaviour patterns (Table 1). Mastery behaviour is generally associated with perseverance, whereas helpless behaviour is associated with task avoidance. Several domains of ITs have been shown, for example judgements and relationships [6,7]. Also, IT manipulations have been found both possible and helpful [8], but have not been extensively applied to therapy or cyber psychology.

Table 1. Taken from [9]. Theories, goals and behavior patterns in achievement situations.

Implicit Theory	Goal Orientation	Perceived Present Ability	Behavior Pattern
Entity	Performance	High	Mastery
		Low	Helpless
Incremental	Learning	High or Low	Mastery

While developing the STA, feedback was sought from patients with PD at different time-points, creating the opportunity for the studies described here. Two studies investigated ITs when older adults were being introduced to the STA on a Smartphone device. Across the studies, it was predicted that manipulations of participants' (Ps') ITs within different domains would be possible, and that Ps' approach to the STA would be altered as a result. If it is possible to induce mastery behaviour patterns, this could affect the STA's efficacy.

1. Study One: Manipulating Implicit Theories of Ability with New Technologies

Manipulations of ITs were given to Ps to read, indicating either new technological ability is fixed (thus cannot develop beyond a certain level), or is flexible (thus can grow further with effort). The IT domain of focus was beliefs about using unfamiliar technology. It was predicted that being presented with a manipulation suggesting ability is flexible would result in an increased mastery approach using the STA.

1.1. Participants, Materials and Design

Twelve Ps took part (mean age: 67; mean years since diagnosis: 8). All Ps had been diagnosed with Parkinson's, and had previously received a speech therapy referral.

Materials were: a five-item technology-usage questionnaire; two 'technology ability beliefs' manipulations (one entity and one incremental version; adapted from Hong et al. [8]); a 12-item 'beliefs about ability and new technology' measure (six entity and six incremental items; responses were on a four-point likert-scale marked 'strongly disagree' to 'strongly agree'; adapted from Abd-El-Fattah and Yates's IT Scale [10]); two Apple iPod Touches; and the STA (version A).

A between-subjects design was used. The independent variable (IV) was the manipulation type. The dependent variables (DVs) were responses made to the 'beliefs about ability and new technology' measure, and responses and comments transcribed during a semi-structured interview.

1.2. Procedure

The study took place in a therapy suite at King's College Hospital. All items were presented by a research assistant, with the researcher also present, transcribing any comments made. All Ps first completed the technology questionnaire. Next, Ps were randomly given one of the 'technology ability beliefs' manipulations to read, allocating them to the entity condition (EC) or incremental condition (IC). Manipulations were presented as information sheets on current research, to be read carefully. Then, Ps completed the 'beliefs about ability and new technology' measure. Next, Ps were handed an Apple iPod Touch with the STA preloaded onto the screen, and an additional device was held by the researcher. The researcher demonstrated the different components of the STA on their device, and requested Ps mirror these actions on the device they were holding. As the introduction of each component was completed the research assistant requested Ps to perform tasks utilizing that component, followed by semi-structured interview questions. The researcher recorded responses and comments.

1.3. Results

Six Ps were assigned to each condition. Questionnaire responses by EC Ps showed: four had previously used a touch screen; all owned a mobile phone; and half had an email address. For IC Ps, all six had used a touch screen and owned a mobile phone; and five had their own email address. The 'beliefs about ability and new technology' measure involved a possible score range of 6-24, totaling the likert-scale responses. Entity condition Ps showed a mean agreement of 13.2 for entity items and 19.3 for incremental items. Incremental condition Ps showed a mean agreement of 10.7 for entity items and 20.8 for incremental items.

A thematic analysis [11] was conducted on all Ps' responses and comments. Emerging themes included: 'technology failures' (IC Ps more frequently referring to internal causes); 'planned usage' (IC Ps more frequently making elaborated plans); and 'effort' (IC Ps more frequently endorsing the utility of effort).

2. Study Two: Manipulating Implicit Theories of Ability to Affect One's Voice

Participants read an IT manipulation, indicating either ability to affect one's voice is fixed (thus cannot be much improved), or is flexible (thus can improve further with effort). The IT domain of focus was beliefs about whether voice can be improved through effort. It was predicted that being presented with a manipulation suggesting voice affect is flexible would result in more effortful approaches using the STA.

2.1. Participants, Materials and Design

Ten Ps took part (mean age: 75; mean years since diagnosis: 4), with the same inclusion criteria as Study One.

Materials were: a five-item technology-usage questionnaire; a six-item speech questionnaire; a 12-item 'beliefs about ability and new technology' measure; two 'voice-change ability beliefs' manipulations (one entity and one incremental version, adapted from Hong et al. [8]); an eight-item 'beliefs about speech and voice quality'

measure (four entity and four incremental items; responses on a four-point likert-scale marked 'strongly disagree' to 'strongly agree'; adapted from Dweck's 'Kind of Person' scale [12]); two Apple iPhones; and the STA (version B).

A between-subjects design was used. The IV was the manipulation type. The DVs were responses to the 'beliefs about speech and voice quality' measure, and responses and comments transcribed during a semi-structured interview.

2.2. Procedure

The procedure was similar to Study One, with minor changes. Where possible, the procedure took place in Ps' homes. One participant was met at King's College Hospital. The technology questionnaire was presented, then the 'beliefs about ability and new technology' measure, and then the speech questionnaire. Next, Ps read one of the 'voice-change ability beliefs' manipulations, presented as an information sheet on current research to be read carefully, followed by the 'beliefs about speech and voice quality' measure. Following this, the STA was presented to Ps using Apple iPhones.

2.3. Results

Five Ps were assigned to each condition. Questionnaire responses by EC Ps showed: one participant had previously used a touch screen; all owned a mobile phone; and three had an email address. For IC Ps: one had used a touch screen; three owned a mobile phone; and two had their own email address. Responding to the 'beliefs about ability and new technology' measure, EC Ps showed a mean agreement of 15 for entity items and 20 for incremental items. Incremental condition Ps showed a mean agreement of 15.2 for entity items and 22.2 for incremental items. From the speech questionnaire, 'issues with speech volume' involved a likert-scale of 1-4, from 'none' to 'severe'. Results showed a mean response of 3 for EC Ps and 2.6 for IC Ps. 'Speech problems becoming more of an issue in the future' involved a likert-scale of 1-4, from 'not at all concerned' to 'very concerned'. Results showed a mean response of 2.4 for EC Ps and 2.6 for IC Ps. Responding to the 'beliefs about speech and voice quality' measure (possible score range of 4-16, totaling the likert-scale responses), EC Ps showed a mean agreement of 9 with entity items and 12.6 with incremental items. Incremental condition Ps showed a mean agreement of 8.6 with entity items and 11.6 with incremental items.

A thematic analysis was conducted on all Ps' responses and comments. This analysis centered on themes found in Study One. Emerging themes included: 'voice failures' (EC Ps less frequently acknowledged failings); 'planned usage' (EC Ps showed more reluctance to use the STA); and 'effort' (IC Ps more frequently endorsed the utility of effort).

3. Discussion

Study One manipulated theories of ability with new technology. Agreement with items on the 'beliefs about ability and new technology' scale did not vary between conditions. Study Two manipulated theories of ability to affect one's voice. Agreement with items on the 'beliefs about speech and voice quality' scale did not vary between conditions. Due to low Ps numbers, these findings were not statistically analysed.

Study One's, thematic analysis found IC Ps more frequently blamed themselves for problems encountered, and more frequently endorsed a need for effort when using technology. These findings concur with the prediction that holding an incremental theory predisposes mastery behavior patterns, regardless of perceived ability. The target user group for the STA is primarily older adults, whose perceived ability with new technology may be lower than an average population sample. Encouraging incremental theories regarding technology domains could potentially enhance the STA's utility, by avoiding challenges becoming obstacles to continued use. Despite low Ps numbers, Study Two revealed similar findings. Thematic analysis showed IC Ps more frequently acknowledged voice failings, and more frequently endorsed need for effort to improve volume. Given the opportunity to increase volume exists, and the degenerative nature of Parkinson's, it is important to believe that effort is useful. Encouraging an incremental theory for a voice-affect domain could potentially enhance the STA's utility. Perceiving speech volume can intentionally be improved could encourage goals that result in mastery behaviors. Across studies, IT manipulations show potential to alter STA approach, possibly contributing towards the STA being something that is fully utilized, helping people with PD find their voice.

Acknowledgements

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Mindfulness Training Online For Stress Reduction, A Global Measure

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Abstract. According to the World Health Organization (WHO), stress-related chronic diseases are the main source of death in developed countries. During the last decade, e-mental health, telepsychology or telepsychiatry interventions are showing its growing potential due to the gradual global adoption of the internet and mobile phone technologies. A significant number of studies have concluded that mindfulness helps to reduce physical and psychological symptoms of stress related to various health concerns and that it is a psychological skill that can be trained. The purpose of this online research study is to gather the participants' socio-demographics as well as stress and mindfulness data during an online mindfulness training program. Sustained attention and the state of mindfulness experienced in single meditation sessions are also tracked and stored.
Correlational analysis yielded to a statistically significant relationship between high scores in stress and low scores in mindfulness facets ($p < .001$) and between state and trait aspects of mindfulness ($p < .01$).

Keywords. Stress, mindfulness, web application, e-health, online training.

Introduction

Stress occurs mainly when the demands of our environment exceed our physical, mental or emotional capacities. When we feel stressed, our capacity to pay attention and our self-control tend to decrease.

Stress is related to, and is the cause or concomitant to, various psycho-physiological diseases such as some types of cardiovascular diseases, cancer, depression or anxiety. Moreover, the World Health Organization (WHO) global status for 2011 [1] reports that noncommunicable diseases are the biggest cause of death worldwide (36 million in 2008), mainly cardiovascular diseases (48%) and cancer (21%).

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In addition and regarding mental diseases specifically, depression is affecting about 121 million people worldwide. By the year 2020, depression is projected to be one of the two major disabling health concerns calculated for all ages, both sexes [2].

Information and communication technologies (ICTs) can provide numerous advantages for the field of psychology in order to make mental health interventions more accessible to different types of users and for different purposes, including diagnosis, counseling and treatments [3].

In the last decade, e-mental health interventions are showing their growing potential due to the global adoption of the internet and mobile phone technology [4] in addition to the broad spectrum of possibilities derived from the specific fields comprised under the terms of e-mental health, telepsychology, telepsychiatry or psychotechnology [5-6].

A significant number of studies have concluded that mindfulness helps to reduce physical and psychological symptoms of stress-related health concerns [7-8] and that it is a psychological skill that can be trained.

Mindfulness is the capability of focusing one's attention, on purpose, in the present moment and without judgment [9]. Mindfulness training for stress reduction mainly begins with practicing attentional focus on breathing [10].

Previous laboratory research has sought to validate breath counting as a behavioral measure of mindfulness [11]. Moreover, this study was conducted in laboratory controlled settings, where users wore a respiration monitor that found participants lawfully tracked their breathing with keyboard presses and therefore were allowed to train with breath counting in an online computer-based program from home.

Mindfulness researchers have stressed the lack of tools, up to now, to record the time of practice and the mindfulness and awareness progress during a meditation session. In this applied research, we were able to compile objective data on the quantity and quality of mindfulness practice through the web application MindFocus ® embedded in the website that makes this research available online (http://www.mindfulnets.co).

The purpose of this online research study is to gather the participants' socio-demographics as well as stress and mindfulness data during an online mindfulness training program. Sustained attention and the state of mindfulness experienced in single meditation sessions are also tracked and stored.

1. Method

1.1 Participants

A total of 182 (117 women and 65 men) from 23 countries have participated voluntarily so far. The mean age was 39.06 (SD = 11.32), and ranged from 14 to 77

years. Spanish was the mother tongue of 89% of the participants (N = 162), 4% (N = 8) English and 6% (N = 12) other languages.

As for the experience in relaxation-meditation techniques, 11% of participants (N = 20) did not practice any mind-body technique to reduce stress and were not interested in practicing any; 12% (N = 22) had occasionally practiced at least one technique to reduce stress and they would practice it again; 30% (N = 55) are ready to start practicing at least one technique to reduce stress (in less than a month); 29% (N = 54) practiced at least one body-mind technique, but less than 3-4 times a week and not regularly; and finally, 17% (N = 31) had continuously practiced with 3-4 days per week frequency for over 6 months.

2. Procedure

2.1. Registration and pre-program participation assessments

Users signed up on the web site http://www.mindfulnets.co, with a user ID and password validation, either in the Spanish or the English version and accepted the terms and conditions of use that included the informed consent for this online research. The web screen flow guided users sequentially: (1) To set up a mindfulness training, (2) To fill in a survey and (3) To fill in two questionnaires, before they were allowed to start their training program.

Participants set up their own individualized mindfulness training program, choosing between training periods of 1 to 8 weeks; and from 1 to 55 minutes of single meditation sessions (treatment condition). They filled in a survey including questions on their general socio-demographic data.

Finally two questionnaires were administered: the Perceived Stress Scale (PSS) [12] and the Five Facets Mindfulness Questionnaire (FFMQ) [13]. Users received a brief feedback statement and the score right after they filled in every one of these questionnaires. At this point, users were allowed to start the first session of their training (an attentional training task).

2.2. Attention training task (treatment condition)

Training sessions consist of sitting comfortably in front of the computer with one's back straight and in practicing an attentional focus task by following a set of instructions: (1) To focus attention on breathing; (2) To click each time one breathes out; and (3) If one gets distracted, to gently bring one's attention back to the feeling of the breath and to the click.

2.3.   *Post-task assessment*

A self-developed questionnaire was filled in just after the attentional task, to assess the level of mindfulness state experience. A 28-items scale assessed 7 different facets of the degree of attention and awareness which users had during the attentional focus task.

2.4.   *Post-program assessment*

Perceived stress (PSS) and mindfulness (FFMQ) questionnaires were administered again after completion of the last session of the individually established training program. A brief survey about the user's experience and satisfaction was also handed at the end.

Participants were able to track their progress by checking their statistics of every single session results (attentional task and mindfulness state experience). Pre- and post-program stress and mindfulness level were given as feedback to users too.

3.   Design

In a pre-post program design, Perceived Stress (PSS) and Facets of Mindfulness (FFMQ) were measured to assess the effects of the program chosen by users. In addition, the mindfulness state experience was assessed after every single session during the training program. The assessment instruments used were the following:

Perceived Stress (PSS). The Perceived Stress Scale in its 10-item variant [12], measures "the degree to which individuals appraise situations in their lives as stressful". Respondents rate how often they feel or think in a certain way during the last month.

Mindfulness (FFMQ). The Five Facets Mindfulness Questionnaire [13] is a 39-item instrument measuring the general tendency to be mindful in daily life. Users rate what best describes their own opinion of what is generally true for them.

Mindfulness State Experience. It is a specifically self-developed for this study measurement. It is a 28-item survey, which assesses the mindfulness state experience related to the attentional focus task of paying attention to breathing. Respondents rate the degree to which they have experienced the mentioned states.

User Experience. Once participants finish the mindfulness training program, they are invited to fill in a survey with basic questions regarding their experience and the quality of the program.

4. Results

At the time of preliminary data collection, a total of 182 individuals had started the program. The mean stress score was 19.69 (SD = 5.9) and for the mindfulness trait scale it was 122.15 (SD = 21.68); noticing that the highest score for the FFMQ is 195 and for the PSS is 40).

Regarding the relationship between perceived stress (PSS) and mindfulness trait (FFMQ), we found out that there was a significant negative correlation between stress values and the mindfulness trait scale ($r2 = -.698$, $p < .001$). Individuals that are stressed, have lower mindfulness skills that cannot protect them from suffering the effects of stressful situations.

A total of 63 participants fulfill the inclusion criteria for the statistical analysis aimed at comparing mindfulness trait ($M = 122.32$, $SD = 24.18$) and mindfulness state ($M = 54.32$, $SD = 9.5$). There was a significant positive correlation between mindfulness trait and state ($r2 = .418$, $p < .01$). These results suggest that the more an individual has mindfulness state experiences in particular activities in life, the more likely is he/ she to have a general tendency (trait aspect) to be mindful in daily life and vice versa.

We expected a positive correlation regarding the relationship between the attentional task on one side and mindfulness trait (FFMQ) and mindfulness state experience (measured by the self-developed assessment) on the other. However, analysis of high scores in the attentional task, in comparison with mindfulness state experience scores and mindfulness trait scores, did not yield outcomes in that direction.

Analysis regarding the pre-post training program comparison has not been conducted yet due to the low rate of participants that have finished the training program.

5. Discussion

Promotion of this web application to train mindfulness online among end users and researchers is needed to enroll more volunteers and to gather more data from their participation.

Some aspects in this study may be addressed. For instance, the feedback side effect on the results. Although we try to provide a limited feedback to avoid bias during the training program, but enough to reinforce users' participation, the feedback provided could be causing a side effect that could influence the outcomes.

As expected and congruent with the literature background, mindfulness and stress levels were inversely related to each other. The absence of an correlation between the attentional task of breathing and the mindfulness state experience assessed just after the attentional task might be explained by the absence of control on individual differences. The wide range of minutes of practice (from 1 to 55 minutes) and the number of sessions of practice obviously have an effect on the data analysis.

Similarly we did not find correlation between scores of the attentional task and the trait aspect of mindfulness. This fact could be mainly due to the group characteristics of motivation and previous experience. Motivation and previous experience in the practice of relaxation-meditation techniques have to be considered in this kind of studies. Thus, an analysis of their influence on the outcomes would be necessary.

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Psychophysiologic Identification of Subthreshold PTSD in Combat Veterans

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Abstract. Posttraumatic stress disorder (PTSD) is linked with adverse health outcomes, and many military service members (SMs) are afflicted with it after they return from combat. Since many SMs have an initial honeymoon period characterized by limited symptoms before the onset of full-blown PTSD, the identification of independent predictors of PTSD upon return from deployment could facilitate early intervention. We measured psychophysiologic responses to stimuli including explosions in a Virtual Iraq/Afghanistan environment, as well as a fear potentiated startle paradigm, in a prospective cohort of SMs who did not meet criteria for PTSD and were within 2 months after return from deployment. We report marked psychophysiologic differences between those with (n=29) and without (n=30) subthreshold PTSD symptoms (PTSD Checklist score ≥28 vs. <28). We believe this is evidence that psychophysiologic measures can help to identify individuals at high risk for PTSD.

Keywords. posttraumatic stress disorder, psychophysiology, virtual reality

Introduction

Posttraumatic stress disorder (PTSD) has been reported to be about 2.5 times more common after deployment to Afghanistan and 5 times more common after deployment to Iraq, than in military service members (SMs) who have not deployed [1]. PTSD is associated with higher rates of depression and other mental disorders, poor physical health, and impaired occupational and social functioning [1, 2]. In addition, PTSD has been characterized as a failure to extinguish normal reactions following a traumatic experience [2]. However, with combat veterans, a honeymoon period is often seen in which the onset of PTSD and depression is delayed for months after returning from deployment, so that PTSD increases in prevalence by 2- or 3-fold at 3-6 months after deployment [2]. This pattern likely results from the fact that SMs initially overlook or underreport symptoms upon return, pushing them to the background amid happy reunions with family. Expectations that symptoms will subside with time are dispelled in ensuing months and SMs begin to recognize and acknowledge them. A reliable method for delineating those at high risk for persistent symptoms would therefore be useful, particularly given that medication therapies for PTSD have been found to achieve a response rate of 50-60% [3]. The first step in defining effective early interventions is developing a convincing and reproducible risk stratification, to then target those at high risk. With that goal in mind, we conducted a comprehensive

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baseline assessment of a cohort of SMs who did not meet criteria for PTSD and we are now engaged in serial follow-ups at 3, 6, and 12 months to identify which baseline measures best predict the development of PTSD. In this paper we present preliminary analyses of potentially the most promising baseline measures, the psychophysiologic. Since it is intuitive that those with more symptoms are somewhat more likely to go on to develop a full disorder, we compare psychophysiologic profiles for those with subthreshold symptoms on the PTSD Checklist-Military Version (PCL-M) to those with fewer symptoms. We also present a case study that further elucidates the potential value of psychophysiological measures.

1. Methods

1.1 Participants

The sample includes SMs (50 men, 9 women) with a mean age of 28.7 (range = 20 - 51) evaluated within two months of return from Iraq or Afghanistan at the National Intrepid Center of Excellence in Bethesda, Maryland. They were medically stable, were not suicidal, homicidal or psychotic and did not meet criteria for PTSD or major depression, and had never lost consciousness for more than 60 minutes.

1.2 Baseline Evaluation

- ***Medical History and Physical Examination***
The principal investigator, a board-certified internist, obtained informed consent from each participant and then performed a medical history and physical examination, as well as a detailed assessment of balance and smell.
- ***Psychological Health Measures***
All participants completed several well-validated questionnaires including the PTSD Checklist-Military Version (PCL-M) [4], a screen for PTSD, the Short-Form Survey (SF-36) [5], a self-report measure of functional status, and, the Patient Health Questionnaire (PHQ) [6], a screen for psychiatric disorders including depression (PHQ-9) and generalized anxiety (GAD-7). For inclusion in the study, participants had to have PCL-M and PHQ-9 scores below 50 and 10, respectively, to rule out PTSD and depression. An experienced, licensed psychologist confirmed the absence of PTSD with the gold standard Clinician-Administered PTSD Scale (CAPS) [7].
- ***Psychophysiologic Measures***
We employed a fear potentiated startle paradigm previously validated at Emory University [8]. The fear acquisition phase pairs a combination of shapes with a 108-dB, 40-ms burst of broadband noise followed 500 msec thereafter by a 140 psi airblast to the larynx (danger cue, AX), while another pattern of shapes heralds noise with no ensuing airblast (safety cue, BX). The noise probe without the airblast is also presented without a visual cue (noise alone, NA). The acquisition phase includes 3 blocks with 12 trials (4 AX, 4 BX, and 4 NA trials) in each block for a total of 36 trials. For each condition, the participant is asked to press a button denoting whether they anticipate danger, safety, or are uncertain. The fear extinction phase presents the same visual cues in the complete absence of airblasts (e.g., no danger), so the participant learns there is no longer harm. Fear extinction is 10 min after the fear acquisition phase and is presented in 6 blocks of 12 trials each (4 AX, 4 BX, and 4 NA trials). Expectancy ratings are also recorded during this session.

The second psychophysiologic assessment features three 2-minute sequences of a Virtual Iraq/Afghanistan environment that we use to treat PTSD [9]. Two sequences present a HUMVEE in a convoy confronted with improvised explosive devices (IEDs) and ambushes, while the third offers a foot patrol through a village marketplace replete with explosions and terrorists firing rocket-propelled grenades. The sequences are presented on a computer screen rather full immersion in the virtual environment and were separated by 30 seconds of a blue screen baseline.

Psychophysiological data was collected using Biopac MP150 for Windows (Biopac Systems, Inc., Aero Camino, CA). We recorded electromyographic (EMG), galvanic skin response (GSR) electrocardiogram (ECG) and respiratory rate (RR). EMG activity was recorded with electrodes placed over the orbicularis oculi muscle; GSR from the palmar surface of the non-dominant hand; ECG from electrodes on the chest, below the right clavicle and the other inside of the left arm; and RR with a chest band across the sternum. All data were sampled at 1000 Hz, digitized at 16 bit A/D resolution, amplified and processed with the Biopac system and exported for statistical analyses in Excel. The dependent measures were computed in the manner consistent with previous studies examining EMG [8], GSR [10], RR [10] and HR [10] during similar tasks. Planned comparisons between the AX and BX conditions were statistically computed with Excel.

During each VR session, mean HR and GSR values were computed during the 2 minute viewing period. A difference score was computed by subtracting the mean for the 30 second baseline period prior to the video onset from the 2 minute VR video mean. EMG for the VR was computed in the same manner as mentioned above [8].

2. Results

We divided the study participants according to their PCL-M total scores, yielding 30 with PCL-M scores below 28 (B28) and 29 with scores of 28-49 (A27). Mean scores were derived for the A27 and B28 groups respectively for the PCL-M (M=34.1, SD=6.32; M=21.57, SD=3.30), PHQ-9 (M=4.41, SD=1.70; M=1.57, SD=1.76), GAD-7 (M=4.34, SD=2.45; M=2.1, SD=2.42), and the following SF-36 subscales: General Health (M=80.96, SD=13.30; M=83.70, SD=12.97), Mental Health (M=87.14, SD=12.20; M=92.50, SD=13.82) and Social Functioning (M=82.14, SD=17.82; M=94.17, SD=12.61).

2.1 Psychophysiology, A27 versus B28

During fear acquisition, A27 and B28 participants have a more marked EMG response to danger cues compared to safety cues (Figure 1).
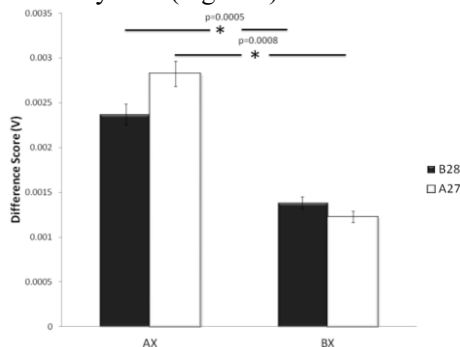

Figure 1. Fear Acquisition EMG results in Volts (V) for the Below 28 (B28) and Above 27 (A27) group.

For GSR, the B28 group demonstrated a significantly greater response to danger cues than to safety cues, whereas the A27 group failed to show such discrimination and instead demonstrated a statistically equivalent response to danger and safety. In addition the means revealed a trend towards a greater response for the A27 group during the fear acquisition period compared to the B28 group (Figure 2). HR monitoring revealed no significant differences between AX and BX for either group.
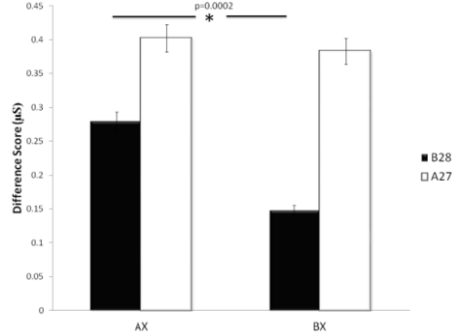
Figure 2. Fear Acquisition GSR results in microsiemens (µS) for the Below 28 (B28) and Above 27 (A27) group.

During fear extinction, the A27 group evidenced more marked EMG responses to safety cues than danger cues (Figure 3) whereas the reverse was true for GSR responses (Figure 3). HR revealed no significant differences between cue categories for the A27 group. No significant differences in EMG, GSR, and HR responses between danger and safety cues were found for the B28 group, consistent with fear extinction learning.
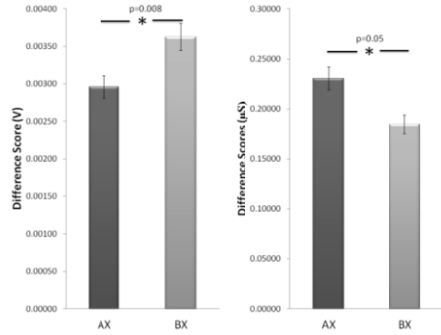

Figure 3. Fear Extinction results for the Above 27 group. The left plot indicates the EMG (Volts) and the right plot represents the GSR (microsiemens).

2.2 Marine A versus Marine B

In addition to the preliminary group analysis described above, the following two cases further support the initial findings of the study. Marine A is an Exploded Ordnance Disposal (EOD) technician who was in the close vicinity of many explosions while deployed, was the driver of a vehicle that hit an IED, and is a veteran of 3 deployments to Iraq and Afghanistan. Marine B is in the infantry, also had 3 deployments, and had several psychologically traumatic experiences including holding a fellow Marine and close friend while he died after a mortar attack. Marine A had PHQ-9, PCL-M and CAPS scores of 0, 18 and 5. Marine B had corresponding scores of 5 (mild depression), 24 and 42, respectively. While a CAPS score > 40 is often consistent with a diagnosis

of PTSD, Marine B lacked the functional impairment and symptom distribution to meet full diagnostic criteria.

Overall, Marine A was able to consistently discern danger from safety in the fear acquisition phase, whereas Marine B correctly identified danger but appeared uncertain when presented with the safety cue. Physiologically, Marine A displayed significant EMG and GSR responses to danger cues but little response to safety cues and this discrimination was also evident in the behavioral self report expectancy ratings (Figure 4, top panel). Marine B had equivalent rises in GSR and EMG to both danger and safety cues and his expectancy ratings confirm his generalized danger predictions (Figure 4, bottom panel). Consistent with the group results, HR comparisons between AX and BX did not result in significant differences for either Marine.
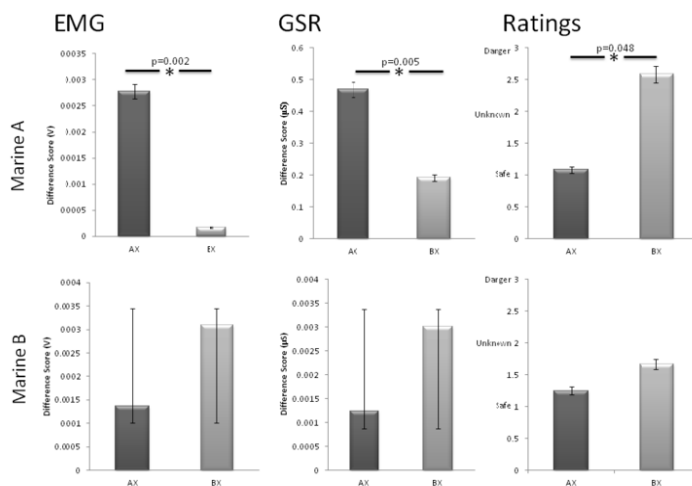
Figure 4. Case study comparison for Marine A and Marine B during Fear Acquisition. EMG (Volts) GSR (microsiemens) and Expectancy Ratings (1=safety, 2=unknown, 3=danger) during the AX and BX conditions.

In the fear extinction phase, both Marines correctly identified that they could anticipate safety regardless of the visual cue by demonstrating equivalent expectancy ratings (Marine A AX 2.83, BX 2.90, p=0.30; Marine B AX 2.88, BX 2.82, p=0.38). However, Marine A tended to display a more marked GSR response to danger cue than safety cues, similar to the pattern observed in fear acquisition (GSR AX 0.158 μS, BX 0.075 μS, p=0.09) whereas Marine B continued to have similar EMG, GSR, and HR responses to both cues, with a trend favoring more marked GSR and HR responses to safety than danger cues (GSR AX 0.0004 μS, BX 0.00061 μS, p=0.15; HR AX 1.56 BPM, BX 2.58 BPM, p=0.22).

Marine B consistently demonstrated a marked increase in respiratory rate across the three 2-minute Virtual Iraq/Afghanistan sequences environment, with no other notable differences between the two in response to the virtual stimuli.

3. Discussion

We compared psychophysiologic responses during the fear potentiated startle paradigm for 59 military SMs, which we divided into two groups based upon whether their PCL-M score was either 28 to 49 or less than 28. The cut-off level of 28 was chosen in part

because some experts have suggested a score of 28 or more might be used as an initial [11], high sensitivity screen, to be followed by a more specific assessment measure (e.g., the CAPS) to clarify whether there is in fact a true diagnosis. Thus, while we await outcome measures, this comparison provides valuable insight on the potential utility of psychophysiologic markers in discerning risk for PTSD after military deployment. In fact, we believe this represents the first documentation of significant psychophysiologic differences between those with significant subthreshold symptoms of PTSD and those without. The more marked psychophysiologic responses we identified in response to safety cues in those with subthreshold symptoms (A27) likely represent failure to engage in fear inhibition, consistent with what has been previously reported in PTSD [8]. These results mimic the hypervigilance behavior as well as the lack of trust often seen in those with PTSD.

The case study comparison of the two Marines further displays the potential discerning power of psychophysiologic measures. Marine A has an adaptive response profile characterized by behavioral and physiologic distinction between danger and safety conditions. However, Marine B's physiologic responses suggest an inability let his guard down, and perhaps a lack of trust in the safety cue. His expectancy ratings confirm that he never characterizes either condition as safe, which is consistent with his high CAPS score. The elevated respiratory rate manifest by Marine B in response to the virtual reality sequences is consistent with this pattern, and suggests a new potential application of virtual reality; the environment may not only facilitate treatment, but also identify those at greatest risk.

The inability to differentiate danger from safety, and the failure to recover after danger is removed may be a critical indicator of risk. We have shown that those with subthreshold PTSD symptoms are less adept at physiologically distinguishing danger from safety during fear acquisition learning and continue to react to danger and safety cues during fear extinction, even though they are out of harm's way. Moreover, even though Marine B was in fact in the group with lesser symptoms, he still demonstrated an equivalent affective response to danger and safety cues both physiologically and behaviorally, suggesting an inability to inhibit a prepotent threat appraisal. It is notable that Marine B had a relatively low PCL-M score, yet both the CAPS and psychophysiologic measures corroborate our clinical suspicion that he was at higher risk for PTSD. Thus, while the comparison of psychophysiologic measures according to PCL-M score for our entire study population shows a strong positive relationship between measures and scores, and presumably risk for PTSD, the case comparison shows the PCL-M alone is not an adequate risk delineator.

It is important to note that this is a preliminary analysis and not the primary intended outcome of our investigation, but we believe it is nevertheless provocative and noteworthy. We anticipate the inclusion of multiple factors will be necessary in order to create a robust risk model, and we look forward to identifying those factors.

4. Conclusions

We provide evidence of significant psychophysiologic differences between those with and without subthreshold PTSD symptoms in recently returned combat veterans. Identification of additional risk measures, as well as corroboration of these results in other populations, will be important in stratifying SMs for risk of PTSD.

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On The Comparison of VR-Responses, as Performance Measures in Prospective Memory, with Auditory P300 Responses in MCI Detection

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Abstract. Patients with amnestic mild cognitive impairment are at high risk for developing Alzheimer's disease. Besides episodic memory dysfunction they show deficits in accessing contextual knowledge that further specifies a general spatial navigation task or an executive function (EF) virtual action planning. There has been only one previous work with virtual reality and the use of a virtual action planning supermarket for the diagnosis of mild cognitive impairment. The authors of that study examined the feasibility and the validity of the virtual action planning supermarket (VAP-S) for the diagnosis of patients with mild cognitive impairment (MCI) and found that the VAP-S is a viable tool to assess EF deficits. In our study we employed the in-house platform of virtual action planning museum (VAP-M) and a sample of 25 MCI and 25 controls, in order to investigate deficits in spatial navigation, prospective memory and executive function. In addition, we used the morphology of late components in event-related potential (ERP) responses, as a marker for cognitive dysfunction. The related measurements were fed to a common classification scheme facilitating the direct comparison of both approaches. Our results indicate that both the VAP-M and ERP averages were able to differentiate between healthy elders and patients with amnestic mild cognitive impairment and agree with the findings of the virtual action planning supermarket (VAP-S). The sensitivity (specificity) was 100% (98%) for the VAP-M data and 87%(90%) for the ERP responses. Considering that ERPs have proven to advance the early detection and diagnosis of "presymptomatic AD", the suggested VAP-M platform appears as an appealing alternative.

Keywords. mild cognitive impairment, prospective memory, virtual reality, spatial navigation, P300 responses.

Introduction

Most neuropsychological assessments of prospective memory and spatial navigation tasks bear little similarity to the events that patients actually experience as memories in daily life. The first aim of this study was to use a virtual museum environment (VAP-M) to characterize cognitive profiles in an ecological fashion, which includes memory

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for central and perceptual details, spatiotemporal contextual elements, and binding. This study included subjects from two different populations: patients with amnestic mild cognitive impairment (aMCI) and an age-matched group of healthy adults (non-impaired; (NI)).

When people are in the early stages of AD, they may get lost, forget where they put things, and have trouble driving, all of which are examples of impairments in executive functions and spatial cognition. During the last 5 years, researchers investigated the potentials of virtual supermarkets to evaluate executive dysfunctions in several populations including the MCI [1-2]. One the other hand, spatial cognition tasks tap very broad networks in the MTL and the cortex, areas of the brain that are sites of the earliest pathological changes in AD and that are known to play an important role in episodic memory function. Thus, virtual reality tests of spatial cognition could be used to detect early deficits in AD [3]. Furthermore, virtual reality action planning cues (VAP-M) might enhance executive function and thus late cognitive components, such as the late positive potential P300 [4-5]. This paper describes the comparative study of virtual reality reaction times and cognitive brain activity in order to define cognitive profiles and reliably detect abnormalities in older adults

1. Methods

1.1. Subjects

We used a sample of 25 aMCI (18 females and 7 males) and 25 controls (20 females and 5 males) with a mean age of 64.3 years. The original criteria for mild cognitive impairment set out by Petersen *et al* require that a person must present with a memory complaint, show evidence of objective memory decline in relation to age and education, demonstrate preservation of other areas of cognitive function and activities of daily life, and not fulfill criteria for dementia. [6]. Because it has since become apparent that not everyone who demonstrates cognitive impairment short of dementia has a 'memory' complaint, we used the recently expanded criteria that include people with non-memory complaints (single-domain non-memory MCI), as well as those exhibiting multiple domains of cognitive impairment who none the less fail to fulfill criteria for dementia (multiple domains slightly impaired) [7].

1.2. Experiments

Two groups: NI and aMCI following two different paradigms VAP-M and ERPs (auditory paradigm) a) virtual reality museum alone (VAP-M) and b) event-related potential (ERP). Subjects in the VAP-M paradigm were instructed to encode all elements of the environment as well as the associated spatiotemporal contexts. Following each immersion, we assessed the patient's recall and recognition of central information (i.e., the elements of the environment), contextual information (i.e., temporal, egocentric and allocentric spatial information) and lastly, the quality of binding. For the ERP paradigm, a standard auditory odd-ball task was adopted [5], and the subjects were assessed based on the temporal patterning of the late components in the averaged P300 response.

Figure 1. Screenshot from the Virtual Reality museum. The participants had to encode all elements of the environment as well as the associated spatiotemporal contexts. Following each immersion, we assessed the patient's recall and recognition of central information.

1.3. Data Analysis

We adopted a generic classification scheme, suitable for dealing with multivariate data that incorporates standard pattern-analytic steps leading from feature ranking to train/test a learning algorithm (a detailed description can be found in [8]. In short, the derived measurements (related to the performance of a subject in either experimental procedure) were treated as a set of features and ranked according to their importance in subsequent classification. Based on the most appropriate subset of features, we built a k-nearest neighbor (knn) classifier. Following a two-fold cross-validation scheme, we measured the performance of the classifier in terms of sensitivity and specificity. The performance measures were accompanied with the appropriate visualizations (scatter-plots). The advantage of using a common algorithmic procedure for analyzing subjects' performance in both VAP-M and ERP experimental procedures facilitated the direct comparison of the two different prognostic tools.

2. Results

We found that the aMCI patients' performances in both paradigms were inferior to that of the healthy controls, in line with the progression of hippocampal atrophy reported in the literature. Spatial allocentric memory assessments were found to be particularly useful for distinguishing aMCI patients from healthy older adults, when performing the VR tasks (t (25) = 2.057; p < 0.05). The performance of a common classifier was proved enhanced when VR related scores were fed as features. The situation is demonstrated vividly via the contrast of Fig.2b with Fig.3c, where the scatter-plots for the same subset of subjects have been included for the VR and ERP paradigm respectively. The sensitivity of the classifier was 100% and the specificity 98% for the VAP-M paradigm (regarding the NI vs aMCI discrimination). For the ERP characteristics (mainly corresponding to prolonged latencies) the same classifier reached a sensitivity of 87% and specificity of 90% .
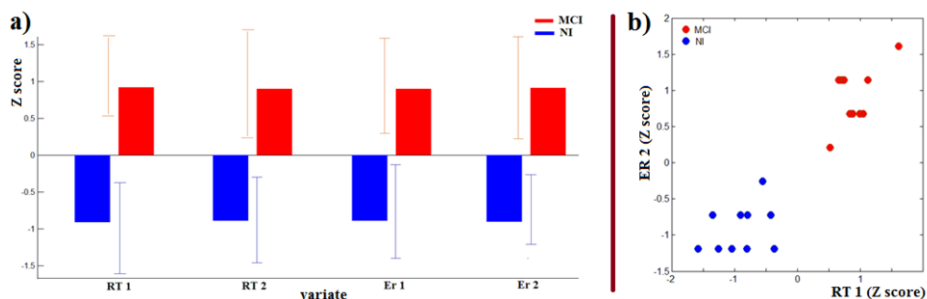
Figure 2. a) Comparison of the group means for the four different variables (Reaction times (RT) and Errors (Er) for two different sessions). To facilitate visual comparison, the measurements of each variable have been transformed to Z-scores (each variable has been treated independently) using the mean value and standard deviation of the measurements in both groups. All four variables have higher mean values (statistically significant ; P<0.001) for the MCI-group. The vertical bars indicate the range of values for every variable within each group. **b)** Scatter plot based on the most discriminating variables (RT1 and Er2). A clear cut saparation is evident. Perfect classification can be easily accomplished even with simple classifiers (e.g. 100% correct classification was achieved with a knn classifier (using k=1 or 3))

3. Conclusion

The rationale guiding the present study was the accumulation of knowledge about the relationship between spatial navigation tasks, ERPs and MCI and the need to find a valid and non-threatening way of diagnosing MCI. The VAP-M might, therefore combined with P300, provide an additional tool to improve the early diagnosis of MCI while avoiding the difficulties of neuropsychological tests. In particular, neuropsychological studies would benefit to use virtual tests and a multi-component approach to assess episodic memory, and encourage active encoding of information in patients suffering from mild or severe age-related memory impairment.
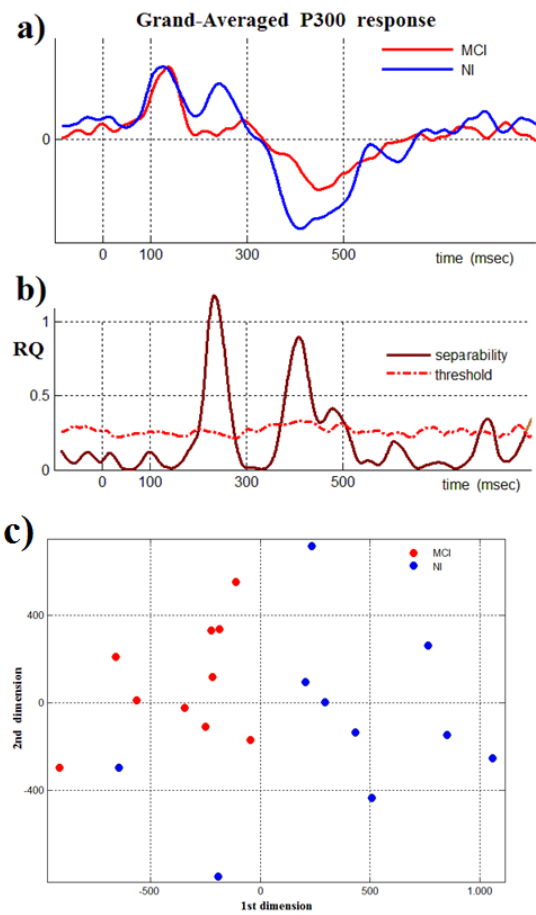
Figure 3. a) The Grand Averaged ERP waveforms for both groups. **b)** The shown latency-dependent measurements of RQ-separability were estimated using a moving window approach (with a technique described in (Liu et al. 2003)). Using a randomization statistical procedure, a threshold corresponding to a random partition of the data in two groups was estimated and used to identify the latency of interests (LOIS). Interestingly, two distinct groups of latencies with high discriminatory power are revealed. The first one centers around 230 msec and the second around 410 msec. **c).** Scatter plot based on feature vectors extracted from the average P300 response waveforms. Using the LOIs defined in Fig.3b, 10 feature-vectors were defined for each group. The weighted euclidean distance (with weights based on the RQ scores) was used to perform all the pairwise comparisons between the feature vectors. The classic MDS technique was then employed to summarize all these comparisons within a 2D display (in a format similar of Fig.2b). The two groups appear well separated, and with the knn-classifier a performance of 89% correct classification was achieved.

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Section III

Original Research

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Tackling Sensitive Issues Using a Game-based Environment: Serious Game for Relationships and Sex Education (RSE)

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Abstract. Experiencing sexual coercion during adolescence can lead to adverse psychological and physical health outcomes for those affected. Eliminatingsuch experiences is important for enhancingadolescent wellbeing, and the provision of good quality relationships and sex education (RSE) is needed. Engaging young people in sensitive subjectmatters in RSE can be challenging, and using Serious Gaming technology may support young people and educators in this process. This paper describes the use of Intervention mapping (IM) in the development of a serious game on the topic of sexual coercion for use in RSE. IM is a process that draws on stakeholder engagement and the theory and evidence base to support health improvement intervention planning. Serious game developers transformed the game concept 'flat plan' into an interactive gameshow. The game is teacher ledand aims to engage students in gameplay and discussion around the issue of sexual coercion. The final product known as PR:EPARe (Positive Relationships: Eliminating Coercion and Pressure in Adolescent Relationships) is the subject of an ongoing cluster Randomised Controlled Trial (RCT) in local schools. Early data analysis shows improvements in psychological preparedness for dealing with sexual coercion against some change objectives. This work represents the first attempt to use IM in the development of a Serious Game and the use of Serious Gaming for RSE delivery. RCT work is ongoing and PR:EPARe will become part of local RSE delivery in the new school year. Plans for ensuring broader impact of the game are in development.

Keywords. Serious game; Relationships & Sex Education;Sexual coercion; Intervention Mapping;adolescents.

Introduction

Adverse psychological and physical health outcomesassociated with having experienced sexual coercion as an adolescent are well documented [1].There is a strong link between incidence of sexual coercion and increased sexual risk-taking, rates of sexually transmitted infections (STIs) and unwanted or unintended pregnancy [2]. Working to reduce and eliminate coercive sexual experiences amongst young people is therefore important for enhancingtheir sexual health and wellbeing [3].Delivering good quality relationships and sex education (RSE) in schools and other educational settings, can help to achieve this aim.

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Within the UK there is a growing ambition for RSE to not only provide young people with knowledge about reproduction, contraception and prevention of STI transmission, but also issues related to the nature of sexuality and relationships [4]. It is asserted that RSE should encourage the acquisition of skills and attitudes which allow pupils to manage their relationships positively and responsibly [5]. In addition, one of the challenges of delivering RSE is to do so in a way that engages the young people involved *and* draws on the evidence-base about what will work to deliver positive outcomes.

It was felt that use of games technologies could provide a medium toengage target audiences. We therefore aimed to assess whether an interactive evidence-based Serious Game could have a positive influence on identified outcomes when comparing intervention participants to controls.

1.   Game development

Intervention Mapping (IM; [6]) was used to develop the Serious Game.Input from young people (n=25), sexual health service (n=4) and local authority commissioners (n=5), and those involved in sexual health education (n=6) was carried out as part of needs analysis. Over the course of several meetings, stakeholders identified experience of pressure and coercion in sexual relationships as a priority topic for RSE.

Year 9 students (aged 13-14 years) were identified as the priority target group for RSE on this topic. An iterative process of further stakeholder engagement, and systematic literature review led to the development of a series of change objectives (e.g. Young people will be able to recognize different types and levels of coercion; young people will develop an expectation that there will be negative consequences of allowing coercion to continue) for the serious game. Evidence-based techniques that addressed the change objectives were scoped out and applied in the 'flat plan' concept design. Throughout the process stakeholders were engaged in progress and asked to provide input and ideas. Once the concept was finalizedit was passed to the Serious Game developers. A script for the game was developed and young people from the local stakeholder groups auditioned to provide game audio for characters' voices.

User engagement and usability within a classroom context were major priorities for the development build. A combination of highly stylized 3D and 2D graphics and characters with audio-based interaction have been used to create a dynamic game to build and maintain motivation to play. The user is placed within a high fidelity game show environment, providing an entertaining platform in which the subject matter is addressed. The gameavoidstype heavy interfaces which can gradually decrease attention in users. Allowances for group discussions as are also integrated within the game mechanics through use of a pause button. A timer supports pace-setting and a menu function puts control in the hands of the educational facilitator in selecting the most appropriate content for their students. A scoring system supports the provision of feedback to game players and helps to build a sense of purpose and achievement. By applying these specific games mechanics, the game provides a virtual educational platform that attempts to maximise usability and engagement for both user and educationalist. The final product is known as PR:EPARe (Positive Relationships: Eliminating Pressure and coercion in Adolescent Relationships) and an illustrative image is provided in figure 1 below.

Figure 1. Screenshot from a studio scene in part 2 of the PR:EPARe game

2. Method

2.1. Design

A 2(time: baseline vs. follow-up) x 2(condition: Intervention vs. control) mixed design was used to assess impact of the intervention on change objectives over time and between groups in the CRCT.

2.2. Participants

To date, 19 classes from three schools have participated in a trial of part 1 of the game. Three further schools are due to participate in CRCT evaluation ofthe full version of the game in the coming weeks and months.Data collection to date has resulted in a total of 505 participants (males = 253; females = 247; no info = 5). All participants were in school year 9 and aged 13-14 years with a mean age of 13.5 years (s.d. = 0.5 years). Data from 17 classes has been inputted and subject to preliminary analysis and is reported below.

2.3 Measures

Self-report questionnaire measures based on the change objectives identified in the IM process were devised. Variables measured are: Confidence in knowledge about what coercion is; Personal relevance (as coercer and coerced); negative outcome expectancies associated with coercion (for coercer and coerced); positive outcome expectancies of resisting coercion (as coercer and coerced); self-efficacy to say no; self-efficacy to recognize coercion; self-efficacy to recognize when being coerced; self-efficacy in communicating to avoid coercion (as coercer and coerced); descriptive norm relating to others experiencing pressure and others being able to say no; subjective norms relating to putting pressure on others and saying no to coercion.

2.4 Procedure

Ethical approval was sought before data collection began. Letters about the research were sent to parents and they were given the opportunity to withdraw their child(ren) from the study. Schools provided *locoparentis* consent and students were given Information Sheets so that they could consider whether they wished to participate. Students were given a week to consider their participation before being asked to make a decision and sign a consent form. Those who were willing were asked to complete

the questionnaire. After baseline data had been collected each participating class was randomly allocated to either the control (standard RSE lesson) or intervention condition (Serious Game based lesson) using a computerized dice. In the week following the delivery of the RSE session participants were asked to complete questionnaire measures again. De-brief sheets were provided to all participants.

3. Results to date

3.1. Descriptive statistics

Table 1 shows the means and standard deviations of participants scores for each measure in the questionnaire by game condition (control vs. game) and by time (baseline vs. follow-up). A lower score represents greater psychological preparedness for sexual coercion and a potentially lower risk of being coerced or coercing someone else. Thereis an indication that for some variables at least scores are lower in the game intervention condition by follow-up.

Table 1. Means and (standard deviations) for questionnaire measures by condition and time.

Questionnaire measure	Control (no game) condition		Game condition	
	Baseline	Follow-up	Baseline	Follow-up
Confidence in knowledge Q1	1.75 (0.71)	1.38 (0.21)	1.93 (0.64)	1.72 (0.55)
Personal relevance (coerced) Q2	2.54 (0.97)	2.90 (0.45)	2.78 (0.76)	2.79 (0.69)
Personal relevance (coercer) Q3	3.36 (1.17)	3.27 (0.44)	3.35 (0.95)	3.22 (0.86)
Negative consequence beliefs (personal) Q4	2.45 (0.96)	2.25 (0.34)	2.50 (0.80)	2.43 (0.69)
Negative consequence beliefs (others) Q5	2.73 (0.80)	2.6 (0.32)	2.83 (0.68)	2.58 (0.67)
Positive attitude to saying 'no' (coerced) Q6	1.59 (0.70)	1.4 (0.28)	1.57 (0.62)	1.64 (0.61)
Positive attitude to saying 'no' (coercer) Q7	1.52 (0.67)	1.58 (0.29)	1.62 (0.56)	1.69 (0.67)
Confidence to say 'no' (coerced) Q8	1.93 (0.91)	1.92 (0.32)	1.99 ((0.73)	1.89 (0.63)
Confidence to recognize self as coercer Q9	2.01 (0.76)	2.03 (0.35)	2.13 (0.67)	2.01 (0.52)
Confidence to recognize coercion against self Q10	1.89 (0.70)	1.77 (0.29)	1.92 (0.65)	1.87 (0.58)

Communication Q11confidence (coerced)	2.12 (0.75)	2.13 (0.34)	2.14 (0.69)	2.14 (0.56)
Communication confidence (coercer) Q12	2.32 (0.86)	2.25 (0.34)	2.24 (0.68)	2.20 (0.66)
Descriptive norm – under pressure Q13	2.51 (0.89)	3.80 (3.84)	2.62 (0.77)	2.48 (0.62)
Descriptive norm – say no Q14	2.42 (0.79)	2.38 (0.29)	2.34 (0.64)	2.23 (0.58)
Subjective norm – under pressure Q15	2.11 (0.88)	2.13 (0.28)	2.10 (0.74)	2.17 (0.65)
Subjective norm – say no Q16	2.02 (0.74)	2.00 (0.28)	1.87 (0.61)	2.04 (0.60)

3.2. Inferential statistics

A 2(condition: control vs. game) x 2(time: baseline vs. follow-up) mixed multivariate analysis of variance (MANOVA) was applied to the data to assess whether the PR:EPARegame had any impact on the psychological change objective measures taken from participants. The MANOVA demonstrated a significant main effect of time (F [16, 488] = 12.38, $p <$ .001, η_p^2= .289), a significant main effect of condition (F [16, 488] = 7.27, $p <$ .001, η_p^2= .192), and a significant time by condition interaction (F [16, 488] = 6.54, $p <$ .001, η_p^2= .177). This finding suggests that the PR:EPARegame does have an impact on the identified change objectives. In particular the time by condition interaction indicates that there may be changes over time in the game condition compared with the control that are important. Follow-up analysis of variance (ANOVAs) produced in the analysis were consulted to identify which change objectives were affected. These analyses suggest that there are no significant times x condition interactions on responses to questions 7, 8, 11, 12 and 15 nor over time or by condition of the intervention (see table 1).

There are several measures where improvements are seen over time in both conditions. These are on questions 1, 2, 3, 4, 5, 10 and 14 (see table 1).There are two items that appear to demonstrate improvements for the control condition but not the game. These are items 6 and 16 (see table 1). For two further items however, the game condition demonstrates improvements over time while no change is observed for the controls. This is for items 9 (F [1, 1.192] = 3.859, p = .050, η_p^2= 008) and 13 (F [1,125.478] = 39.786, $p <$ .001, η_p^2= 073) (see table 1).

These early findings suggest that whilst two measures change in the opposite direction to that expected and five measures demonstrate no statistically significant change, taking part in part 1 of the PR:EPARegame evaluation has brought about improvements in psychological preparedness across nine of the 16 measures assessed, and for two of these, the improvements are specific to participants who have played the Serious Game and not the controls.

4. Conclusions

There are still further trial data to collect and analyze at the time of writing, which will be included and discussed in subsequent publications. Findings at present show a mixed picture of the impact of the game, but part 1 only delivers techniques mapped to some of the change objectives and we would therefore not expect to see an impact on all variables for those who have only engaged with part 1 of the game. Analysis indicated that we do not see any change in the current data for attitude towards saying 'no' from the perspective of the coercer, confidence to say 'no' from the perspective of the coerced, confidence in communicating generally from the perspective of either coercer or coerced or beliefs about whether peers experience pressure in relationships. These beliefs are not targeted strongly in part 1 of the game and we would therefore not expect an impact on them.

Improvements for participants in both conditions are seen in confidence in knowledge about what coercion or pressure in relationships is, personal relevance for both the coercer and coerced, and negative personal consequences of coercion from the perspective of the coercer and the coerced. This also occurs for confidence to recognize coercion against self and the belief that peers would say 'no' to coercion. This is a positive outcome from this early evidence, and suggests that simply raising this issue with the students through giving them questionnaire two sets of measures on the subject of coercion and pressure in relationships is enough to produce at least a short-term impact on identified change objectives. There is evidence in the literature that giving participants questionnaire measures on a particular subject can be enough to have an impact (e.g. [7]).

The fact that we appear to see improvements in positive attitude towards saying 'no' from the coerced perspective, and improvements in the belief that peers would expect you to say 'no' when coerced, in the control group but not the intervention group is difficult to explain and we reserve judgement until further data are analysed. The fact that confidence to recognise self as coercer and believing others experience pressure in relationships increases in the intervention condition compared with controls is promising, and again, we await further data based on participants playing both parts of the game to explore this outcome further.

This work represents the first application of an Intervention Mapping approach to the development of a Serious Game. The process brings together the expertise of a range of stakeholders and partners to produce an innovative tool for improving wellbeing in young people. PR:EPARe is set to become part of RSE provision in extended learning centres and schools in Coventry and Warwickshire from September 2012, providing the opportunity for further evaluation. The PR:EPARe project team are working to ensure the game has a sustainable impact on local RSE delivery. We are working on early commercialization plans that may help to further improve and develop the game and develop further resources to address wider RSE relevant issues.

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Changing Heartbeat Perception to Induce Anxiety in Virtual Environments

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Abstract. In this paper, we first propose a general technique to induce anxiety in virtual environments (VEs) which exploits auditory heartbeat perception and biofeedback. Then, we consider a VE that reproduces a real-world anxiety-inducing experience (being suddenly surrounded by smoke during a fire evacuation of a building), and we describe an experiment that contrasts 3 conditions: (i) an augmentation of the VE with a bar that indicates when the user's avatar gets hurt, (ii) an augmentation of the VE with the typical audio visual stimuli which are employed in violent videogames when the user's avatar gets hurt, (iii) introduction of the proposed biofeedback technique in the previous condition. We carry out an electrodermal analysis showing that the introduction of the proposed technique produces much higher physiological arousal in terms of skin conductance level (SCL) than the other two conditions. Subjective measures of users' state anxiety are consistent with the recorded physiological reactions.

Keywords. biofeedback, anxiety induction, auditory heartbeat perception, stress, virtual environments

Introduction

Anxiety induction and elicitation of associated strong physiological arousal with Virtual Environments (VEs) is important for diverse domains such as stress inoculation training in soldiers and medical responders [1], treatment of stress-related disorders [3], phobia therapy [5] and assessment [6], and as a stimulus in several psychology experiments. Explorations of which techniques are effective to induce anxiety in VEs and their relative strength in physiological arousal are thus needed.

While biofeedback-enhanced VEs are often used to decrease stress and anxiety [4], in this paper we test biofeedback for the opposite purpose, i.e. to increase anxiety and physiological arousal. The idea we explore is to use a biofeedback mechanism based on auditory perception of the user's own heartbeat and the possibility to digitally alter that perception when the VE has to induce anxiety. The idea is inspired by the fact that hearing our own heartbeat becoming abnormal is an anxiety-inducing cue and studies of anxiety-sensitive individuals [7] have shown that, among the features of a panic attack, cardiac symptoms are rated as the most anxiety-provoking.

1. Method

To test the effectiveness of the proposed approach, we carried out a between-groups study with three conditions. The employed VE reproduces a real-world anxiety-inducing situation, i.e. being suddenly surrounded by smoke during a fire evacuation of

a building.

In the first condition, an horizontal green bar (Figure 1) is employed to display the level of health of the user's avatar: the bar progressively decreases in length when the participant is in the anxiety-inducing situation, indicating that the participant is being hurt by smoke.
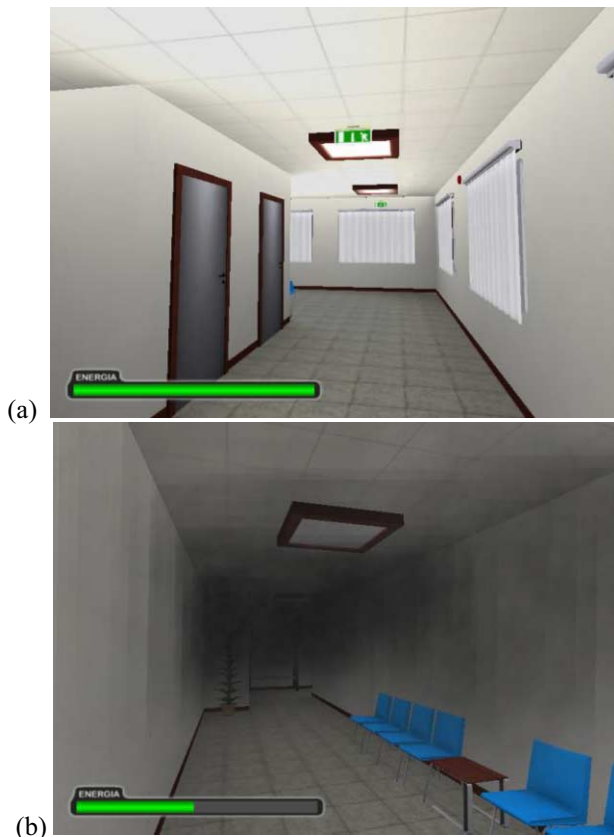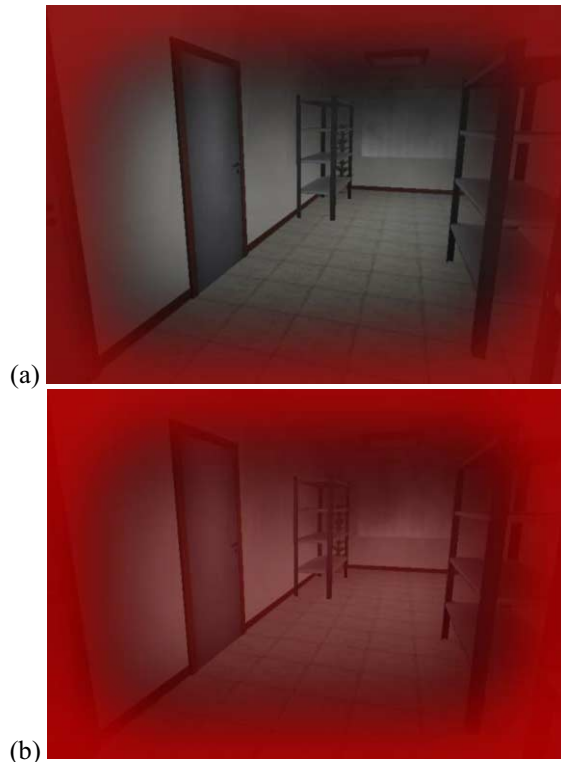

Figure 1. Examples of participant's view in the first condition. The green bar is respectively indicating that: (a) the user's avatar is fully healthy, (b) the user's avatar is being hurt by smoke inhalation.

In the second condition, the green bar is replaced by auditory and visual stimuli that violent videogames routinely employ to indicate that the user's avatar is being hurt. More specifically, when the participant is in the smoke situation, two audio files are played (a digital recording of an heartbeat sound that increases in frequency, and a digital recording of a respiration sound that increases in frequency) while the visual field of view is reduced to simulate tunnel vision phenomena which occur in extreme stress conditions (Figure 2a) and a red aura flashes (Figure 2b) in synch with the heartbeat sound.

The third condition is identical to the second one except for the fact that the heartbeat sound is controlled by the proposed technique: when the participant is not in the anxiety-inducing situation in the VE, she hears her actual heartbeat through the headphones of the head-mounted display (HMD), while confronted with the anxiety-

inducing situation the frequency of the heartbeat sound is linearly increased via software until it doubles, e.g., if the actual heart rate of a participant is 75 BPM during the 10 seconds that precede the smoke situation, the frequency progressively rises to 150 BPM during the smoke situation. When the participant exits smoke, frequency returns to the actual one in about 1 second. To detect the participant's cardiac frequency, we employ a pulsioxymeter on the participant's earlobe.

(a)

(b)

Figure 2. Examples of participant's view in the second and third condition: (a) tunnel vision phenomena, (b) the red aura flashes.

We recruited 108 (84 male, 24 female) participants through personal contact and a campus mailing list for general announcements. Participants were volunteers who received no compensation. Most of them were students enrolled in different programs (engineering, medicine, computer science, business administration, architecture). The mean age of participants was 24.1 (SD=3.2).

To measure participants' level of arousal elicited by the three conditions, we recorded skin conductance level (SCL), which is increasingly used in cyberpsychology studies of stress and anxiety, e.g. [5] [6] [8]. Questionnaire-based measures of state anxiety were also acquired before and after the experience using the state anxiety part (20 items) of the State-Trait Anxiety Inventory (STAI). Initial questionnaires included previous experience with VEs and videogames to ensure that there were no significant differences of that kind among the three groups. There were also no significant differences between the initial levels of state anxiety measured in the three groups by

the STAI that participants filled before the experience.

Skin conductance electrodes were applied to two fingers of the non-dominant hand, and the pulsioxymeter to the earlobe of participants. Although the pulsioxymeter was needed only for the third condition, we used it with all participants to avoid introducing a confounding factor. Once the sensors were in place, participants were asked to relax for three minutes to record baseline values. During baseline recording, a video with relaxing images and music was shown in a dim light. Participants could close their eyes and only listen to the music if they preferred.

Participants experienced the VE through a stereoscopic HMD with 800*600 resolution, 31.2° field of view, 3DOF head tracker, audio headphones, and using a Nintendo Nunchuk joystick in their dominant hand to control movement. After participants donned the HMD, they were immersed in a training environment (a small building) to familiarize with joystick control. After familiarization, the participant was immersed in a room of a large building and was told to reach the exit of the building by following the usual signs placed on the walls of public buildings. Along the way, participants were subjected to the anxiety-inducing experience, whose timing and duration was the same for all groups. The first smoke situation occurred after 1 minute from the start of the virtual experience: the participant was surrounded by smoke coming from all directions, the smoke cloud (together with the previously described associated stimuli) persisted around the participant for 30 seconds, regardless of her movements. After this first event, smoke retreated and the environment in which the participant moved was smoke-free for 1 minute. Then, the second event started with smoke surrounding the participant and the associated stimuli provided for 30 seconds. This ended the entire experience (the large size of the building was designed to ensure that it was impossible to reach the exit within the time length of the experience): the environment faded away, and after a few seconds we invited the participant to remove the pulsioxymeter and HMD, and administered again the STAI.

2. Results

Baseline SCL values were subtracted from the data recorded during the experimental conditions to separate the physiological responses to the conditions from the intrinsic biological differences among participants [2]. At the group level, extreme outliers (values which are smaller than Q1–3*IQR or greater than Q3+3*IQR, where Q1 is the first quartile, Q3 the third quartile, and IQR the interquartile range) were removed. There was 1 extreme outlier in the first condition, 2 in the second, and 1 in the third condition. Then, we ran a between-subjects ANOVA with SCL as dependent variable that revealed a significant effect, $F(2,101)=7.85$, $p<.01$, $\eta^2=.14$. Bonferroni post-hoc analysis showed that, while the difference between the two conditions which did not employ the biofeedback technique was small and not significant, the difference between the biofeedback condition and the first ($p<0.01$) as well as the second ($p<0.05$) condition was significant, with the biofeedback condition eliciting much more physiological arousal than the other two. The average increase in SCL with respect to baseline values with the three conditions was respectively 0.01 (SD=.31), 0.07 (SD=.19), and 0.30 (SD=.46) μS.

Change in state anxiety measured by the STAI questionnaire (obtained by subtracting the STAI scores before the VR experience from those after it) were consistent with the indications of the SCL analysis: the effect on change in state

anxiety was significant, $F(2,105)=4.06$, $p<.05$, $\eta^2=.07$; the average increase in STAI scores for the three conditions was respectively 1.5 (SD=6.3), 2.2 (SD=7.4), and 5.5 (SD=5.3); Bonferroni post-hoc analysis revealed a significant difference ($p<0.05$) for the change in STAI scores between the biofeedback condition and the first condition.

3. Conclusion

The experiment presented in this paper has shown the effectiveness of the proposed technique. In particular, while the difference between the two conditions which did not employ the biofeedback technique was small and not significant, the biofeedback condition elicited much more physiological arousal than the first as well as the second condition.

Being based on auditory heartbeat perception, the proposed technique can be generally applied to any existing VE without making graphics changes (in our case, the third condition of the experiment differed from the second one only in the introduction of the biofeedback technique, leaving the graphic elements unchanged). Therefore, the proposed technique can be useful and of interest to any researcher and practitioner who needs to induce anxiety in a VE or to augment her currently employed anxiety-inducing techniques.

We are now continuing the exploration of the effects of the technique with respect to additional variables (e.g., risk perception) as well as different VEs.

Acknowledgements

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Quality of Experience in Real and Virtual Environments: Some Suggestions for the Development of Positive Technologies

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Abstract. What does one feel when one uses virtual reality? How does this experience differ from the experience associated with "real life" activities and situations? To answer these questions, we used the Experience Sampling Method (ESM), a procedure that allows researchers to investigate the daily fluctuations in the quality of experience through on-line self reports that participants fill out during daily life. The investigation consisted in one-week ESM observation (N=42). During this week, participants underwent two virtual reality sessions: Immediately after the exposure to virtual environments, they were asked to complete a ESM report. For data analysis, experiential variables were aggregated into four dimensions: Mood, Engagement, Confidence, and Intrinsic Motivation Intrinsic Motivation. Findings showed that virtual experience is characterized by a specific configuration, which comprises significantly positive values for affective and cognitive components. In particular, positive scores of Mood suggest that participants perceived VR as an intrinsically pleasurable activity, while positive values of Engagement indicate that the use of VR and the experimental task provided valid opportunities for action and high skill investment. Furthermore, results showed that virtual experience is associated with Flow, a state of consciousness characterized by narrowed focus of attention, deep concentration, positive affect and intrinsic reward. Implications for VR research and practice are discussed.

Keywords. virtual reality, Presence, Flow, experience sampling method, quality of experience

Introduction

So far, virtual reality (VR) experience has been mainly investigated from the perspective of "Presence", broadly defined as the feeling of "being there" [1]. This type of research has been mainly conducted in laboratory settings to assess how specific system variables (such as perceptual fidelity, interaction modalities, duration of exposure and many others) affect perceived "feeling of reality" [2]. However, to our best knowledge, there has been no attempt to compare the profile of virtual and real experiences. Here, we report findings of a study that investigated the subjective experience associated with virtual and daily-life activities, in its cognitive, affective and motivational components. A more specific objective was to assess whether the use of VR is associated with Flow, an optimal experience characterized by high concentration, enjoyment, engagement, focused attention, and intrinsic motivation [3]. To study virtual and real experiences, we used the Experience Sampling Method (ESM), a procedure based on repeated online assessments of the external situation and personal states of consciousness [4].

1. Method

1.1. Participants

A sample of 42 students (27 females and 15 males, $m = 21.0$, $sd = 1.4$), was recruited from the Faculty of Medicine of the Public University of Milan. All participants volunteered to take part in the research with no monetary or other forms of compensation.

1.2. Materials and procedure

Quality of experience in real and virtual situations was assessed by means of the ESM. Participants filled up self-report forms in response to random signals sent by an electronic pager 6-8 times a day for one week. Each ESM form contains open-ended questions about situational variables such as place, activities carried out, social context, and subjective variables such as the content of thought, perceived goals, and physical conditions. The form also contains 0-12 Likert-type scales investigating the quality of experience in its various components: affect, motivation, activation, and cognitive efficiency. Two additional scales investigate participants' perceived levels of challenges and skills in the activity carried out when beeped. The week of observation included two VR sessions within the laboratory, taking place in non-consecutive days. The VR system consisted of a portable PC, a head-mounted display equipped with head-tracking sensor, and a joypad used to navigate through the virtual scenes. Each VR session had the following structure. First, participants were trained to use the VR system. After training, they were given instructions about the experimental task, which consisted in exploring an open space (a virtual beach) or a closed space (a virtual supermarket) and counting loudly the male and female virtual characters. The task was designed to induce participants exploring the whole virtual space, while keeping their attention focused on its content. The order of presentation of the VEs in the two sessions was counterbalanced across participants. Immediately after the exploration of the virtual environment, which lasted averagely 5 minute, participants were asked to fill out a ESM self-report form.

1.3. Data analysis

After one week of observation, all participants, except one, returned the booklet of ESM forms. Given the repeated sampling, Lykert-type scales data were standardized ($M = 0$; $SD = 1$) on each participant's weekly mean for every variable before performing the analyses. ESM data can be aggregated at the report level (the unit of analysis is the single self-report) or at the subject level (the unit of analysis is the participant). In the present study, most of the analyses were conducted using the subject-level aggregation, because this approach avoids problems related to unequal weights and produces more conservative significance tests [5]. We used factor analysis (Varimax rotation) to identify four main dimensions of experience: Mood (cheerful, happy, sociable, friendly), Engagement (alert, active, concentrated, involved), Confidence (clear, control, satisfied), and Intrinsic Motivation (free, wish to do the activity, relaxed). Cronbach alpha confirmed the groupings for the subsequent data analysis: Mood ($\alpha = .85$), Engagement ($\alpha = .82$), Confidence ($\alpha = .73$), and Intrinsic Motivation ($\alpha = .54$). In order to assess the influence of challenges' and skills'

perception on the overall quality of experience, we used the Experience Fluctuation Model [6]. The model is built on the Cartesian plan, whose coordinates are the standardized values of perceived skill (x-axis) and perceived challenge (y-axis). The origin of the axes is zero and corresponds to the aggregated subjective mean. The model is divided into eight circular sectors (channels), each representing a specific experiential state. More specifically, channel 2 is characterized by an above-average balance between challenges and skills. In this channel, most of the examined samples report optimal experience, the complex and positive psychological state described in the introductory paragraph. In channel 4, the perception of higher-than-average skills and lower-than-average challenges is associated with an experience of relaxation. In channel 6 (challenges and skills scoring lower than average) a negative and disordered state of consciousness is reported, called apathy. In channel 8, skills are lower and challenges higher than subjective mean: the related state has been labelled as anxiety. The remaining channels represent intermediate experiential states, and are referred to as transition channels.
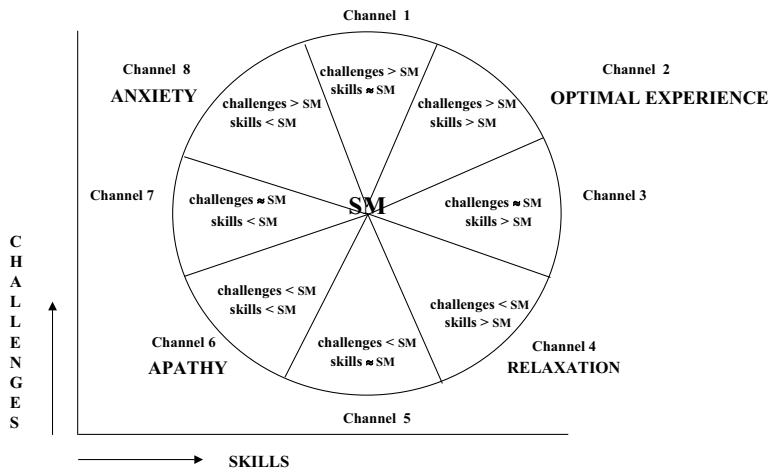

Figure 1. The Experience Fluctuation Model

2. Results

2.1. Virtual reality versus daily activities

We compared VR experience profile with that reported in different daily activity categories, namely: studying at home, free-time activities (which included hobbies and sport activities), socializing, and watching television. Fig. 2 shows the channel distribution in selected activities. In VR, the prevalent experience was anxiety (28%) followed by Flow (20%).
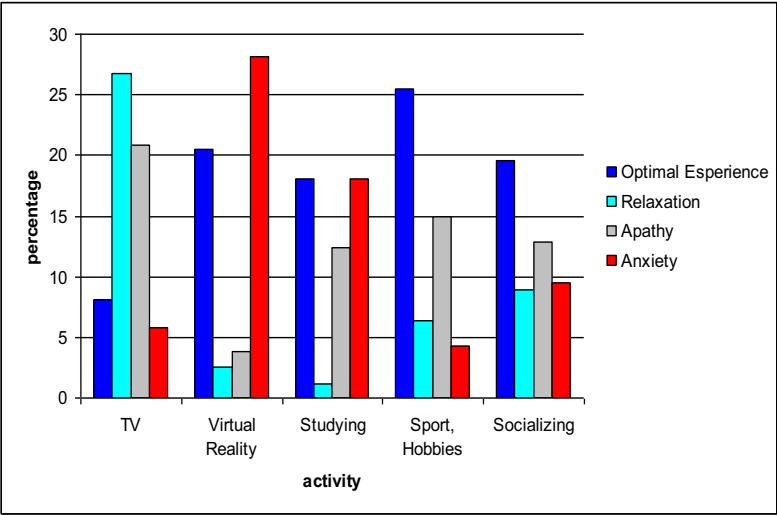
Figure 2. Channel distribution in the selected activities in daily activities and VR

In contrast, watching TV was mostly associated with relaxation (27%), and apathy (21%), while Flow was linked with this activity in only 8% of reports. The most frequent experiences associated with studying were anxiety (18%) and optimal experience (18%). Not surprisingly, free-time activities were highly associated with optimal experience (25%).

2.2. Quality of experience in virtual reality

In order to explore the specific features of the virtual experience, we compared the scores of the experience dimensions in the four main channels with the subjective mean. To perform the analysis, we used the subject-level approach. Anxiety in VR was characterized by quasi-significant positive scores of Mood (t = 2.1, p<.057), significantly positive scores of Engagement (t = 9.4, p<.001) and significantly negative scores of Confidence (t = -2.3, p<.05). On the contrary, Flow in VR showed significantly positive values of all variables: Mood (t = 7.5, p<.001); Engagement (t = 9.0, p<.001); Confidence (t = 6.2, p<.001) and Intrinsic Motivation (t = 5.2, p<.001). In relaxation and apathy, values did not significantly differ from the subjective mean.

3. Discussion

The above findings describe the specific features of virtual experience, characterized by significantly positive values of affective and cognitive components. Positive scores of Mood indicate that participants mostly perceived VR as an intrinsically enjoyable activity, while positive values of Engagement (alert, active, concentration, involved) confirms that the use of VR provides high opportunities for action and skill investment [7]. Perception of high challenges explains why VR was mainly associated with anxiety and Flow. Anxiety occurred when participants felt the demands of interacting with the VE higher than their abilities, whereas Flow was associated with a perceived balance between challenges and skills. The experience of anxiety in VR was characterized by

positive scores of Engagement and negative scores of Confidence. In contrast, Flow in VR was characterized by positive scores of all aggregated dimensions: Mood, Engagement, Confidence, and Intrinsic Motivation. Therefore, the common feature between anxiety and optimal experience in VR is the positive scores of Engagement. Since the variables comprised in the Engagement dimension (alert, active, concentrated, involved) are often used to describe the "cognitive core" of Presence [8], these findings support the hypothesis [9; 10] that Flow and Presence share similar cognitive features.

4. Conclusion

Previous research has shown that Flow can be associated with any activity, provided that complex challenges are perceived [11]. In VR, challenges might be represented by the use of a novel technology, the virtual situations and the increasing complexity of tasks to be performed. These findings have implications for positive applications of VR technology. By enhancing the experienced level of Presence, VR can foster optimal (Flow) experiences triggering the empowerment process (transformation of Flow) [12; 13]. The Flow-inducing characteristics of VR technology may therefore be effectively used to enhance applications in education, training and rehabilitation.

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A System for Automatic Detection of Momentary Stress in Naturalistic Settings

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Abstract. Prolonged exposure to stressful environments can lead to serious health problems. Therefore, measuring stress in daily life situations through non-invasive procedures has become a significant research challenge. In this paper, we describe a system for the automatic detection of momentary stress from behavioral and physiological measures collected through wearable sensors. The system's architecture consists of two key components: a) a mobile acquisition module; b) an analysis and decision module. The mobile acquisition module is a smartphone application coupled with a newly developed sensor platform (Personal Biomonitoring System, PBS). The PBS acquires behavioral (motion activity, posture) and physiological (hearth rate) variables, performs low-level, real-time signal preprocessing, and wirelessly communicates with the smartphone application, which in turn connects to a remote server for further signal processing and storage. The decision module is realized on a knowledge basis, using neural network and fuzzy logic algorithms able to combine as input the physiological and behavioral features extracted by the PBS and to classify the level of stress, after previous knowledge acquired during a training phase. The training is based on labeling of physiological and behavioral data through self-reports of stress collected via the smartphone application. After training, the smartphone application can be configured to poll the stress analysis report at fixed time steps or at the request of the user. Preliminary testing of the system is ongoing.

Keywords.psychological stress, physiological monitoring, wearable sensors, knowledge models, decision support system

Introduction

Mobile phone usage has already been harnessed in health care generally, but in thelast few years the use of mobile devices has being explored also in the mental health field [1]. An emerging area of research is the use of mobile devices, in particular smartphones, as support tools for the treatment of anxiety disorders [2; 3] and stress management [4; 5]. Taken together, results of these pioneering studies support the use

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of mobile phones for the assessment and management of stress: they offer an attractive possibility to bridge the gap between inpatient and outpatient treatment if supported by a real-time monitoring of stress.Repeated exposure to psychological stress is associated with several diseases, including cardiovascular disease, HIV/AIDS, cancer and clinical depression [6]. Stressful events may influence the pathogenesis of physical diseases by causing negative affective states (e.g., feelings of anxiety), which in turn exert direct effects on biological processes or behavioural patterns that influence disease risk. Therefore, measuring stress in daily life situations through non-invasive procedures has become an important challenge [7].Previous works suggests that Hearth Rate Variability (HRV) may represent a viable measurement for the continuous assessment of stress in ecological contexts, because it directly reflects the natural variability of heart rate in response to affective and cognitive states [8; 9]. However, the classification of physiological response requires appropriate strategies to a) control the confounding effect of physical activity, and b) correlate physiological data to perceived stress levels (ground truth).

1. Method

To address these challenges, we designed and developed a mobile system that allows to automatically detecting stressful events from sensor data (ECG and accelerometer), following a training process in which the system learns the association between physiological input and self-reported stress levels. Detected stress events are reported to the user and graphically displayed on the mobile phone application. The system's architecture consists of two main components: a) a mobile acquisition module; b) an analysis and decision module.

1.1 Mobile acquisition module

The mobile acquisition module is a smartphone application running on Android coupled with a newly developed sensor platform (Personal Biomonitoring System, PBS) [10]. The PBS acquires physiological variables (ECG, respiration signal) and motion activity(via a three-axis accelerometer), performs low-level, real-time signal pre-processing, and wirelessly transfers datato the smartphone application using a Bluetooth protocol. The mobile application implements dedicated algorithms to filter, process and extract relevant features from the three lead ECG and three-axis accelerometer signals. In addition,the mobile acquisition module collects self-reported stress levels, which are used as ground truth to train the decision module. All data collected by the acquisition module are sent to a remote database.

1.2. Decision module

The decision module allows classifying the current stress level using data collected by the acquisition module. At regular intervals, the decision module queries the remote database and downloads data related to all users and sessions. The decision process is implemented using an Artificial Neural Network and a fuzzy-logic rule-based algorithm. The fuzzy-logic rule-based algorithm consists of three steps: fuzzification, inference and defuzzification. The fuzzification converts the input from continuous values to linguistic variables through the definition of membership functions. The inference engine applies a set of fuzzy rules to generate linguistic values as output. In

the final, defuzzification step, the linguistic variables are converted to continuous values (real outputs of the system) [11]. We developed membership functions and fuzzy rules for each relevant parameter, including heart rate, LF/HF and motion activity (Figure 1). The fuzzified features extracted are the inputof the classifier, a Kohonen's self-organizing artificial neural networkbased on unsupervised learning [12]. Data processing in the decision module consists of a *training phase* and a *test phase*. In the training phase, the self-organizing map is trained to adapt itself to classify the input features. The training set includes features extracted from sensors and self-reported stress levels. With the support of a learning algorithm, synapticweights of networks are modified, in order to force the output to minimize the error with the presented example (in this case, self-reported levels of stress). In the *test phase*, the fuzzified features are given as an input to thenetwork.When the neural network is adequately trained, it is able to classify the given input in order to present a consequent output value (the inferred stress level).When the decision module infers a new stress level value, this is uploaded to the remote database.
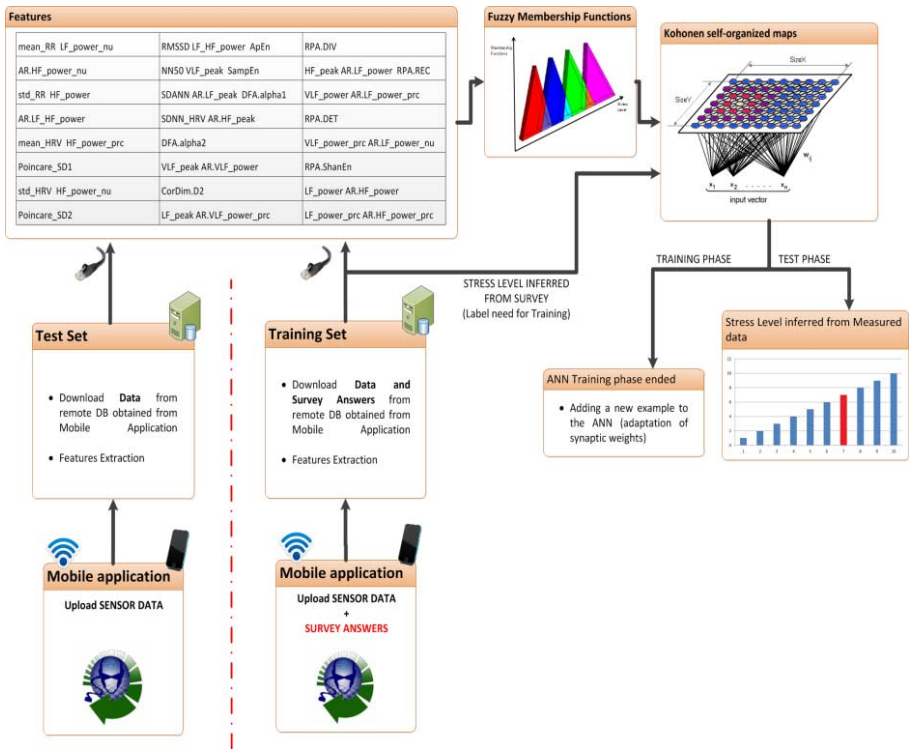

Figure 1. Architecture of the decision module: Artificial Neural Networks and Fuzzified Inputs, in training and test phases.

1.3. Visualization of stress levels

When the training of the artificial neural network is completed, the mobile applicationgoes in "stress monitoring mode" andcan be configured to poll the stress levels reportfrom the remote database at fixed time intervals, or at user's request.The

Stressometer and *StressTracker* components of the mobile application provide the user with graphic representations reflecting the measured stress. The *Stressometer* (Figure 2a) displays the current stress level of the user, which can be either a recent accurate estimate acquired from the central decision module, or an HRV-based approximation from the lightweight mobile decision module. Apart from the instantaneous values, the user can check the history of stress-level variations during the monitoring period. This information is visualized by the *StressTracker* (Figure 2b), which shows the number of detected stressful events over the course of last day, week, or month.
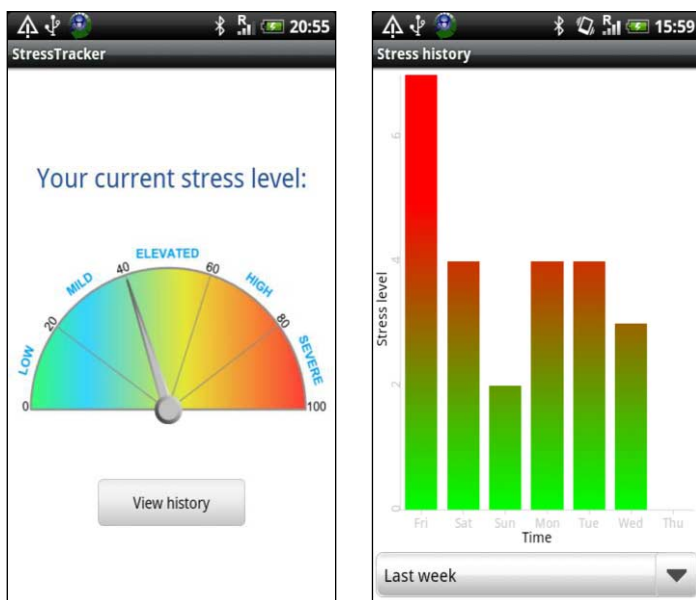
Figure 2a. The *Stressometer* (left) and **2b.** *StressTracker* (right) components of the mobile application.

2. Results

The system is currently being tested for validation in a pilot study involving healthy volunteers.

3. Conclusions

We present apervasive architecture for automaticdetection of stress levels with a minimal discomfort for the user. Differently from the state-of-the-art, our system is suitable for prolonged stress monitoring during daily activities. The innovative contribution of the proposed solution relies on the processing approach, able to automatically identify stress conditions of the user from the combination of psychological, physiological and behavioural information collected in ecological contexts.

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Immersive Virtual Environment for Visuo-Vestibular Therapy: Preliminary Results

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Abstract. The sense of equilibrium aggregates several interacting cues. On vestibular areflexic patients, vision plays a major role. We developed an immersive therapeutic platform, based on 3D opto-kinetic stimulation that enables to tune the difficulty of the balance task by managing the type of optic flow and its speed. The balance adjustments are recorded by a force plate, quantified by the length of the center of pressure trajectory and detection of disequilibrium corrections (leans, compensation step). Preliminary analysis shows that (i) patients report a strong immersion feeling in the motion flow, triggering intense motor response to "fight against fall"; (ii) the ANOVA factorial design shows a significant effect of flow speed, session number and gaze anchor impact. In conclusion, this study shows that 3D immersive stimulation removes essential limits of traditional opto-kinetic stimulators (limited 2D motions and remaining fixed background cues). Moreover, the immersive optic flow stimulation is an efficient tool to induce balance adaptive reactions in vestibular patients. Hence, such a platform appears to be a powerful therapeutic tool for training and relearning of balance control processes.

Keywords. Virtual Reality; clinical study; vestibular areflexy; visual immersion; visual-vestibular interaction; balance control.

Introduction

The human balance control system uses several aggregated sensory information (vision, vestibular, proprioception and somatosensory). It is well known [1] that among these sensory interactions, the visual-vestibular one plays a major role on the postural adjustment to visual disturbance. Patients with vestibular deficits show defective balance mechanism; leading to equilibrium troubles, up to fall. The classical therapy involves opto-kinetic stimulation technique that immerses the patient into a visual moving scene, made of a dense field of projected sparkling dots. The projected motion (essentially 2D) is far from the real characteristics of the natural optic flow used by the visual system to control equilibrium.

It has been demonstrated that immersive virtual reality is appropriate to study reactive balance control [2, 3] to question visual-vestibular disorders [4, 5], or as a therapy for balance disorders [6, 7, 8, 9]. We have demonstrated [3] that virtual optic flow using perspective and parallax effects enable to immerse healthy subjects into 3D

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scenes and provide stronger stimulation of functional visuo-vestibular regulation for balance control than regular 2D projections.

1. Hypothesis of the Study

The aim of the complete study is to measure, for vestibular areflexic patients, the therapeutic effect of the visual optics flows on the postural reaction to stabilize the standing posture. We postulate that virtual optic flow drives visuo-postural adaptation and stimulate the relearning of balance control strategies for vestibular patients. We hypothesize that: (H1) our visual flows do trigger strong adaptive postural adjustments; (H2) those adjustments do interfere with balance control, and impose patients to develop alternative sensory-motor strategies; (H3) varying flow speed and gaze anchoring does change the balance task difficulty.
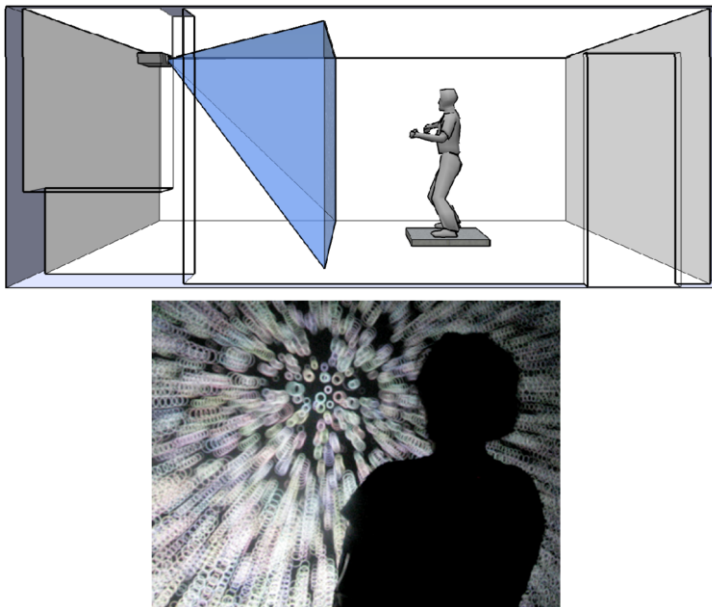
Figure 1. Left: Drawing of the *PIVViiT* immersive platform, set up in an available room of the hospital. The large retro projected screen is at 60 cm of the patient, covering most of his visual field. The patient is standing on a force plate, recording center of pressure trajectories. **Right**: Photo of a patient viewing the forward-moving stimulus.

2. Methodology

The present paper is the result of collaboration between specialists of computer graphics from the *INRIA Grenobles-Alpes* research center, of vestibular disorders from the *Grenoble University Hospital ENT Clinic* and of cognitive neurosciences from the *GIPSA-Lab*.

2.1. Experimental setup

The platform (Figure 1 left) is based on a single PC, a video projector and a large retro projection screen (*3 m × 2.4 m*). The system generates smoothly moving stimuli at 120Hz. A *WiiFit balance board* records the *center of pressure* trajectory (CoP) at foot level at 100 Hz, with a precision > *0.1 mm*. For security, we added lateral supports to lean in case of disequilibrium.

2.2. Subjects

Nine volunteer patients (aged from 44 to 61, mean 52, 3 males and 6 females) participated in the clinical study. All of them are impaired by unilateral vestibular areflexia (consequences of peripheral vestibular disorders: e.g. neurinoma or vestibular neurectomy), and where screened by the *dizziness handicap inventory* test (DHI-test) [10]. The protocol was approved by the French ethical medical research committee (CPP). This paper presents preliminary results.

2.3. Protocol

Subjects stand upright, on the balance recording force-plate, in front of a large immersive screen (see Figure 1). Moving visual flows are projected, and the subjects have to stabilize their balance, in reaction to the visual perturbation.

The complete study consists of ten immersive sessions: the first four with a visual anchoring target (a visual target visible or not at the screen center), the last four without. Each session consists of 6 identical blocks of trials with increasing speed of the visual flow. Each block is composed of 8 stimuli (upon the five: up-, down-, clock-, counter-clock- and forward-moving) in random order, lasting 15 sec, with 5 sec preparatory and 5 sec recovery periods. A 5 minutes resting period is imposed between blocks to alleviate fatigue impact. The factorial design is Anchor(2)×Session(4)×Speed(6)×Stimuli(5). Qualitative results were obtained by questionnaires.

2.4. Data Analysis

To compute the CoP trajectories, we use the four weight sensors at the corners of the force-plate that give the barycentric coordinates of the CoP. Force-plate data is filtered with a Butterworth low pass filter, with a cut-off frequency of 10Hz. To detect subject disequilibrium, we quantify lateral leans or compensatory step by computing the integral of body weight losses ratio (when greater than 5%). We used the *R* statistic software to test the hypothesis that CoP trajectory's length and disequilibrium indicator are related to the increasing speed of the flow, the session number, and the gaze anchor condition.

3. Results

Both qualitative and quantitative results demonstrated a real functional effect of the virtual immersion on balance control and self-confidence.
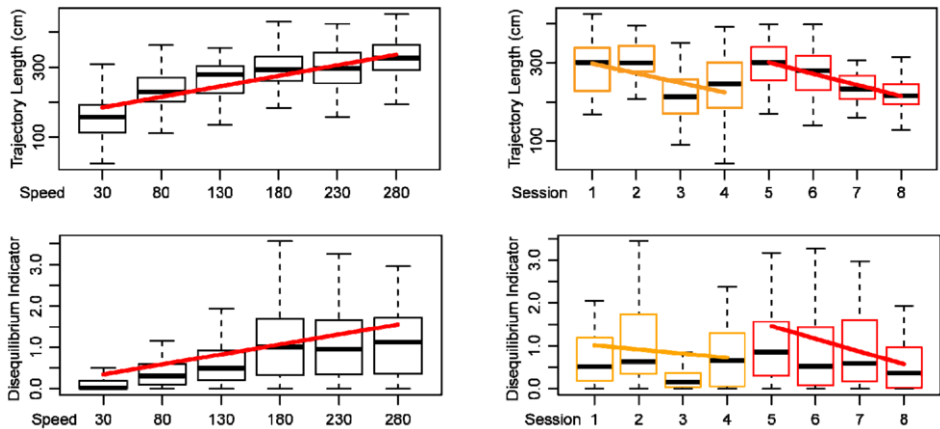
Figure 2. Results for a representative patient. **Top**: length of the center of pressure trajectory. **Bottom**: disequilibrium indicator, measured as weight losses ratio (due to lean on lateral supports or compensatory steps off the platform) integrated over time. **Left**: plotted against speeds. **Right**: plotted against sessions. The first four with the visual anchor (fixed target at screen center), the last four without. Boxes show medians, first and third quartiles, the whiskers represent 5% and 95% percentiles.

3.1. Qualitative results

All patient reported strong motion illusions that generated intense muscular efforts to maintain the upright standing position using "fight against fall". Most patients consider the 3D stimuli are more involving than traditional opto-kinetic, which could be explained by perspective and parallax [3]. Most patients also reported a self-confidence gain from the first sessions, up to resuming balance-dependent everyday life activities (gardening, housekeeping or cycling).

3.2. Length of the center-of-pressure trajectory

The ANOVA of CoP trajectory for a representative patient demonstrates that the three factors have significant effects. The increasing *speed of the optic flow* increases the CoP trajectory length from 185 cm to 336 cm, ($F(1,369)=258.2,\ p<0.001$), see Figure 2 top-left. *Repeating sessions* decrease CoP trajectory length by 73 cm for 4 sessions with visual anchor ($F(1,187)=27.7, p<0.001$), and by 86 cm for the 4 sessions without visual anchor ($F(1,180)=76.7,\ p < 0.001$), see Figure 2 top-right. The removal of the *visual anchor* adds an additional gap to the CoP trajectory length of 107 cm.

3.3. Disequilibrium indicator

The ANOVA of our disequilibrium indicator shows similar correlations to the same three factors. Increasing *speed of the visual flow* from 30 to 280 increases the disequilibrium indicator from 0.145 to 0.453 ($F(1,456)=9.5,\ p=0.002$), see Figure 2 bottom-left. *Repeating sessions* with visual anchor decrease the indicator by 0.171 ($F(1,223)=9.2, p=0.003$), by 0.162 for the 4 sessions without anchoring ($F(1,231)=11.2,\ p < 0.001$), with an additional gap of 0.307 added by *anchorage* removal, see Figure 2 bottom-right.

4. Conclusions

In this study, we demonstrated the efficiency of our virtual immersive platform to trig balance perturbations using virtual optic flow, which impose postural reactions to vestibular patients (H1). Patients reported that those perturbations have similar effects than those experienced in standard opto-kinetic protocols. We also demonstrate a habituation-like process along sessions with significant reduction of the postural adjustments (H2). Moreover, correlations demonstrate that difficulty of the exercises can be tuned (H3): Both the optic flow speed and the visual anchor presence do have a significant effect on postural reactions, as measured by the decrease of the length of the CoP trajectory and of the disequilibrium indicator.

Finally, this study shows that virtual 3D immersive systems are a valuable improvement to standard projection systems for opto-kinetic therapy. Moreover, recording patient's scores along sessions provides an objective measure of reduction of balance disorder and of strategies' effectiveness developed by the patient to evaluate and circumvent its visuo-vestibular disability.

Acknowledgments

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Automatic Mechanisms for Measuring Subjective Unit of Discomfort

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Abstract. Current practice in Virtual Reality Exposure Therapy (VRET) is that therapists ask patients about their anxiety level by means of the Subjective Unit of Discomfort (SUD) scale. With an aim of developing a home-based VRET system, this measurement ideally should be done using speech technology. In a VRET system for social phobia with scripted avatar-patient dialogues, the timing of asking patients to give their SUD score becomes relevant. This study examined three timing mechanisms: (1) dialogue dependent (i.e. naturally in the flow of the dialogue); (2) speech dependent (i.e. when both patient and avatar are silent); and (3) context independent (i.e. randomly). Results of an experiment with non-patients (n=24) showed a significant effect for the timing mechanisms on the perceived dialogue flow, user preference, reported presence and user dialog replies. Overall, dialogue dependent timing mechanism seems superior followed by the speech dependent and context independent timing mechanism.

Keywords. Virtual Reality exposure therapy, social phobia, anxiety level measurement, SUD score, speech recognition, speech detector.

Introduction

Social phobia is an anxiety disorder, where individual fear to do or say something in front of others that will be perceived as humiliating or embarrassing. The disorder is one of the most often occurring anxiety disorders, with reports that estimate this to affect 13.3% of the US population [1], 6.7% of European population [2], and 9.3% of Dutch population [3] during their live. The effect of this phobia on patients includes secondary depression and substance abuse (e.g. alcoholism, drug abuse), restricted socialization (e.g. professional, romantic and everyday informal social interaction), and poor employment and education performance [3]. Social phobia sufferers have a strong fear of social situations, such as talking in public, making a phone call, entering room with other people, ordering food in the restaurant, starting a simple conversation with strangers, etc.

The gold standard for treatment of social phobia is exposure *in vivo*, where patients are gradually exposed to these social situations. One significant limitation of exposure *in vivo* is the difficulty for the therapist to get adequate and controlled social

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interactions (e.g. arrange the audiences, setup specific situation, etc.). Virtual Reality (VR) can overcome many of the shortcomings of *in vivo* exposure; in addition it provides a treatment that is more readily accepted by clients [4, 5].

During an exposure session, therapists normally ask patients about their anxiety level often using the Subjective Unit of Discomfort (SUD) score instrument [8]. SUD is a scale from zero ("no anxiety at all") to 10 ("the highest level of anxiety that you can imagine") measuring the subjective intensity or level of anxiety the individual is experiencing. With the aim of developing a home-based VRET system, where the system can be used for home treatment in which the patient can perform self-treatment without intensive therapist supervision, this measurement ideally should be done automatically using speech technology. However, with a VRET system for the treatment of social phobia, patients might be involved in a dialogue with an avatar in a virtual environment.

Since the SUDs measurement is done automatically with speech technology, a key question becomes the timing of asking for a SUD score as unexpected interruption might negatively affect patients' experience in a given situation, since poorly timed interruptions can adversely affect task performance [9, 10] and emotional state [11] of the users. To study the proper timing of asking participants to rate their SUD score in the dialogue-based virtual world, three proposed timing mechanisms were examined: (1) dialogue dependent (i.e. naturally in the flow of the dialogue, e.g. just before the start of a new avatar questions), (2) speech dependent (i.e. when both patient and avatar are silent), (3) context independent (i.e. randomly, but in this study when the patient is talking, testing a worst case interruption scenario).

1. Method

To study the proper timing of asking participants to rate their SUD score, 24 participants (11 females) were recruited in the study that was approved by the university ethics committee. The age of the participants ranged from 23 to 39 years ($M = 30.3$, $SD = 4.7$). All participants had a university background (current master and PhD students). Further, all participants had seen 3D stereoscopic images or movies, and none of them reported to have been exposed to virtual reality before. At the start of the experiment participants received a short introduction about the overall aim of the study and signed a consent form. After this, they completed the Personal Report of Confidence as a Public Speaker (PRCS) and the basic information questionnaire. Subsequently, speech recognizer was trained.

The main part of the experiment consisted of three sessions with the virtual audience of avatars, talking about three out of four different topics (chosen randomly from the following topics: Democracy, France, Dogs and Penguins [4]). To help them during the initial 3 minutes presentation about the topic, they were provided with a sheet containing some general pointers to talk about, which did not overlap with the question sets of the avatars. The presentation phase lasted 2 to 3 minutes, after which avatars started the question and answer phase, which lasted around 1 to 2 minutes. All participants were exposed in a virtual environment using the Delft Remote Virtual Reality Exposure Therapy (DRVRET) system [7] extended with implementation of the three different dialog timing interruption mechanisms for automatic SUD measuring.

The DRVRET system architecture was customized with speech recognition and a speech detector engine interface. The speech recognition engine decodes and

recognizes the speech from patients and then processes this further. In the current setup, DRVRET used Microsoft SAPI (Speech Application Programming Interface) 5.4 based on Windows 7 combined with the SPINX speech engine interface as its main speech engine. Speech detector functioned as a Voice Activity Detection, a technique used in DRVRET speech processing in which the presence or absence of human-avatar speech is detected. The software package Vizard was used for the visualization of the virtual room and avatars. Animations for avatars were done using 3D Studio Max using key frame method. The hardware used was a Dell Precission T3400 with Intel quad core Q6700 @ 2.66 Ghz, 4 GB of RAM, with NVidia Geforce Quadro FX 4600 graphic card running on Windows 7 x64 bit and a Toshiba Satellite L300 laptop running on Windows 7 x32 bit. Participants sat behind a table equipped with microphone, facing a 3.5 by 2.5 meters virtual room projected with a screen resolution of 1280 x 1024 pixels at about two meters distance.

The experiment used a within-subject design and the order of three timing mechanism conditions was counterbalanced. In each session, participants were asked to complete the Igroup Presence Questionnaire (IPQ) [14], the Dialogue Experience Questionnaire (DEQ) [12] and the specially-designed questionnaire for this study to measure participants' experience after answering automatic SUD score questions: the SUD Score Experience Questionnaire (SEQ). During each exposure session participants were asked two to four times to rate their anxiety by giving SUD scores, depending on actual course of the dialogue between avatars and the participant.

2. Results

To study the effects of the timing mechanisms a series ANOVAs with repeated measures were conducted. A significant effect was found in the total SEQ score ($F(2,46) = 1065.24$; $p < 0.001$) and total DEQ score ($F(2,46) = 628.96$; $p < 0.001$). The total SEQ score (Table 1) suggests that participants rated the dialogue dependent timing mechanism as less interruptive than the speech dependent timing mechanism and the latter was again rated as less interruptive as the context independent timing mechanism.

The total DEQ score showed a similar pattern with regard to the dialogue experiences. Yet, an opposite pattern was found in the total IPQ score ($F(2,46) = 4.05$; $p = 0.024$). Participants rated presence highest for the context independent timing mechanism, while again the speech dependent in the middle and lowest for dialogue dependent timing mechanism. This might be a side effect of the phenomenon called Breaks In Presence [13] that participants might have experienced during the exposure, which occurs when they become aware of another reality. A possible explanation could be that the severity of the interruption made participants more aware of the break in presence switching from the virtual world to real world to answer SUD score questions, and back again to virtual world. Participants might have taken the intensity of break in presence as a sign of feeling present in the virtual world.

Table 1. Mean (SD) of measure for three timing mechanism.

Measure	Dialog Dependent	Speech Dependent	Context Independent
Total SEQ**	5.1 (0.6)	18.9 (2.2)	26.3 (2.0)
Total DEQ**	172.6 (3.3)	163.0 (4.5)	141.4 (4.0)
Total IPQ*	42.2 (3.5)	42.6 (3.5)	42.8 (3.5)

* $p < 0.05$; ** $p < 0.001$

During the experiment audio recordings were made of the dialogues between avatars and participants. To understand the effect of the interruption for SUD score the analysis of the recording focused on how the participants continue to talk with the avatars after they had given their SUD score. The participants' replies were coded with the following five labels: (1) detail answer, (2) normal answer (3) simple/short answer (4) "do not know" answer and (5) "lost in the dialog" answer. This resulted in five separate measures; each representing for a session the relative frequency of participants' replies that were coded with a specific label. With this coding scheme, three coders coded the audio recordings independently. Interobserver agreement was evaluated with Pearson's correlation analysis, showing (Table 2) acceptable agreement as all correlations were larger than 0.7 (all $p < 0.01$).

Table 2. Median (IQR) and Interobserver agreement of the relative frequency for five dialog replies in three conditions.

Measure	Dialog Dependent	Speech Dependent	Context Independent	Interobserver agreement (r)
Details answer	1.0 (1.7)	0.6 (1.2)	0.8 (1.3)	0.78 – 0.80
Normal answer	1.0 (1.9)	1.0 (1.9)	1.0 (1.7)	0.82 – 0.92
Simple/ short answer	0.7 (0.7)	1.0 (1.9)	1.0 (0.6)	0.80 – 0.89
"Don't know" answer*	0.0 (0.0)	0.0 (1.0)	0.0 (1.0)	0.98 – 1.00
"Lost in the dialog" **	0.0 (0.0)	0.0 (0.0)	0.0 (1.0)	1.00

* $p < 0.05$; ** $p < 0.001$

To test the overall effect of the timing mechanism on the participants' dialog replies, a series of Friedman test were conducted, using the five relative frequency measures as dependent measures (Table 2). No significant effect was found for the timing mechanism on participants' replies in the detail answer, normal answer and simple/short answer measures. However, a significant effect was found in the "don't know" answer ($\chi^2(2) = 6.05$, $p = 0.049$) and "lost in the dialog" answer ($\chi^2(2) = 22.00$, $p < 0.001$) measures. For more detailed analysis, paired comparisons with Wilcoxon Signed-Rank Tests were conducted on these two measures. In the "don't know" answer, only a significant differences was found between dialog dependent and speech dependent ($Z = -2.45$, $p = 0.014$) timing mechanism. Furthermore, in the "lost in the dialog" answer, significant differences were found between speech dependent and context independent ($Z = -3.03$, $p = 0.002$), and between dialog dependent and context independent ($Z = -3.03$, $p = 0.002$) timing mechanism.

3. Discussion and Conclusion

The results of the experiment seem to suggest that the automatic timing of asking participants to rate their SUD score could affect their subjective experience and their behavior in a dialogue-based virtual world. Although potentially more development intensive, in-cooperating the moment of asking for SUD score into the flow of the

dialogue out performs other timing mechanism such as speech dependent and context independent timing mechanisms. Future research is needed to replicate these finding with social phobic patients. These findings can help developers to re-advance current VRET systems by implementing speech-recognition-based SUD score assessment, a feature especially relevant in future home-based VRET systems equipped with automatic feedback loop control system.

Acknowledgment

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Pulse Oximeter Based Mobile Biotelemetry Application

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Abstract Quality and features of tele-homecare are improved by information and communication technologies. In this context, a pulse oximeter-based mobile biotelemetry application is developed. With this application, patients can measure own oxygen saturation and heart rate through Bluetooth pulse oximeter at home. Bluetooth virtual serial port protocol is used to send the test results from pulse oximeter to the smart phone. These data are converted into XML type and transmitted to remote web server database via smart phone. In transmission of data, GPRS, WLAN or 3G can be used. The rule based algorithm is used in the decision making process. By default, the threshold value of oxygen saturation is 80; the heart rate threshold values are 40 and 150 respectively. If the patient's heart rate is out of the threshold values or the oxygen saturation is below the threshold value, an emergency SMS is sent to the doctor. By this way, the directing of an ambulance to the patient can be performed by doctor. The doctor for different patients can change these threshold values. The conversion of the result of the evaluated data to SMS XML template is done on the web server. Another important component of the application is web-based monitoring of pulse oximeter data. The web page provides access to of all patient data, so the doctors can follow their patients and send e-mail related to the evaluation of the disease. In addition, patients can follow own data on this page. Eight patients have become part of the procedure. It is believed that developed application will facilitate pulse oximeter-based measurement from anywhere and at anytime.

Keywords. COPD, Wireless, Smart Phone, XML

Introduction

Home-remote monitoring is a beneficial way for the management of diseases. In this case, the biomedical data are collected from distance and transferred via the Internet to a central hosting service. The retrieved data are evaluated with decision support algorithms. There are so many studies related to the decision support applications in biotelemetry. In an online rule based study, all the information related to the person's basic life functions such as ECG, blood pressure and geographical location (GPS) are transmitted by means of GPRS to the control centre [1]. In Konstantikaki and colleague's' work, an open spirometry programme and a case-finding programme are statistically compared [2]. In Janckulik and colleague's' work, ECG data is sent to the PDA by means of Bluetooth technology. Then, these data are transferred to the remote server. For the analysis of received ECG data, a self-organizing neural network is used [3].

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Many studies have been conducted in this field. In Hebert and colleagues' work, when patients with severe respiratory illness requiring long-term oxygen therapy are remotely-monitored, hospital admissions are decreased by 50 percent, acute home exacerbations are decreased 55 percent, and the hospitalization costs are reduced by 17 percent, even after the costs of monitoring are included [4]. In Toledo and colleague's work, a feasible and reliable tele-homecare system for chronic obstructive pulmonary patients is presented. In this system, hospital admissions are decreased by 51 percent [5].

The technical details and the testing of pulse oximeter-based care application are presented in this paper. The application consists of finger-type pulse oximeter, a mobile smart phone, a XML web services, a web server database, and a web page. First of all, the pulse oximeter data are acquired by Bluetooth virtual serial port protocol. Then, the data are processed in real time on mobile smart phone with rule-based algorithm. If the evaluation has emergency condition, generated result is sent to the doctor by means of an SMS to take a precaution. The doctor can direct an ambulance or an emergency person to the related patient. In addition, generated and obtained data can be visualized on the web page.

This paper is organized in three sections. The first section aims to summarize healthcare monitoring and to emphasize the importance of wireless biotelemetry. The features and technical details of the pulse-oximeter based care application are presented in the second section. Finally, in the third section, the results are evaluated and the conclusion is presented.

1. Wireless Biotelemetry in Healthcare Monitoring

Wireless biotelemetry of biomedical signals is desirable in many research and clinical applications. These include but are not limited to biotelemetry and the recording of neural activity in laboratory animals and implantable devices for sensory [6]. In addition, the monitoring of biomedical data will have a critical value in many scenarios: for use in patient-clinician discussions at a later time; for connection to an alert system for both patient and provider who has warning of deteriorating clinical status; and/or for immediate linkage to databases, decision support systems, and algorithms for mobile patient self-management based on plans and parameters previously determined by caregivers [7]. It is expected that mobile health application will commonly be used in the next few years [8].

2. Material and Methods

As shown in Figure 1, finger type pulse oximeter (produced by NONIN) is used in the application. The weight of the device is 63. gr and can be used without interrupting the daily work.

Figure 1 Bluetooth enabled pulse oximeter [9]

In developed application, the patient can measure his/her own heart rate and oxygen saturation with this device. Then, the data is automatically sent to a smart phone by means of a Bluetooth serial port protocol. In transmission of data from the smart phone to the remote web server, GPRS, WLAN or 3G can be used. In this transmission, XML SOAP protocol is utilized. Patient can check own data with smart phone or on pulse oximeter screen. The retrieved data are evaluated and the rule-based decision-making is performed. In rule-based decision-making, the oxygen saturation threshold value is 80; the heart rate threshold values are 40 and 150 respectively. If measured oxygen saturation is below the threshold value or heart rate is out of the threshold values, measurement is accepted as an emergency condition. Then, SMS is sent to the doctor. The doctor may contact with hospital or ambulance for treatment purposes. In addition, the doctor or the patient can access generated and measured data with PHP-based web page. The web page provides statistical data about the development of the disease. Designed web page is shown in Figure 2.

Figure 2. Web page of the application

Shown in Figure 3, the designed application under study consists of three main units. These are patient, remote, and expert support units. The pulse oximeter test module, which communicates with smart phone, provides the reception of test results from pulse oximeter by means of the Bluetooth virtual serial port protocol. The decision support module is the most important module of application, which works on mobile phone. Nokia 5800 is used as a smart phone. This smart phone is cheap and also has adequate features such as 3G, WLAN, GPRS and Bluetooth facilities. Real time evaluation of data and the generation of the result is achieved using rule-based algorithm. The communication module provides connection with the remote unit that includes XML Web service. The XML Web service is used to store measured and generated data in the remote server database and also vice versa. GPRS, WLAN, or 3G networks can be used for transferring the data from smart phone to the remote server database.
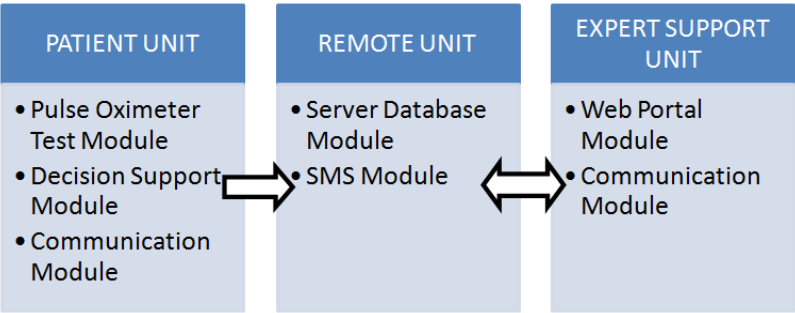
Figure 3. The technical structure of application

There is a MySQL in server database module that is located in remote unit. In this database, the test data of patients, and the generated results are stored. SMS can be sent through SMS module. In addition, BP-ANN results and recommended actions are converted automatically into SMS XML template in SMS module. Then, SMS is sent to the doctor for emergency purposes.

The web portal module, which is located in the expert support unit, provides secure accession through web page. It is used for patients' self control; revision and the tracking of patients' measured and generated test results. The doctor and the patient can send an e-mail to each other through web page for treatment purposes [10].

3. Results and Conclusion

The application is developed with Java 2 Micro Edition environment and tested with eight patients in home environment. The ages of patients are between 36 and 60. Selected patients are visited in their homes. During these visits, detailed information about pulse oximeter and a smart phone are given. They can easily use finger type pulse oximeter. In application trial, some elderly patients can't properly use the smart phone. However, patients who already have smart phone can easily use the application. For instance, a 42-years old patient who already has smart phone can easily use the application. In addition, he checks his pulse oximeter data with web pages.

The primary purposes of the study are to deliver the cost effective, real-time, ease of use, and quality healthcare for patients at home comfort over wireless network. It is expected that the application will provide reduction in the number of doctors visit, increase in the quality of life of patient, and decrease in the cost of treatment. In addition, the application will facilitate pulse oximeter-based measurement from anywhere and at anytime.

Acknowledgments

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Socially Anxious People Reveal More Personal Information with Virtual Counselors That Talk about Themselves using Intimate Human Back Stories

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Abstract. In this paper, we describe our findings from research designed to explore the effect of virtual human counselors' self-disclosure using intimate human back stories on real human clients' social responses in psychological counseling sessions. To investigate this subject, we designed an experiment involving two conditions of the counselors' self-disclosure: human back stories and computer back stories. We then measured socially anxious users' verbal self-disclosure. The results demonstrated that highly anxious users revealed personal information more than less anxious users when they interacted with virtual counselors who disclosed intimate information about themselves using human back stories. Furthermore, we found that greater inclination toward facilitated self-disclosure from highly anxious users following interaction with virtual counselors who employed human back stories rather than computer back stories. In addition, a further analysis of socially anxious users' feelings of rapport demonstrated that virtual counselors elicited more rapport with highly anxious users than less anxious users when interacting with counselors who employed human back stories. This outcome was not found in the users' interactions with counselors who employed computer back stories.

Keywords. virtual counselors, virtual humans, self-disclosure, human back story, anonymity, affective behavior, contingency, nonverbal feedback, psychotherapy

Introduction

Previous studies suggest that self-disclosure is a pre-requisite for verbal psychotherapy [5], and that this is increased when the social relationship between the client and therapist is reinforced by reciprocal self-disclosure [7]. These findings inspired the exploration of associations between self-disclosure and psychosocial disorders, such as social anxiety [8]. Social anxiety disorder has been reported to be the most common chronic psychological disorder, occurring in 18% of the general population [11].

The prevalence and gravity of this disorder inspired us to formulate a novel approach to current treatment. We investigated the potential use of virtual humans as counselors in psychotherapeutic situations, specifically in the socially anxious population. In our previous study [8], we found promising results for the use of virtual humans and interactive virtual environments in therapeutic settings for social anxiety disorder. We observed that socially anxious people revealed greater information and more intimate information about themselves when interacting with a virtual human

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when compared with real human video interaction, whereas less socially anxious people did not show this difference. We [9] also discovered that human clients tended to like virtual human counselors more when the counselors revealed intimate information about themselves compared to when they did not disclose it in virtual counseling situations. This trend has been observed in face-to-face counseling interactions with real human counselors as well. The virtual human counselor in our previous study [9] disclosed information about itself using computer back stories in psychotherapeutic interactions. In physical activity counseling interactions, Bickmore and his colleagues [3] discovered that users were more engaged in conversations with virtual counselors who talked about their back story in first person, e.g. "I workout for three hours per week," compared to third person, e.g. "Jane works out for three hours per week."

   Although previous research has been conducted on the use of virtual counselors, none of these studies has explored whether a counselor's different type of self-disclosure affects users' social responses such as verbal self-disclosure, specifically in the socially anxious population. Therefore, we conducted an investigation to explore this subject in psychological counseling situations. The research question that we formulated for this inquiry was:

> *Do socially anxious users reveal intimate information differently when they interact with virtual counselors who provide their self-disclosure and intimate details using human back stories, compared to other virtual counselors who used computer back stories to talk about themselves?*

In addition, we explored whether virtual counselors' self-disclosure consequently enhanced socially anxious users' feelings of rapport when they interacted with counselors that talked about themselves by employing human back stories or computer back stories.

1. Method

We designed a between-subjects experiment involving two different types of self-disclosure from virtual counselors in an interview interaction: i) human back stories, e.g. "I was born and raised in LA"; ii) computer back stories, e.g. "I was designed and built in LA." We measured users' dispositional social anxiety (the modified Cheek & Buss shyness scale) and verbal self-disclosure. For the data of verbal self-disclosure, we analyzed users' verbal self-disclosure to find whether a virtual counselor's self-disclosure consequently increased users' self-disclosure. The intensity of users' self-disclosure was rated by two coders independently using Altman and Taylor's three-layer categorization scheme [1]: a peripheral layer (low intimacy), an intermediate layer (medium intimacy), and core layer (high intimacy). The results of Krippendorff's alpha showed good inter-coder reliability between the two coders' agreements: Alpha = .83; Do (Observed Disagreement) = 4376.182; De (Expected Disagreement) = 25521.558.

   In addition, we assessed users' feelings of rapport using the Virtual Rapport scale which were created by combining the Co-presence scale [9] and the Rapport scale [13] used in our previous studies. The Virtual Rapport scale was constructed using Likert-type scale with an 8-point metric (1 = Very Little; 8 = Very Much or 1 = Very Unlikely; 8 = Very Likely) and composed of twenty three items (Cronbach's alpha = .93).

Forty people (50% women, 50% men; average 31 years old) were recruited from the general Los Angeles area using Craigslist.com and compensated for seventy five minutes of their participation. The participants were randomly assigned to one of the two experimental conditions. Participants were given instruction describing the counseling interview interaction. The interview questions were modified from ones used in our previous study [9]. The virtual counselors preceded each interview question with some information about themselves before asking each counseling question to participants. Participants (human clients) in all conditions viewed the virtual humans on a 30-inch screen display that approximated the size of a real human sitting 4 feet away. They wore a lightweight close-talking microphone and spoke into a microphone headset. The monitor was fitted with a webcam and a camcorder. To control for gender effects, two types of gender dyads were used in equal numbers in each experimental condition: male-male and female-female. The typical interaction was allowed to last about thirty minutes.

The Rapport Agents [6] were used as virtual counselors (see the image (a) in Figure 1) that presented timely positive feedback such as smile and head nods by detecting and responding to features of smile, voice, head nods and upper-body movements displayed by human clients (see the image (b) in Figure 1). To produce the verbal self-disclosure of the virtual counselor, an experimenter controlled buttons that retrieved pre-recorded voice messages.
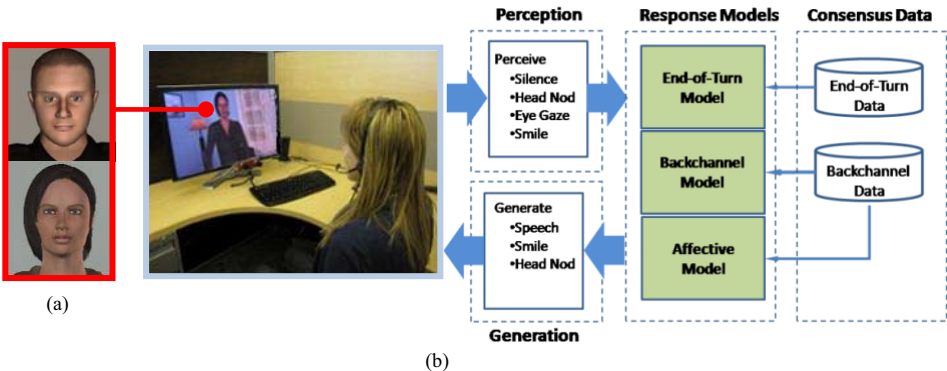
Figure 1. (a) Virtual counselors (Rapport Agents: male & female) (b) Interview interaction between a human client and a virtual counselor (with the system architecture of the Rapport Agent)

2. Results

We ran a between-subjects ANOVA analysis between two social anxiety levels (median split) and verbal self-disclosure. We observed a general trend of facilitated self-disclosure from more anxious users following interaction with a virtual counselor who employed a human back story (N = 20) rather than a computer back story (N = 20). The results $[F(1,18) = 4.60; p = .046; \eta^2 = .203]$ showed that more anxious users revealed personal information more (M = 12.98, SD = 2.43) than less anxious users (M = 9.75, SD = 4.10) when they were interviewed by virtual counselors that employed human back stories (see Table 1). The results $[F(1,18) = 4.18; p = .053; \eta^2 = .192]$ also showed that there

was a moderately significant difference between the level of intimacy seen in the answers from more anxious users (M = 31.79, SD = 6.39) and less anxious users (M = 23.42, SD = 11.08) in the same condition (see Table 1). There was no statistically significant difference in the amount [F(1,18) = .35; p = .56; η^2 = .019] and level of intimacy [F(1,18) = .42; p = .52; η^2 = .023] in the users' self-disclosure based on their level of social anxiety when interviewed by virtual counselors that employed computer back stories.

Table 1. ANOVA results with the explanatory variable *Social Anxiety Levels (median split)* and the response variables *Amount and Level of Intimacy in Self-Disclosure (%)* in the "Human back stories" condition

	More anxious (N=10)		Less anxious (N=10)		F	η^2	p
Amount in Self-Disclosure (%)	*M* 12.98	*SD* 2.43	*M* 9.75	*SD* 4.10	4.60	.203	.046
Level of Intimacy in Self-Disclosure (%)	*M* 31.79	*SD* 6.39	*M* 23.42	*SD* 11.08	4.18	.192	.053

We further ran ANOVA analysis to find users' Virtual Rapport associated with their anxiety levels in each condition. The results [F(1,18) = 5.14; p = .036; η^2 = .222] showed that more anxious users felt rapport more (M = 4.56, SD = 1.07) than less anxious users (M = 3.21, SD = 1.55) when they were interviewed by virtual counselors that employed human back stories (see Table 2). However, we did not detect a general trend of facilitated rapport building from more anxious users who interacted with a virtual counselor that talked about him/herself using a human back story rather than a computer back story. There was no statistically significant difference [F(1,18) = .28; p = .601; η^2 = .015] in users' feelings of rapport based on their level of social anxiety when interviewed by virtual counselors that employed computer back stories.

Table 2. ANOVA results with the explanatory variable *Social Anxiety Levels (median split)* and the response variable *Virtual Rapport* in the "Human back stories" condition

	More anxious (N=10)		Less anxious (N=10)		F	η^2	p
Virtual Rapport	*M* 4.56	*SD* 1.07	*M* 3.21	*SD* 1.55	5.14	.222	.036

3. Conclusions and Discussion

We found that the type of self-disclosure employed by virtual counselors, specifically human life stories, promoted greater verbal self-disclosure in highly anxious users and positively affected their sense of rapport more than less anxious users in interactions with virtual counselors. We discovered a general trend of facilitated self-disclosure from highly anxious users following interaction with the virtual counselors who employed human back stories rather than computer back stories. In our experiment sessions, we observed that users were quite impressed by our realistic characters, although they demonstrated awareness that the counselors were programmed and animated characters. We used a life sized, animated virtual human counselor that presented timely positive feedback by recognizing and responding to attributes of a user's behaviors. It is likely that users perceived the virtual counselors as real human counselors when the counselors self-revealed intimate information using human back stories. This phenomenon is demonstrated in the Computers as Social Actors Theory [12], which posits that people generally treat computers as if interacting with a real human. Existing literature [10] also notes that socially anxious people display more expressive behavior when their partner exhibits positive reactions to their behavior. According to

these findings, highly anxious users could have been more inclined to subconsciously reveal personal information more than less anxious users when the counselors presented timely positive feedback and talked about themselves using human back stories rather than computer back stories.

We found that there was no tendency toward greater rapport reported by highly anxious users when they interacted with the counselors who disclosed personal information using human back stories rather than computer back stories. Although highly anxious users experienced greater rapport than less anxious users when they communicated with the counselors that employed human back stories, the amount of rapport that highly anxious users reported was approximately the same level between both types of the counselors. This may have been related to users' perception of the virtual counselor as a programmed character, thus resulting in feelings like deception [2] or expectancy violation [4] when interacting with a virtual human that employed a human back story. It seems that users' existing views toward interacting with programmed characters contributed to the levels of rapport highly anxious users experienced for both interactions, regardless of whether counselors employed either human or computer back stories.

Based on our findings, we argue that virtual counselors should employ human back stories and likewise reveal intimate information about themselves in psychological counseling interactions in order to enhance socially anxious clients' self-disclosure. This approach would carry the most successful outcome and most likely encourage rapport building. Future work could explore effects of a virtual counselor's self-disclosure on the social responses of human clients who suffer from other types of psychological disorders.

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Use of Internet in an Italian Clinical Sample

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Abstract. This study is aimed at evaluating Internet use in a psychiatric population. We used the UADI questionnaire to investigate the degree of addictive Internet use in our sample of patients affected by various psychiatric disorders. Several psychological and psychopathological variables related to internet use, have been assessed through the five dimensions of the UADI: dissociation (DIS), Impact on real life (IMP), Experimentation (EXP), Dependence (DEP), Escape (ESC).

Keywords. Internet Use, Psychiatric disorders, level of education, UADI questionnaire

Introduction

It's well known that Internet use has an impact on real life. According to several studies, some people show a condition called Problematic Internet Use (PIU) [1] or Internet Addiction Disorder [2]. Even if there isn't a specific diagnostic category about this diagnosis, it's important to recognize the presence of a problematic Internet use in patients affected by psychiatric disorders to understand whether it can impact on their symptoms and on their daily life. The aim of this study is to explore the degree of a problematic internet abuse among outpatients affected by various psychiatric disorders and to analyze the main socio-demographic, psychological and psycho-pathological factors influencing normal/abnormal use of Internet, by the Italian self-report "U.A.D.I." questionnaire (Internet Use, Abuse and Dependence) [3].

1. Methods

One hundred sixty five patients affected by various psychiatric disorders were recruited at the outpatients Unit of Psychiatry of Palermo University Hospital. Ninety-four patients (58%; 46 M, 48 F; aged to 61 years, mean age = 37, SD= ± 12) regularly use internet; 71% of them has a middle/high level of education.
Patients were affected by: Anxiety disorders (32%), Mood disorders (25%), Psychosis (15%), Personality Disorders (16%), Adjustment Disorders (12%) (Figure 1).

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Figure 1. Clinical groups
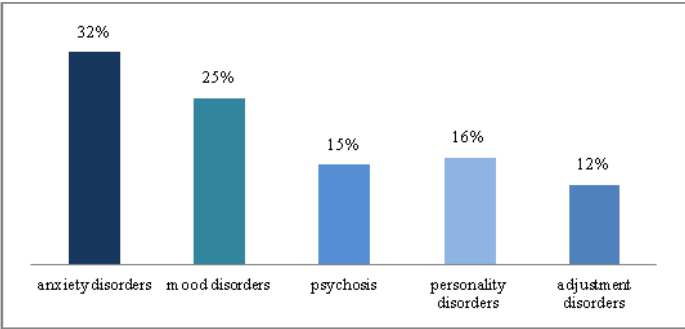
We used the "U.A.D.I." questionnaire to study psychological and psychopathological factors related to Internet use. It's a self-report questionnaire, with 5-point likert scale (totally true vs totally false); it's composed of 80 items. The cut off is 70; scores in between 31 to 69 indicate the presence of dimension but without a psychopathological meaning. It explores 5 dimensions: *Escape* (ESC), *Dissociation* (DIS), *Impact on real life* (IMP), *Experimentation* (EXP), *Dependence* (DEP).

Escape: it consists of items aimed at evaluating if Internet is a way to escape from real life difficulties and routine. Medium scores indicate that Internet is used as a way to escape, even if real life is not denied.

Dissociation: it consists of items aimed at evaluating dissociative experiences (such as depersonalization). Medium scores indicate the absence of dissociative experience or the mild presence of this kind of experience.

Impact on real life: it consists of items aimed at evaluating the impact of abnormal Internet use on real life. Medium scores indicate that Internet activities are integrated with real life.

Experimentation: it consists of items aimed at evaluating if Internet is used to seek new and exciting emotions. Medium scores indicate that the subject needs to experience a new identity or a different role.

Dependence: it consists of items aimed at evaluating presence of craving, impulsivity or withdrawal symptoms. Medium scores indicate absence of these variables.

2. Results

In our sample nobody reach the cut off for Internet Addiction in our clinical sample. Anyway, we obtained interesting data. Dissociation (51 ± 4) and Impact on real life (52 ± 4) scores are higher than other dimensions, even if they are under the cut off ($T>70$) in the entire clinical sample and Experimentation is generally lower than any other factor (40 ± 4). IMP dimension is more represented ($T>70$) in Personality Disorders (33%), Mood disorders (24%), Psychosis (22%), Anxiety disorders (10%).

Men have higher scores in the Experimentation dimension than females (43 ± 10 vs. 38 ± 8; t = 2,73; p= 0,007).

Descriptive statistics indicating that subjects with university level of education have mean scores that are lower than college level and A-level of education in four dimensions are shown in the figure 2.

Figure 2. Descriptive statistics of mean values for UADI dimensions of patients divided for level of education
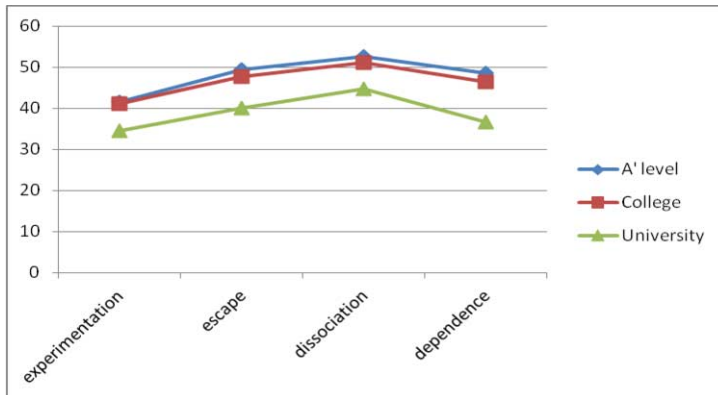

Particularly, there are differences between university and college level, and between university and level A-level concerning experimentation (Welch=37,8; p=0,004), Escape (Welch= 35,7; p=0,004), Dissociation (Welch=38,7; p=0,006) and Dependence (ANOVA F=4,3; p=0,015) dimensions. Post Hoc analysis (Dunnett and Bonferroni) shows that the group with highest level of education has significantly lower scores than any other group in the following dimensions of UADI (Table 1).

Table 1. Post Hoc analysis for level of education and UADI dimensions

Dimension	Level of education	p
Experimentation	University vs College level	.006
	University vs A' level	.035
Escape	University vs College level	.008
	University vs A' level	.012
Dissociation	University vs College level	.018
	University vs A' level	.013
Dependence	University vs College level	.033
	University vs A' level	.015

In clinical groups, T-test shows that psychotic patients have significantly higher scores in the following dimensions of UADI (Figure 3) (Table 2).

Figure 3. Descriptive statistics of mean values for UADI dimensions of patients divided for diagnosis
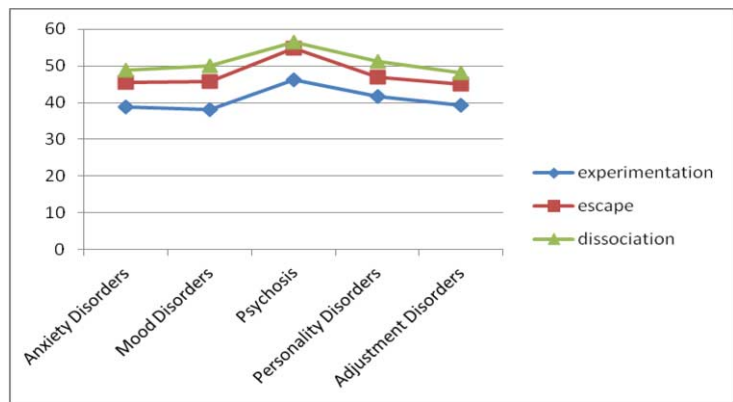
Table 2. T-test for clinical group and UADI dimensions

Dimension	Clinical group	t	p
Experimentation	Psychosis vs Anxiety disorders	2,29	.027
	Psychosis vs Mood disorders	2,41	.021
Escape	Psychosis vs Anxiety disorders	2,76	.008
	Psychosis vs Mood disorders	2,53	.016
	Psychosis vs Personality disorders	2,13	.042
	Psychosis vs Adjustment disorders	2,56	.017
Dissociation	Psychosis vs Anxiety disorders	2,46	.018
	Psychosis vs Adjustment disorders	2,34	.029

3. Discussion and Conclusions

Internet use is common among psychiatric population [4]. Sometimes it becomes a PIU or an addiction in comorbidity with other psychiatric disorder [5]. Even when Internet use is not problematic or pathological, investigating internet-related psychological variables in a clinical sample can be very useful to understand the reasons and the needs underlying patients' Internet use.

Just like in general population, where men seem to be more interested than females in Internet activities (such as messaging, browsing) aimed at communicating and experiencing new feeling [6], in our clinical sample men seem to use Internet as an explorative and exciting activity more than women [7].

Lower educated patients with a lower level of education tend to report an abnormal use of Internet.

This is a controversial data. According to some studies, people with a high level of education tend to use Internet more than other people, and the Internet penetration rate in the group with the highest level of education is much higher than that in the groups with middle and low education [8].

On the other hand, according to other studies, high level of education or good academic performance may protect subject from the risk of an abnormal use of Internet [7].

In our sample, subjects with higher level of education show low scores in Experimentation, Escape, and Dissociation and Dependence dimensions. We hypothesize that they don't use Internet to escape from real life. Moreover, they don't live dissociative experiences and don't develop dependence symptoms.

So, high education seems to mediate the role of Internet in patient's life and it plays a protective role, just like in the general population.

Psychotic patients show different values at UADI than all other clinical groups.

The presence of higher scores in Experimentation, Escape and Dissociation dimensions might indicate that they are more exposed to a dysfunctional use of Internet than other patients. It could be closely related to the clinical characteristics of psychotic syndrome.

Internet is a complex phenomenon with several potentialities and risks. It may provide an environment for individuals to escape from stress in the real world both for patients and non-clinical population [7].

These preliminary data should be supported by other studies about PIU and IA in a larger clinical population, aimed at exploring their diffusion in psychiatric patients and the psychological and psychopathological variables which are associated to a problematic internet use.

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Online Social Networking and the Experience of Cyber-Bullying

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Abstract. Online social networking sites (SNS) are popular social tools used amongst adolescents and account for much of their daily internet activity. Recently, these sites have presented opportunities for youth to experience cyber-bullying. Often resulting in psychological distress, cyber-bullying is a common experience for many young people. Continual use of SNS signifies the importance of examining its links to cyber-bullying. This study examined the relationship between online social networking and the experience of cyber-bullying. A total of 400 participants (M_{age} = 14.31 years) completed an online survey which examined the perceived definitions and frequency of cyber-bullying. Users of SNS reported significantly higher frequencies of stranger contact compared to non-users. Spearman's rho correlations determined no significant relationship between daily time on SNS and the frequency of stranger contact. This suggests that ownership of a SNS profile may be a stronger predictor of some cyber-bullying experiences compared to time spent on these sites. Findings encourage continued research on the nature of internet activities used by young adolescents and the possible exposure to online victimization.

Keywords. Adolescents, social networking sites, cyber-bullying

Introduction

In recent years, research has revealed that one in three teens experience some form of cyber-bullying, often resulting in emotional distress, psychosocial trauma and decreased self-esteem [1,2]. While researchers agree on the alarming impacts of cyber-bullying, a precise consensus on what constitutes cyber-bullying is much less clear [3]. It is strongly supported that cyber-bullying involves the use of technology to harass or intimidate others, although, there is some argument as to the nature and regularity of this harassment [3]. Some researchers believe that an action can only be classified as cyber-bullying if it involves ongoing and repeated attacks [5]. Alternatively, others believe that the public nature of online interaction overrides this as offensive internet content can reach much larger audiences than what is typically achieved in face-to-face bullying [6]. In this study, cyber-bullying is defined as a perceived act or decision on the part of another individual that arouses singular or multiple feelings of victimization, embarrassment or harassment. In addition, this study also includes acts or comments that intimidate others or induce the feeling of being threatened. Specifically, these acts or decisions are delivered through technology.

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Traditionally, cyber-bullying primarily occurred through mobile phone activity and instant messaging programs. In Finnish adolescents, a large population based study revealed that cyber-bullying was most common in instant messaging programs where youth would send internet-based text messages to each other in real time [7]. In these contexts, cyber-victims were often bullied by peers of the same age yet older bullies tended to evoke a stronger impact. Although cyber-bullying was found to be less prevalent than face-to-face bullying, it created a stronger sense of fear in victims as bullies were able to transcend the school yard boundaries. These findings are also confirmed in studies of US and UK adolescents [8,9]. In more recent times, the popularity of instant messaging programs has been rivaled by the uptake of social networking sites (SNS). Currently, a decisive link between this new social medium and cyber-bullying has not yet been established.

Eliminating the dimensions of time and space, SNS are interactive media sources which allow young people to keep in contact and share information [10]. A substantial body of literature indicates that many teenagers interact with their SNS for over an hour a day [11]. While some studies reveal positive impacts for offline social interaction, SNS may expose vulnerable youth to a variety of risks [12,13]. Participation in these utilities encourages teens to display a considerable amount of identifiable information including photos and geographic location [14]. Given the availability of personal details and the array of public peer-to-peer interactions, SNS present extended opportunities for cyber-bullying [15,16]. This study aims to explore early adolescents' perceptions and frequency of cyber-bullying experiences. In addition, this study will also examine the relationship between cyber-bullying experience and time spent per day on SNS. It is hypothesized that the use of SNS significantly increases an adolescent's likelihood of experiencing cyber-bullying.

1. Method

1.1 Sample and Procedure

After parental consent was given, this cross-sectional study was undertaken at an Australian high school under the supervision of a researcher. Using Survey Monkey, a total of 400 participants aged between 12 and 17 years (54.8% female; M_{age} = 14.3 years, SD = 1.2) completed an online survey. Some questions were relevant to only a sub-sample, therefore n varies for different analyses. This study received ethics approval from the University of Sydney Human Research Ethics committee.

In this sample, 76.8% of participants (n = 181) had private access to the internet. The home was the main location of internet access (80.3%) and there was an average of 2.88 (SD: 1.60) computers in each household. A total of 73.7% rarely or never asked for their parent's permission before accessing the internet.

1.2 Measures

The non-standardised online survey consisted of three sections: internet use, perceptions of cyber-bullying and cyber-bullying experience. In section one of the survey, participants were asked how often they used the internet, what they used the internet for and where they accessed the internet. Participants were also asked which SNS they primarily used, how many minutes they spent on their SNS per day and who they communicated with using these sites. In section two, participants were asked to

categorize a list of 23 actions as either examples of cyber-bullying or harmless activity. These actions were adapted from past research in adolescent cyber-bullying and were answered using *'yes'*, *'no'* or *'unsure'* categories [17]. In section three, participants were then asked how frequently they had been victims of these actions in the past month. Answers were given using an ordinal scale of *daily* (1), *weekly* (2), *fortnightly* (3), *monthly* (4) or *never* (5). Participants were not asked how frequently they had cyber-bullied others.

2. Results

2.1 Internet use and online social networking

Participants used the internet for an average of 2.53 (*SD*: 1.85) hours per day; 83.8% of participants rated their ability to use the internet as 'good or excellent'. Online social networking (*n* = 198) was ranked as the most popular internet function alongside information searching (*n* = 144) and IM programs (*n* = 116). Educational programs were the least used function of the internet (*n* = 8).

A total of 72.5% (*n* = 290) of participants reported using SNS. Amongst these users, Facebook was the most popular with 97.5% using this utility. On a typical day, participants visited their site up to 2.75 (*SD*: 3.94) times and spent an average of 63.39 (*SD*: 58.37) minutes networking. The primary use of SNS was keeping in contact with local friends (58.7%). Wall posts were the most popular function (29.9%) followed by chat (19.6%), status updates (13.5%), and photo viewing (12.8%). Without SNS, 66.5% said they wouldn't know less about their friends and 63.7% said they wouldn't have less contact.

When asked about their privacy settings, 75.5% had their profile on private or limited, 11% had a public profile, and 13.5% were unsure of their privacy settings. When asked how often unknown friend requests were accepted, 13.5% reported always, 37.7% sometimes, and 48.7% rarely or never. A total of 75.8% of participants said they would be uncomfortable with strangers accessing their site. The majority of participants (88.6%) had parental acknowledgement to use these sites however 6.8% did not know what their parents thought.

2.2 Perceptions of cyber-bullying:

When asked what actions were considered to be cyber-bullying, the majority of 'yes' responses were reported for *'abusive contact from someone unknown'* (90.4%), *'making threats via email'* (89.8%), *'sending insulting emails'* (89.5%), *'abusive contact from someone you do know'* (89.2%) and *'spreading rumors through email'* (88.7%). The majority of 'no' responses were reported for *'sending a huge amount of emoticons'* (70.3%), *'receiving phone calls in the middle of the night'* (57.7%) and *'prank phone calls'* (46.5%). For the action '*being contacted by strangers'*, 41.9% reported that it was not an example of cyber-bullying, 20.1% were unsure and 38.1% reported that it was.

2.3 The experience of cyber-bullying

Interestingly, '*being contacted by strangers'* (33.1%) was the most frequent experience of cyber-bullying. In addition to this, '*phone calls in the middle of the night*' (30.5%),

'*prank phones calls*' (29.9%), '*receiving a huge amount of emoticons*' (26.7%) and '*name calling/gossiping over msn*' (25.2%) were also frequent experiences of cyber-bullying.

Mann-Whitney U tests were employed to determine the differences between users and non-users of SNS and their experience of cyber-bullying. Users of SNS ($m = 4.36$, $mdn = 5.00$) reported significantly higher frequencies of '*being contacted by strangers*' when compared to non-users ($m = 4.7$, $mdn = 5.00$) ($U = 7308$, $z = -3.108$, $p < 0.001$). Users of SNS ($m = 4.32$, $mdn = 5.00$) also reported significantly higher frequencies of '*phone calls in the middle of the night*' compared to non-users ($m = 4.67$, $mdn = 5.00$) ($U = 7431$, $z = -2.973$, $p < 0.001$).

Point-biserial correlations were conducted to determine the relationship between SNS use and the experience of cyber-bullying. A significant relationship was found between SNS use and stranger contact ($r_{pb} = -.17$, $n = 341$, $p < .001$). Use of SNS accounted for 2.89% of the variance in the frequency of '*being contacted by strangers*'. A significant relationship was also found between SNS use and phone calls in the middle of the night ($r_{pb} = -.16$, $n = 341$, $p < .001$). Use of SNS accounted for 2.59% of the variance in the frequency of '*phone calls in the middle of the night*'.

Spearman's rho correlations were used to determine the relationship between SNS daily time and the frequency of cyber-bullying. No significant relationship was found between '*being contacted by strangers*' and SNS time per day ($r_s = -.073$, $n = 274$, $p = .266$). Using bonferroni adjustments, no significant correlations or differences were found between SNS daily time and the frequency of other cyber-bullying experiences.

3. Discussion

The findings of this study signify that unwanted stranger contact is a common experience in teens which may be provoked by SNS membership. In this study, a greater proportion of SNS users reported higher frequencies of unwanted stranger contact. It may be possible that being part of an online social network increases the likelihood of being contacted by strangers. However, this study can't definitively state that SNS users who experience stranger contact, engage in further communication or build relationships with these strangers. As such, it is important to determine what adolescents 'do' when they are approached by strangers online. It may be that adolescents are aware of the dangers of online strangers and simply ignore their requests for contact. In this sense, the internal functions of SNS, such as increased privacy settings, declining friend requests and blocking others, may provide an effective filter for controlling stranger contact. However, 51.5% of SNS users in this study reported that they accept friend requests from unknown people. Therefore, owning a SNS profile may increase exposure to online strangers and entice youth to make further contact. As adolescence is a phase of significant vulnerability, these results reinforce the need for continued exploration of particular behaviours within SNS.

Interestingly, this study found that time spent per day on SNS had no significant relationship with unwanted stranger contact. No significant correlations were found between SNS daily time and the frequency of other cyber-bullying actions. This suggests that the acts included in the cyber-bullying measure had no association with how much time was being spent on Facebook. This is consistent with Sengupta and Choudari [18] who also found that using SNS did not increase the likelihood of

experiencing online harassment. However, as previously discussed, cyber-bullying is a multidimensional construct. It encompasses a range of experiences from online harassment to online stalking and identity theft. Cyber-bullying is also a subjective experience; an act of cyber-bullying may induce a distressful response in one adolescent but not impact another. As such, many teens may not perceive the same actions to be acts of cyber-bullying. This is supported by our findings as many participants were unsure if being contacted by strangers was indeed an act of cyber-bullying. In addition, the most frequent experiences of cyber-bullying as defined by the literature were not actually categorized as cyber-bullying by the majority of participants. This highlights the need for continued research into the perceptions of cyber-bullying and how it is conceptualized and best operationalised in adolescents. With the technology arena changing so quickly, it may be difficult to find a truly appropriate measure of cyber-bullying which addresses all communication sources being used by young people and the changing dynamics of their social interaction.

In conclusion, this study suggests that some cyber-bullying experiences may be moderated more significantly by owning a SNS profile in contrast to how much daily time is spent on this medium. As this study cannot determine the reaction to or impact of online stranger contact, future research would need to reveal what adolescents do when they encounter online strangers via SNS. Determining the reactions to this experience will help minimize the potential harm related to the use of these utilities. In addition, a mixed-methods approach may be more appropriate when exploring this issue in contrast to solely employing a quantitative measure [19]. In addition to surveys, focus groups and interviews may provide more personal insight into the nature of this experience. For now, this study encourages further examination of the safety of SNS and cautions against the un-moderated use of these utilities amongst youth.

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Designing Virtual Audiences for Fear of Public Speaking Training – An Observation Study on Realistic Nonverbal Behavior

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Abstract. Virtual Reality technology offers great possibilities for Cognitive Behavioral Therapy of fear of public speaking: Clients can be exposed to virtual fear-triggering stimuli (exposure) and are able to role-play in virtual environments, training social skills to overcome their fear. Usually, prototypical audience behavior (neutral, social and anti-social) serves as stimulus in virtual training sessions, although there is significant lack of theoretical basis on typical audience behavior. The study presented deals with the design of a realistic virtual presentation scenario. An audience (consisting of n = 18 men and women) in an undergraduate seminar was observed during three frontal lecture sessions. Behavior frequency of four nonverbal dimensions (eye contact, facial expression, gesture, and posture) was rated by means of a quantitative content analysis. Results show audience behavior patterns which seem to be typical in frontal lecture contexts, like friendly and neutral face expressions. Additionally, combined and even synchronized behavioral patterns between participants who sit next to each other (like turning to the neighbor and start talking) were registered. The gathered data serve as empirical design basis for a virtual audience to be used in virtual training applications that stimulate the experiences of the participants in a realistic manner, thereby improving the experienced presence in the training application.

Keywords. Fear of public speaking, virtual environments, training application, avatars, nonverbal behavior

Introduction

According to the American Psychiatric Association, Fear of Public Speaking (or glossophobia or speech anxiety) is the third most common psychiatric disorder [16]. It is characterized by anxiety prior to or at the thought of having to communicate verbally with any group of people. It leads to avoidance of events which focus the group's attention on individuals in attendance and can lead to physical distress and even panic [8]. Treatment typically involves Cognitive Behavioral Therapy (CBT), including exposure to fear-triggering stimuli (e. g. speaking in front of a group), reframing thoughts associated with the social scene, social skills training and relaxation training [15].

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Virtual Reality technology as a therapeutic or training tool offers great possibilities for Cognitive Behavioral Therapy on anxiety disorders: Clients can be exposed to virtual fear-triggering stimuli (exposure) and are able to role-play repeatedly in virtual and different scenarios, training social skills to overcome their fear [13].

1. Related work and Rationale

Research on the efficiency of virtual exposure with clinical samples indicates that virtual audiences can induce a significant increase of anxiety in phobic people when compared to speaking in front of an empty virtual seminar room [10]. Further, findings suggest that virtual reality exposure can lead to reduction of fear of public speaking symptoms. For example Harris, Kemmerling and North [3] could show that four virtual reality treatment sessions were effective in reducing public speaking anxiety in university students, both on self-report and physiological measures compared to a control group on a waiting list with no treatment. Similar results were obtained by North, North and Coble [4] who compared virtual reality treatment with exposure to a public speaking scene to exposure to a trivial virtual reality scene. In comparison between virtual reality exposure and conventional CBT and waiting list control, Wallach, Safir and Bar-Zvi [12] found that virtual reality treatment and CBT were more effective than the waiting list condition on anxiety measures [see also 1; 2], and on subject's self-rating of anxiety during a behavioral task.

Usually, prototypical (neutral, social and anti-social) audience behavior serves as stimulus in virtual training sessions [5; 6; 11]. Results show that especially negative audience behavior triggers experiences of anxiety, namely irrespective of the normal level of public speaking confidence of subjects [5; 6]. Besides, physiological indicators of anxiety like subjectively assessed somatization were higher after giving a talk to a negative audience compared to positive and neutral ones [5]. However, considering self-rating of the subjects' own performance, the authors could not find a difference between positive and negative audiences.

Up to now, there seems to be a significant lack of theoretical basis on typical and realistic audience behavior, although this may have consequences on presence experienced by users. Presence can be described as a user's subjective psychological response to a VR system [9] and is related to the experience of emotions [9]. As fear is an emotional experience, using prototypical behavior – instead of realistic audience behavior – may lead to lower experiences of presence and in the end to lesser performance in VR training applications.

The work presented in this paper aims at overcoming this problem by designing an application including natural audience behavior. We describe an explorative observation study on realistic audience behavior. The results obtained are used to design a virtual training scenario for fear of public speaking in a CAVE.

2. Method

A real audience (consisting of n = 18 men and women) in an undergraduate seminar was observed in a structured, non-participant overt observation. We used event samples of three frontal lecture sessions, taping the lectures on video and analyzing the video material.

Behavior frequency of four nonverbal dimensions (eye contact, facial expression, gesture, and posture; N = 5916 behavioral actions in total, coded into 35 categories) was rated by means of a quantitative content analysis, in regard to frequency and positioning across three rows of seats within the lecture room. We explicitly included positioning as we hypothesized that nonverbal behavior differs between rows of seats (for example more disruptive behavior actions like talking to the neighbor happening more often with growing distance to presenters).

Further, we analyzed the first, middle and last 15 minutes of the lecture sessions (with a duration of 90 min. each), as we assumed that nonverbal audience behavior may change over time (for example packing away things towards the end of a session).

3. Results

In this section, selected findings on facial expressions, body posture, and behavior patterns will be given [for results on gestures see 7]. Behavior actions are presented by means of mean frequencies for one person per row and per minute.

3.1. Facial expression

Due to the multitude of facial expressions rated, the findings are highlighted by prototypical expressions.

Table 1. Means of frequency of facial expressions for one person per row and per minute

Facial expression		First part of session	Middle part of session	Last part of session
Pleasure	First row	0.11	0.23	0.44
	Middle row	0.16	0.17	0.34
	Last row	0.24	0.24	0.41
Neutral	First row	0.12	0.17	0.24
	Middle row	0.17	0.2	0.32
	Last row	0.24	0.17	0.32
Anger	First row	0.03	0.02	0.04
	Middle row	0.03	0.02	0.01
	Last row	0.01	0	0.01

As table 1 shows, friendly and neutral face expressions are rather common. Also, they are closely related, as a joyful facial expression changes into a neutral one when coming to an end. Social facial expressions increase with distance to the presenter, maybe to establish a closer contact. Further, neutral and social expressions increase with time. This can be explained by the fact that at the end of a lecture session, more interactions and discussions take place, as frontal presentations are already finished. The anti-social expression of anger was shown rather seldom, so a natural audience seems to be either social or neutral.

3.2. Posture

To give examples on body posture, frequencies of leaning forward (social), sitting upright (neutral) and leaning backward with folded arms (anti-social) are presented in Table 2.

Table 2. Means of frequency of body postures for one person per row and per minute

Body posture		First part of session	Middle part of session	Last part of session
Leaning forward	First row	0.04	0.02	0.07
	Middle row	0.11	0.12	0.14
	Last row	0.06	0.03	0.03
Sitting upright	First row	0.03	0.06	0.08
	Middle row	0.04	0.05	0.03
	Last row	0.01	0	0.01
Leaning back with folded arms	First row	0.06	0.07	0.09
	Middle row	0.01	0.06	0.04
	Last row	0.03	0.07	0.06

Considering body postures, neither social nor anti-social postures are very common in the course of a lecture. However, people in the middle row have a tendency to lean forward more often than the rest of the audience. It can be hypothesized that leaning forward in the first row means intruding into the personal space of presenters, which is usually experienced as an anti-social action. In the middle row, the same gesture could signal interest. All in all, the selected postures are shown seldom but constantly.

3.3. Behavior patterns

Several behavior patterns were noted during the qualitative video analysis. Especially patterns like these should be acknowledged in virtual audience design, as they may lead to a more realistic perception by users of VR applications.

- Turning the upper part of the body sideways is related to start talking with a neighbour. Also, it is accompanied by smiling, either at the presenter or the conversational partner.
- If people take notes (with paper and pencil or laptops), they do so for a very long time, often up to 15 minutes. During this time, they often establish eye contact to presenters.
- People sitting next to each other imitate behaviour actions, like adapting viewing direction and imitating body postures.

4. Discussion

Virtual Reality technology offers considerable potential for treatment of and training against fear of public speaking. However, preliminary research has mostly dealt with prototypical audience behavior. In order to develop highly immersive applications, the opportunity to include realistic audience behavior should be taken. The study presented explored natural audience behavior in regard to four nonverbal dimensions (eye contact, facial expression, gesture, and posture). Findings show that firstly, audiences tend to be social, but neutral and anti-social behavior is also shown seldom but constantly. Secondly, behavior differs between points of time during a lecture session and between different rows of seats. The results of this study serve to design a virtual audience in a training application for fear of public speaking in a CAVE.

However, the work presented has certain limitations. First of all, an undergraduate student audience at a university lecture session in Germany was observed. Different

settings and cultural backgrounds may lead to different behavior. Secondly, the audience consisted mostly of women. Gender-balanced audiences could show different behavioral patterns. Thirdly, this being an explorative study, aspects like interactions between presenter and audience, interaction between audience members themselves or exact duration of behavior actions were not considered. Future studies should aim at replicating and supplementing the obtained findings with different kinds of audiences and settings. Also, future work should examine how different behavior actions and patterns are interpreted and reacted to by presenters. Still, in light of the lack of theoretical background on realistic audience behavior, the study can serve as a starting point for future research and as a first guideline for audience design.

Acknowledgments

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Using Portable EEG Devices to Evaluate Emotional Regulation Strategies During Virtual Reality Exposure

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Abstract. As Virtual Reality (VR) is starting to be used to train emotional regulation strategies, it would be interesting to propose objective techniques to monitor the emotional reactions of participants during the virtual experience. In this work, the main goal is to analyze if portable EEG systems are adequate to monitor brain activity changes caused by the emotional regulation strategies applied by the participants. The EEG signals captured from subjects that navigate through a virtual environment designed to induce a negative mood will be compared between three experimental groups that will receive different instructions about the emotional regulation strategies to apply. The study will allow us to validate the possibilities of portable EEG devices to monitor emotional regulation strategies during VR exposure.

Keywords. EEG, Emotional Regulation Strategies, Virtual Reality

Introduction

Virtual Reality (VR) is starting to be applied to train emotional regulation strategies (i.e., [1]). To evaluate if these virtual environments (VE) are achieving their goals, it is fundamental to have instruments to analyze the emotional regulation strategies that each subject applies during the exposure to the VE.

Traditionally, the evaluation of emotional regulation strategies is based on questionnaires, which are used to ask subjects about how they are feeling and managing their emotions [2]. However, there have been other approaches for this purpose that have analyzed physiological responses of subjects that have been exposed to situations with highly emotional content in which different emotional regulations are applied [3]. Other approaches have analyzed brain activity measures such as the electroencephalogram (EEG), which reflects the brain's electrical activity, and in particular postsynaptic potentials in the cerebral cortex. There have been several studies which have pointed out the important role of the prefrontal cortex for emotional regulation [4, 5].

Brain activity monitoring using EEG can be easily combined with VE, as long as it does not impose restrictions in the way of presenting stimuli to the subjects of the study.

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Furthermore, portable devices to capture EEG that have appeared in recent years may even make easier the integration of these monitoring systems in the VR experience.

This fact has generated research that has combined EEG and VR with different purposes. For example, EEG has been used to assess driver cognitive responses in a virtual reality based driving environment [6], to analyze sex differences in brain activity (theta oscillations) associated to navigation in a VR environment [7] and to evaluate the level of presence of participants in virtual reality experiences [8]. However, as can be observed, these studies were not focused on the field of emotional regulation.

In the present work, the possibilities of EEG monitoring to evaluate emotional regulation techniques of participants of VR experiences will be analyzed, focusing on a specific kind of EEG monitoring systems: portable EEG systems. The goal is to analyze if portable EEG systems are adequate to monitor brain activity changes caused by the emotional regulation strategies applied by participants of VR experiences.

1. Method

Thirty subjects will participate in the study. They will be university students without any psychological disorder. In the experimental session, they will navigate through a VE designed to induce them a negative mood (sadness). Some pictures of the used VE are shown in Fig. 1.

Figure 1. Captures of the virtual environment used to induce sadness

This VE has already been used in previous studies from our group to show that VEs can be used as an effective mood-induction procedure [9]. Specifically, this VE is able to induce a sad mood in the subjects that navigate through it. The VE is a park in which variations of the following elements traditionally used to induce emotions are included: music [10], Velten self-statements [11] plus pictures (selected from the International Affective Picture System IAPS [12]) and movies [13]. A woman's voice is used to guide the user through the different sections of the park.

This VE will be shown in a retro-projected screen and users will navigate through the environment using a wireless pad (Logitech Rumblepad). EEG will be monitored by means of an EEG portable device (Emotiv EPOC). The configuration can be observed in Fig. 2.

Figure 2. Subject navigating in the virtual environment while brain activity is monitored with Emotiv EPOC

There will be three experimental groups that will receive different instructions: the cognitive reevaluation group will receive instructions to apply cognitive evaluation strategies during the induction; the expressive suppression group will be told to control the somatic responses to the induced mood; and, finally, the control group will not receive any special instructions to regulate their emotions.

The experimental session will start with participants filling in some questionnaires about their emotional regulation strategies [2-14]. They will also fill in pre-induction visual analogue scales (VAS) and PANAS [15] measures. Following, and with the help of the researcher, participants will practice how to move and interact with virtual objects in a specifically designed training environment. After that, the EEG portable device will be adjusted in the participant's head by the experimenter. Then, the VR session will start, with an approximate duration of 20 minutes. After the session, subjects will fill in again the emotion measurements (VAS and PANAS) and, also, the SUS presence questionnaire [16] to guarantee that they have felt present during the experience. Finally, the participants will be invited to visualize a film to induce them a positive mood before finishing the experiment, which will be checked asking them again to fill in the VAS and PANAS measures.

2. Results

Different spectral parameters of the EEG signals captured during the experience will be calculated and compared between the different experimental groups, to evaluate the influence of the emotional regulation technique on the EEG signal.

The study will focus initially on the analysis of the frontal activity of the EEG (corresponding to these channel names in the International 10-20 locations: AF3, AF4, F3, F4, F7, F8, FC5 and FC6).

3. Discussion

One of the important conclusions that will be extracted from the study will be associated to the role of frontal activity in emotional regulation.

Frontal activity of the EEG seems to reflect not only the degree with which the individual is able to emotionally answer to a specific context (in our study, created with VR technologies), but also his or her capability to inhibit those responses. As long as frontal activity of the EEG should reflect (at least, partially) prefrontal cortex activity, it is probable that the asymmetry of the EEG could be associated with emotional regulation capability [17].

There are several studies that have shown the important role of the prefrontal cortex in emotional regulation [4, 18, 19], although obtaining different lateralization patterns. A recent EEG study which used film clips for emotional induction [5] observed that an effective emotion regulation was associated to a higher bilateral frontal activity in the EEG during the emotional induction of fear or sadness.

Results from the present work will help us to evaluate which of the possible hypotheses of frontal asymmetry of the EEG associated to the suppression or reevaluation of negative emotions is observed during the mood induction with VR. Specifically, it will be analyzed which pattern is observed in the frontal activity of the EEG: left, right or bilateral frontal asymmetry.

Furthermore, the study will allow us to validate the possibilities of portable EEG devices to monitor emotional regulation strategies applied by the participants of VR experiences. The efficacy of the combined used of VR and portable EEG devices for the analysis of emotional regulation strategies will be evaluated. The obtained results will be compared and related with available psychometric instruments for the evaluation of emotional regulation strategies.

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Electro-Physiological Data Fusion for Stress Detection

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Abstract. In this work we describe the performance evaluation of a system for stress detection. The analysed data is acquired by following an experimental protocol designed to induce cognitive stress to the subjects. The experimental set-up included the recording of electroencephalography (EEG) and facial (corrugator and zygomatic) electromyography (EMG). In a preliminary analysis we are able to correlate EEG features (alpha asymmetry and alpha/beta ratio using only 3 channels) with the stress level of the subjects statistically (by using averages over subjects) but also on a subject-to-subject basis by using computational intelligence techniques reaching classification rates up to 79% when classifying 3 minutes takes. On a second step, we apply fusion techniques to the overall multi-modal feature set fusing the formerly mentioned EEG features with EMG energy. We show that the results improve significantly providing a more robust stress index every second. Given the achieved performance the system described in this work can be successfully applied for stress therapy when combined with virtual reality.

Keywords: Electrophysiology, Stress, Soft Data Fusion, EEG, EMG

Introduction

Our main objective in this work is to find the most suited features related with stress in the EEG signal and in a second step fuse these results with the features extracted from the facial EMG energy in order to improve the robustness of our stress detector system.

In order to do so a protocol was defined, in which 12 subjects performed a number of tasks designed to induce different level of stress.

1. Protocol

We designed a number of different tasks including two classical psychophysiological tests: the Trier Social Stress Test (TSST [1]) and the Stroop Color Word task [2].

The used acquisition device was a BIOSEMI ActiveTwo amplifier in which we connected 32 EEG channels using the standard 10/20 layout and 4 EMG electrodes placed in two respective bipolar set-ups to record Zygomatic and Corrugator muscular

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activity of the subject. The sampling rate was set to 2048 Hz. The different tasks in the experimental protocol were: Baseline (stare at a cross in a screen), Relax (close eyes and relax), Stroop Test, Mathematical calculations and Reading.

A second part was also recorded, having the subjects performing the same tasks but now we introduced 3 actors in the room, telling the subject that these new people were experts on non-verbal communication and that they would be observing and taking notes. This was done with the sole purpose of increasing the stress level of the subjects. This procedure is inspired on the TSST.

At the very end of the experiment we also faked an unexpected blood sample extraction performed by a (false) male nurse. Once everything was set-up (syringe, test tube, rubber band around subject's arm…), the subject was told that no blood extraction was needed. Again, this was done with the sole purpose of increasing the stress level of the subjects.

2. EEG data analysis

EEG can be used to extract information about the emotional state of the subject, in terms of the variables of "Valence" and "Arousal" as shown in [3]. While the Beta-Alpha (power) Ratio is related with the arousal dimension [4], the Alpha (power) Asymmetry is related with the valence dimension [5].

All electrodes were referenced to Cz. After applying an EOG artifact correction we cut the EEG data of each task in 50 % overlapping 2-seconds epochs and we computed the EEG features for each one of these epochs.
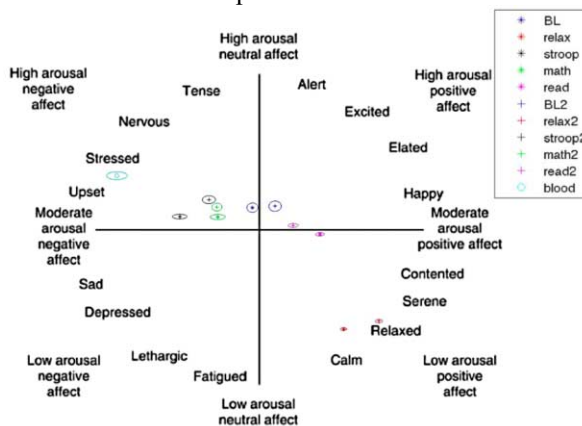
Figure 1: Arousal-valence model of emotions. Y-axis represents the arousal while the x-axis represents the valence. The valence and arousal levels extracted from EEG for each task (mean over subjects), has been superimposed. The ellipses represent the standard deviation of the mean of both features.

In this work, we have used the two dimensional scale of emotion representation proposed by Russel (see [6]). Emotions are mapped according to their valence (positive versus negative), and their arousal (calm versus excited). We can see in Figure 1 how basic emotions are classified using this model. It is interesting to see how the valence and arousal state of each task of our study can be mapped in the model proposed by Russell. In Figure 1 we superimpose the average over epochs and subjects of valence and arousal extracted from EEG to the two dimensional scale of emotion

representation. As we can see the "Relax" task is mapped in the lower right quadrant, whereas the "Fake Blood Sample" task (the more stressful task) is mapped in the higher left quadrant. The "Baseline" task is somewhere in the middle, while the "Reading" task is slightly to the right and the "Stroop" and "Math" task are slightly to the left. These results are very interesting as the data map very well to Russell's model.

3. Classification using EEG

In the previous sections we worked using group averages over subjects and we successfully found interesting correlations with the different tasks. Although this work sheds some light on how stress can be measured using EEG, it does not allow us to build an application where stress can be detected via EEG on a subject-to-subject basis. To address this we applied machine-learning techniques, i.e., classifiers, to our dataset. For this work we focus on the classification of 2 tasks: Baseline (Normal) and Fake Blood Sample (Stress). We did not want to include in this analysis the Relax task since the subjects were asked to close their eyes, and thus modifying their EEG signals (it is well know that alpha rhythm increases significantly when closing the eyes).

Specifically we used Fisher Discriminant Analysis (FDA). Our EEG feature vectors have 3 components (Alpha Asymmetry chX-chY; Beta-Alpha ratio chX; Beta-Alpha ratio chY) and we only focus on the aforementioned tasks of the second part of the experiment, when the actors were present. In order to perform the classification, we use a cross-fold validation using the leave-one-subject--out approach: we use all the features from subject 1 for the test set and the features of the remaining 11 subjects for the training set, then we use all features from subject 2 and the rest of the subjects are used for the training set and so on and so forth. The result of our FDA classifier is a Posterior vector for each epoch, i.e., a vector of probabilities that a given epoch feature vector belongs to any one of the available classes. The way we compute the performance is by taking the mean of the Posterior vector for all the epochs of a given task, and then choosing the maximum's location as the result of our classification. We perform this for all subjects and for all the tasks. We have 24 classification results (12 subjects * 2 different tasks).

As we recorded 32 channels, we can build 14 pairs of symmetric channels. The performances of the classification algorithm for these features are shown in Table 1.

| | Fp1 | AF3 | F7 | F3 | FC1 | FC5 | T7 | C3 | CP1 | CP5 | P7 | P3 | PO3 | O1 |
	Fp2	AF4	F8	F4	FC2	FC6	T8	C4	CP2	CP6	P8	P4	PO4	O2
Normal Stress	**79**	71	75	58	63	67	63	63	54	63	67	46	54	54

Table 1: Performance for our Normal vs Stress classification problem in terms of classification rate percentage for each pair of symmetric channels (best performances in bold)

From Table 1 we see that we reach a classification rate of 79% in the frontal pair of channels Fp1-Fp2. We also reach 75% for the pair F7 and F8. A random classification would yield to a 50%, so these results can be considered quite

meaningful. Moreover, those results are expected since the alpha asymmetry and alpha-beta ratio are usually extracted from the frontal channels [4][5].

4. Fusion of EEG and Peripheral sensors Features

In a further performance evaluation we looked at the feasibility of implementing a stress detection system in real-time. For this purpose we fuse the data of separate information channels, namely EEG, and EMG data. We take into account here the classification of stress related tasks, i.e. math, stroop, fake blood extraction, vs tasks not related to stress, i.e. baseline, relax, and read. We only consider the EEG channels reported in the literature to be most related with valence and arousal, namely those in the frontal part. These channels also delivered better performance in the classification of Stress vs Normal (Table 1), the most difficult case since the subject was keeping his eyes open in both tasks, as explained before. Therefore we selected the pairs F3-F4, and F7-F8. We compute here the alpha asymmetry, and the alpha-beta ratios. Moreover we take into account the EMG energy on the zygomatic and the corrugator muscles. This gives us a system based on 5 features delivered each second with an analysis window of 2 seconds length.

After normalizing the time dependent features, we deliver them to a fusion operator tree [7]. This is a methodology based on structuring the recursive application of a soft data fusion operator in a tree form. We have selected for this implementation the so-called Sugeno Fuzzy Integral [7]. This is a generalization of the average based on the utilization of max. and min. operators. The result of the fusion operator tree is a real number in the interval [0,1], which corresponds to the membership degree of the epoch being generated during a stress task, i.e. equivalent to a stress index.

For the performance evaluation we have used a 5-cross-fold validation procedure. Therefore we use in each fold 80% of data for training and 20% for test, repeating this procedure 5 times. Finally we compute the True Positive (TPR) and the False Positive Rates (FPR) by using the stress task epochs as the positive class to detect. Once the TPR and the FPR have been computed, we visualize them in a ROC space for each subject after averaging over the 5-cross-fold runs. We additionally compute the Area Under the Curve as synthetic performance measure, i.e. the integral of the TPR wrt. FPR. Both performance measures are given in Figure 2.

As can be observed we obtain excellent performance for 3 out of 12 subjects (AUC over 97%). The minimal achieved performance is around 83% AUC for 2 of the subjects. The average AUC over subjects is of 91.7 ±0.7%. This is in summary an excellent performance for a real-time system given its 2 sec. detection rate.

5. Discussion

This study demonstrates the feasibility of implementing an emotion/stress/mental workload monitoring system through EEG data analysis. As a first part of this work, a statistical analysis has been performed and a clear trend among the EEG features of the 12 subjects has been found: both Beta-Alpha ratio and Alpha Asymmetry evolve accordingly to the level of stress of each task. In the second part of our work, we applied a classifier to identify the stress level of the subjects on a subject-to-subject

basis. The results are very encouraging, reaching a performance of 79% for Normal vs Stress on a 3-minute take-to-take basis. Moreover, the results of our research show that using only 2 EEG channels (plus a reference in Cz) we would have enough information for our system to work with this performance.
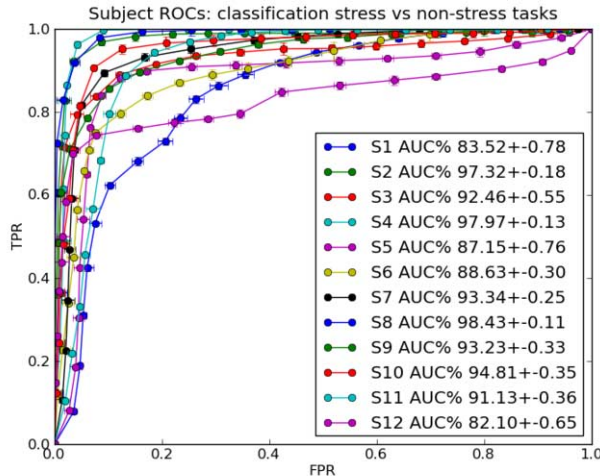
Figure 2: Performance in terms of ROC and AUC for the classification of stress vs non-stress tasks for each subject. Averages and error bars over 5-cross-fold validation are shown. The AUC of each subject is given.

In the last part of this work, after fusing some selected EEG channels and the EMG ones we obtain a remarkable performance of 92% AUC in average over subjects and epochs. This means we are able to classify the stress level each second with this performance.

Another interesting and important characteristic of this work is its real-time capability. Not only all data processing steps, but also the fusion stages can be performed in real-time, thus allowing this system to work in many applications such as neurofeedback, affective computing and augmented reality in virtual telepresence.

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Involving Elderly Users in Design: Techniques to Collect Preferences for Interactive Digital Television

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Abstract. SeniorChannel is a European project that explores the potential of using an Interactive Digital Television (IDTV) to turn elderly people at home into an active audience. Techniques to involve elderly users in the requirement collection during the design phase should take into account the decrease in perception, cognition and motor abilities associated with aging. The paper describes the specific solutions adopted here to elicit users' contribution, as well as the contributed preferences in terms of IDTV content and interaction modalities.

Keywords: elderly people, design, requirements, social inclusion, and interactive television

Introduction

The social isolation and loneliness frequently observed in older people have been effectively reduced by interventions focusing on specific, group-based activities [1]. Since isolated older people are difficult to recruit and might find it difficult to reach the place where groups meet, an alternative strategy to counter social isolation is to exploit home communication technologies, such as the Internet (which proved effective in several interventions [2]), or home entertainment technologies, such as the television, which is already widely used in the population older than 55 years [3]. This latter strategy has been adopted in a research project, named SeniorChannel, aimed at designing and testing an Interactive Digital Television (IDTV)[2] to turn elderly audience into an active elderly audience [4].

Elderly people are active within this project not only as target users, but also in the design phase. A serious challenge too involving elderly users in design is the psychological and physical impairments that accompany the aging process [5][6]. These make traditional participatory design methods inefficient, since they would place

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[2] An IDTV is a TV system where the user receives services above the main programming by requesting them via remote control (http://ec.europa.eu/avpolicy/info_centre/a_z/index_en.htm#a6).

an unnecessary burden on the participants' perceptual, motor, and cognitive systems, diverting efforts from the main task goals [7]. A decrease in episodic memory, which makes it difficult to recall events that occurred in the recent past, hampers inquiries about past experiences through questionnaires, interviews, focus groups, etc. The decrease in the working memory (i.e., temporary information storage and manipulation), in inhibiting irrelevant information, and in paying attention to peripheral stimuli in the visual field, makes it difficult to efficiently organize and manage great numbers of items, as is typical of design workshops with card sorting or assimilation tasks. The slowness in processing speech/text regarding unfamiliar subjects, and circumstances that make older people unaccustomed to new technologies, make demos and explanations inappropriate strategies to encourage contributions and imagination. Therefore, design procedures should include contextual cues that support participants' memory and attention, and adopt familiar language and resources that value older people's expertise, as with dramatization techniques [7], role-playing, and low-fi prototypes [8]. The next sections describe the ad-hoc method devised in the SeniorChannel project to collect users' preferences for IDTV content and interaction modalities, and the outcome of this method.

1. Method

1.1. Participants

Twenty-one elderly people (mean age = 72.29, *SD* = 4.65) and five caregivers (mean age = 39.75, SD = 11.33) were involved in the requirement collection sessions. All participants were Spanish, and they were recruited by a public elderly center offering classes on various subjects. Informed consents were signed before each session.

1.2. Activities

The strategy to identify users' preferences in IDTV content and interaction modalities was to (a) include a "*warm-up*" phase before data collection and to (b) *assimilate* the future device to technologies with which participants had some form of familiarity, e.g., popular TV content and existing audience participation modalities. The method then included two activities (Figure 1) carried out on different days and based on the use of video fragments and illustrated cards.

Activity 1 was aimed at identifying the preferred interaction modalities with IDTV. The activity consisted of having small groups of participants watching short video fragments of popular TV programs, and then asking them about possible ways to intervene in those programs. The video fragments were meant to generate a vivid audience experience instead of asking them to recall one from their past. Also, the interactive modalities proposed in the questionnaire were a collection of familiar ways for the audience to interact with TV shows (phone calls, voting, clapping, letters, overlayered messages).

Activity 2 was meant to define which types of TV content participants preferred to watch and to produce. A set of illustrated cards was used in conjunction with a preparatory questionnaire, meant to warm-up participants' opinions before they ranked the contents as a group. The questionnaire asked each participant individually, which of six kinds of content they preferred, illustrating each kind with a picture (news, debates,

movies, music, community album, events calendar). In addition, the questionnaire asked for content not included in the six predefined types of content proposed. The six cards described each type of TV content textually on one side and pictorially on the other side; the cards materialized the discussion topic, thereby helping participants to consider all items at once and to orient the discussion target. The pictures on questionnaires and cards were the same, to provide continuity between the two tasks.
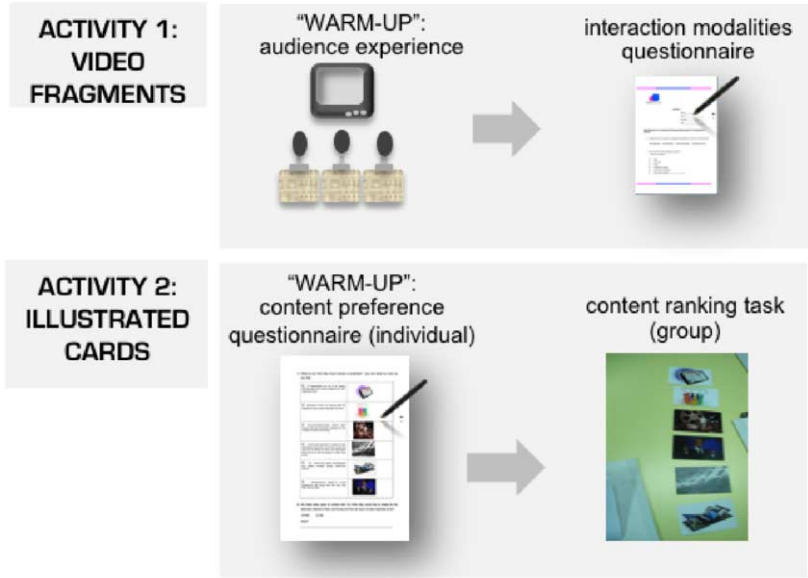
Figure 1. The structure of the activities composing the preference collection sessions

1.3. Procedure

In both activities, the twenty-one elderly people convened in small groups of four to five members; in the second activity a group of caregivers participated as well. The video fragments in the first activity belonged to different genres: news, news interview, variety show, commercial, and TV series. The presentation order of the five fragments was balanced in the different groups in a Latin square design. After watching each fragment, participants were asked individually to fill in a short questionnaire, which mainly inquired about their willingness to intervene in the just-seen program and the preferred modalities to do so. They were asked to choose two modalities out of a list of six options (letter, phone call, voting, over-layered message, clapping sound, plus an open, not pre-defined modality). In the second activity, participants first filled in a questionnaire individually about content preferences; then each group was provided with a set of six content cards and asked to achieve a shared decision about their preferences for which content to produce. As the decision was achieved, the ranked cards lying on the table were shot with a photo camera.

2. Results

The types of TV content favored by more than one half of the sample, both in terms of watching them and in terms of possibly participating in producing them were: *information, interviews/debates, and documentaries about news, art, culture, and journeys; recent movies; and variety shows*. The kind of content that was selected by at least one half of the sample was news, art and culture, journey and traveling, and recent movies. Preferences varied by gender: local news and educational programs were more liked by women, respectively $\chi2(1) = 4.07$, $p = 0.44$ and $\chi2(1) = 6.39$, $p = 0.11$; sport programs were more liked by men, $\chi2(1) = 3.88$, $p = 0.49$. Curiously, caregivers were not able to guess the elderly's top preferences, thereby testifying to the importance of involving target users directly: caregivers underestimated elderly people's appreciation for recent movies, news, and journey/travelling programs, $\chi2(1) = 4.54$, $p = 0.33$, $\chi2(1) = 6.62$, $p = 0.10$, $\chi2(1) = 4.54$, $p = 0.33$ while they overestimated elderly people's appreciation for TV series like soap operas, $\chi2(1) = 4.75$, $p = 0.29$.
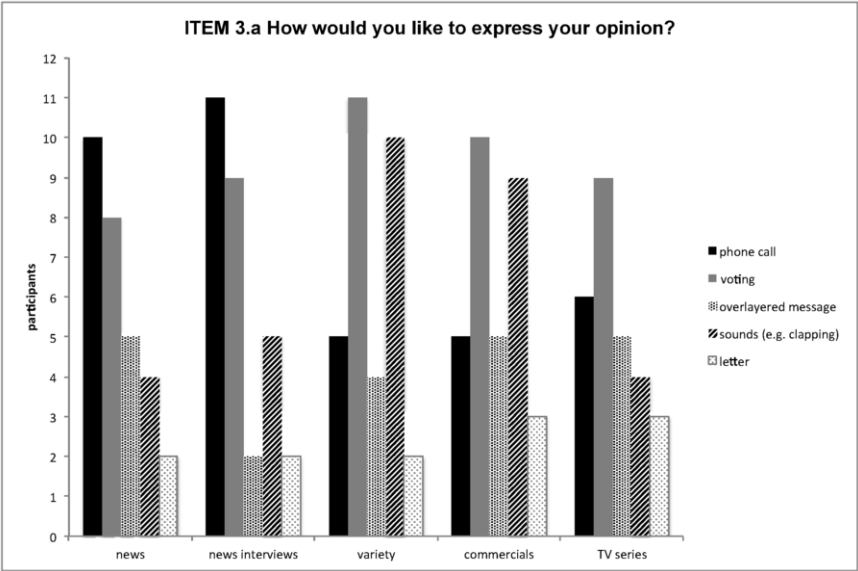
Figure 2. Number of participants selecting each interactive modality, grouped by TV genre. Each participant could provide up to two preferences.

Regarding the modality in which respondents imagined that they would intervene from home, *voting* was the preferred one, along with sound clapping and phone calls. Voting and clapping were selected as suitable for all contents, including content that is usually not broadcasted live, such as commercials or TV series. Interaction modalities not included in the options provided and entered by participants in the comment box were neither appropriate nor specific enough (e.g., participating live from the broadcasting studio and participating via the Internet). Preferences seemed to vary across TV genres (Figure 2), and were probably connected to the kind of intervention respondents would like to make in each different program: e.g., voting or sound clapping would allow them to evaluate a program, while phone calling would allow

them to express an idea or talk to the program host. In fact, voting and sound clapping were selected for programs that included contests, such as variety shows, while phone calling was selected for news and news interviews, where respondents would probably like to express their opinions in a more extended way. The percentage of participants who would have fully or quite appreciated the possibility of having their messages to the TV program displayed to the rest of the audience was 28% and 31%, respectively.

3. Conclusions

The strategies used in SeniorChannel preferences collection sessions to overcome elderly participants' impairments were the inclusion of warm-up tools to generate the experience subsequently targeted in the data collection, and the assimilation of the prototype to technologies with which participants were already familiar. The users' preferences collected through these techniques inspired the subsequent design decisions. Regarding IDTV content, it was decided to produce information, interviews/debates, and documentaries about news, art, culture, and journeys. Regarding the interactive features, voting seemed like the preferred interactive feature to implement, also considering that some participants did not wish to expose themselves publicly. It was then decided to implement a "LIKE/DISLIKE" feature active several times during a TV program.

Acknowledgments

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Auditory-Visual Integration of Emotional Signals in a Virtual Environment for Cynophobia

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Abstract. Cynophobia (dog phobia) has both visual and auditory relevant components. In order to investigate the efficacy of virtual reality (VR) exposure-based treatment for cynophobia, we studied the efficiency of auditory-visual environments in generating presence and emotion. We conducted an evaluation test with healthy participants sensitive to cynophobia in order to assess the capacity of auditory-visual virtual environments (VE) to generate fear reactions. Our application involves both high fidelity visual stimulation displayed in an immersive space and 3D sound. This specificity enables us to present and spatially manipulate fearful stimuli in the auditory modality, the visual modality and both.
Our specific presentation of animated dog stimuli creates an environment that is highly arousing, suggesting that VR is a promising tool for cynophobia treatment and that manipulating auditory-visual integration might provide a way to modulate affect.

Keywords. Dog phobia, spatial audition, multisensory integration, emotion, and therapy

Introduction

VR-based exposure therapy has successfully treated several specific phobias using gradual confrontation to simulations of real-life anxiogenic situations [3, 4, 5]. Traditionally, studies primarily concentrate on accurate visual rendering of VE, while auditory rendering is often neglected. Consequently, the auditory aspects are often underexploited in the treatment of phobias. Thus, it is not yet clear how VR involving multiple sensory stimulations impacts this procedure. This is in stark contrast with natural environments, where emotional information is perceived via multiple senses. Furthermore, interactions between sensory inputs from all modalities influence perception and behavior in multiple ways. Thus, high-fidelity auditory inputs are also of great importance to evoke accurate affective reactions with virtual stimulations, especially since auditory augmentation of VE improves presence and immersion [1, 2].

This study aims to precisely assess the impact of multisensory stimulation on fear reactions. For this purpose, we investigated the potential of auditory-visual VE

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involving 3D sound for the treatment of cynophobia. The acoustic aspect of this phobia is much more relevant than in some other phobias, providing an ideal target to study how to combine the visual and the auditory stimulus' features to enhance sensory processing and modulate attention.

1. Methods

Upon arrival, all participants provided informed consent to take part in the experiment, previously approved by the local ethical committee.

Each participant was first submitted to an encounter with a virtual dog during a Behavioral Assessment Test (BAT1). After this first BAT, the participant then had to become acquainted with the equipment (training) before navigating within 2 different virtual environments. Then, he/she was again submitted to the encounter with a virtual dog with the same procedure as the first time (BAT2). Finally, the participant completed several questionnaires and was asked by the experimenter to comment on his experience (debriefing).

1.1. Virtual environments

The virtual environment used for the BATs was a simple corridor. The training environment was a garden with trees, a house, tables and benches. The first virtual scene used for the exposure to virtual dogs was again the garden scene. The second environment was an interior virtual scene in a large dark hangar, in which different pieces of industrial machinery are active and noisy.

In the virtual scenes used for the exposure to virtual dogs, several dogs were displayed in a progressive manner. They could be unimodal and static: auditory or visual alone (a dog barking from far or a dog lying down), unimodal and dynamic (looming and receding barking or visual dog standing up when the participant approaches), audiovisual and static (visual dog lying down and growling), audiovisual dynamic (visual dog standing up and growling when the participant approaches).

1.2. Virtual Reality setup

The experiment took place in the immersive space of INRIA in Sophia Antipolis, a four-sided, retro-projected cube with Infitec stereoscopic viewing (BARCO iSpace). The auditory scene was presented through Sennheiser HD650 headphones and the sound stimuli were processed through binaural rendering using selected non-individual Head Related Transfer Functions (HRTF) of the LISTEN HRTF database (http://recherche.ircam.fr/equipes/salles/listen/). The scenes had an ambient audio environment rendered through virtual ambisonic sources and binaural audio rendering. Head movements were tracked using an ART optical system so that visual stereo and 3D sounds were appropriately rendered with respect to the users position and orientation. The participants were equipped with a wireless joystick to navigate in the virtual environment. With this device, they controlled both rotations and translations within the virtual scene.

Figure 1. Participant in the hangar virtual environment

1.3. Participants

Participants were recruited on the basis of a questionnaire exploring fear of dogs (possible range for this cynophobia score: 0-42) [6]. One hundred and ten individuals (forty-four females) filled this questionnaire. A mean rating of 10,3 (SD=7,8) was obtained, which served as a basis to select participants to the current experiment. Eleven individuals whose scores on the cynophobia questionnaire were higher than 18,1 (mean + 1 SD) were selected from this pool.

1.4. Questionnaires and Interview measures

We used the State Trait Anxiety Inventory (STAI) to measure anxiety levels [7]. The state portion of the STAI was used upon arrival at the laboratory and after completion of the exposure session. A 22-item cyber sickness scale was used to assess the level of discomfort immediately after exposure [8]. The presence questionnaire from the I-group [9] was presented after immersion.

Anxiety ratings were collected during the BATs and navigation within the two virtual environments with the Subjective Unit of Distress (SUD), a self-report measurement of anxiety on a 0–100 points scale [10]. The participant was asked when facing each dog about his/her level of anxiety.

1.5. Procedure

Each participant was first invited to participate in a virtual reality BAT for the assessment of dog phobia. During this test, the participant was presented with a virtual dog, step by step, until it was extremely close and the participant could look at it from at a 5-centimeter distance. He/she had to rate his/her anxiety at each step. The BAT was scaled from 0 to 14 where 0 is refusal to enter the iSpace and 14 is putting one's face against the face of the virtual dog for more than 5 seconds.

All participants took then part in a training session completed in the garden scene in which no dogs were present. During training, the experimenter interacted with the participant in order to assist him/her in his/her first navigation.

After training the participant was immersed in the garden and hangar environments, aiming to expose him/her to the scenes with virtual dogs. He/she was instructed that

there was a frog somewhere in the environments and that his/her task was to explore them to find the frog. The frog was an auditory-visual object and could be both seen and heard. The sound spatialisation played a major role in this scenario, as the participant could rely on the auditory information to locate both dogs and the frog.

After the immersion in the hangar, the participant was exposed to a second BAT.

2. Results and discussion

Two participants had to stop the experiment because of high cybersickness. The measures collected on the 9 remaining participants are presented in table 1. There was no significant difference between the scores on BAT 1 and on BAT 2, probably because we worked with a non-phobic sample.

Table 1. Mean Subjective Units of Distress (SUDs) in VEs and Behavioral Assessment Tests (BATs) scores.

Variable	Mean	Standard deviation
BAT 1 score	13,6	0,73
BAT 2 score	13,4	1,0
SUDs in VE		
SUD in response to unimodal stimuli	14,7	9,3
SUD in response to bimodal stimuli	45,4	26,0

We conducted non-parametric statistics (Wilcoxon test) on the SUDs reported by the participants in the VEs. The participants reported higher anxiety levels in response to auditory-visual stimuli ($p<0.01$), compared to unimodal stimuli.

Our results suggest that our auditory-visual VEs are highly arousing. Moreover it confirms that the fearful stimuli are actually displayed in a progressive way since participants encountered unimodal virtual dogs before bimodal ones in the VEs. It also strongly suggests that manipulating auditory-visual integration might be a good way to modulate affective reactions. Altogether, these results depict auditory-visual VR as a promising tool for the treatment of cynophobia.

Acknowledgements

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User Validation of an Empathic Virtual Buddy against Cyberbullying

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Abstract. People are able to comfort others by talking about their problems. In our research, we are exploring whether computers can provide social support in a similar manner. Recently, we proposed a design for an empathic virtual buddy that supports victims of cyberbullying. To validate our approach in providing social support and to gather feedback from potential users, we performed an experiment (N = 30) to compare interaction with the buddy to reading a text. Both the buddy and the text received high scores; scores for the buddy were consistently higher. The difference was significant for the extent to which feelings were taken into account. These results indicate that participants liked to interact with the buddy and that they recognized the emotional cues emitted by the buddy, thus validating our approach in comforting users.

Keywords. Social support, embodied conversational agents, cyberbullying

Introduction

Today, children and adolescents spend a lot of time on the Internet. One of the risks they run online is to become a victim of cyberbullying. Cyberbullying refers to bullying through electronic communication devices. It is a complex problem that has a high impact on victims [1]. To help victims deal with their negative emotions, specialized helplines, such as Cybermentors[2] and Pestweb[3] enable them to talk to online counselors and/or peers trained to give social support. Social support or comforting can be defined as communicative attempts, both verbal and nonverbal, to alleviate the emotional distress of another person [2].

Since one-on-one online counseling is very labor intensive, automating this kind of support could help to reach more victims. In our research, we are exploring whether Embodied Conversational Agents (ECAs) can provide social support in the same way as humans do. An ECA is a user interface consisting of a virtual character that interacts with users based on the principles of face-to-face communication. Recently, we proposed a design for a virtual empathic buddy that tries to comfort victims of cyberbullying [3]. The buddy 'lives' on the computer screen of potential victims of cyberbullying. When a child feels uncomfortable because of a cyberbullying incident, it

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can turn to the buddy for emotional support and practical advice on how to deal with the situation. To validate our approach and explore how users experience interaction with the buddy, we performed an experiment with the target audience.

This paper is organized as follows. In section 1, we present the virtual empathic buddy. Section 2 describes our methodology. In section 3 the results are discussed. Finally, in section 4, we present our conclusions.

1. Empathic Virtual Buddy

The virtual empathic buddy is a virtual agent that acts as a supportive friend to victims of cyberbullying. For this experiment we implemented a prototype of the buddy. Figure 1 shows a screenshot of the interface. In the top left of the interface, a virtual character is displayed for non-verbal communication. Verbal communication between the user and the buddy is facilitated through the chat window. The prototype is a Wizard of Oz (WOZ) system; this means a human experimenter controls the actions of the buddy (i.e. the text sent to the chat window and the emotional expressions displayed by the virtual character).
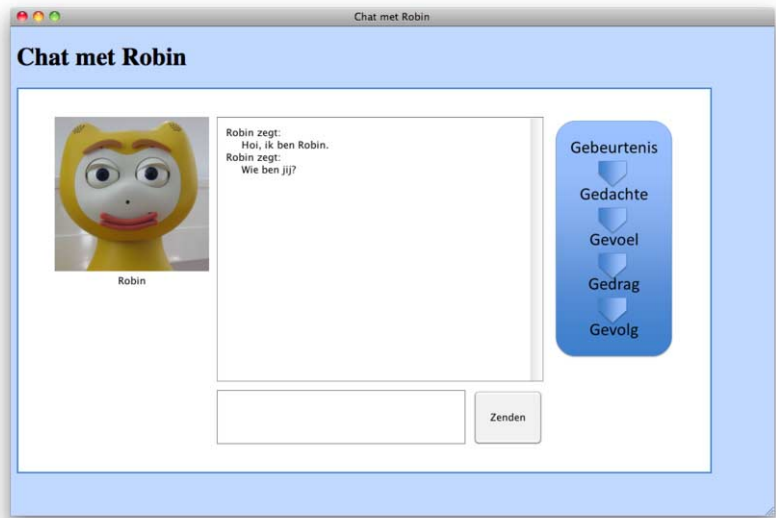
Figure 1. Screenshot of the virtual empathic buddy.

The structure and contents of conversation between the user and the buddy are based on the validated anti-bullying and social competence training named 'Fun at school' [4]. 'Fun at School' is a two-day summer course aimed at children aged 11-13 suffering from social anxiety, social-behavioral problems, or classroom bullying. During the training, participants learn they cannot change events, but they can change the way they deal with the thoughts and feelings that stem from these events. To remind our participants of the interaction between thoughts and behavior, the diagram visualizing this interaction is depicted on the right side of the chat window (see figure 1).

After saying hello to the user, the buddy asks him what happened. This allows the user to give his account of the events. Next, the buddy asks the user what he thinks about the event and how he feels. Then the buddy explains the interaction between events, thoughts, feelings, behavior and consequences. After explaining the theory, the buddy asks the user to come up with a helping thought about his situation. If the user comes up with an unhelpful thought instead of a helpful one, the buddy implicitly corrects the user by saying: *I also thought of an example*: and includes a relevant helpful thought. Finally, the buddy gives some practical tips the user can try to (temporarily) stop cyberbullying. During the conversation, the buddy responds sympathetically to input from the user, gives compliments, and mirrors the user's emotion.

2. Method

A between subjects design was used to gather user perceptions of the virtual empathic buddy. Participants were randomly assigned to either the experimental group or the control group. Participants in the experimental group interacted with the buddy and participants in the control group read an informative text containing the same information as the conversation with the buddy. Thirty children aged 14-16 took part in the experiment (mean age = 14.9, SD = 0.7). Sixty-three percent of the participants were male and all of them were experienced Internet users. Prior to the experiment, written permission from the participants' parents was obtained. The experiment was conducted at a high school in the Netherlands during class hours.

To make sure all participants received the same treatment, the interaction with the buddy (or reading the text) was based on a fictive scenario. The scenario tells the story of René, a fourteen-year-old boy who is verbally abused on msn by a classmate. Participants were explicitly told to take the perspective of René when interacting with the buddy or reading the text. During the experiment, participants received a paper version of the scenario and were asked to empathize with the main character. The scenario was available to the participants for the duration of the experiment.

After reading the scenario, participants in the control group received a text on paper with information on how to deal with cyberbullying. This text was presented as information found on the Internet by the main character in the scenario. Participants in the experimental group interacted with the WOZ buddy, that was presented to them as 'a computer program that offers assistance to children who are victims of online bullying' the main character found on the Internet. The conversation with the buddy took place on a laptop with a keyboard and mouse attached. This laptop was connected to the laptop of the experimenter who controlled the buddy. During the experiment, the experimenter behind the laptop was hidden from view.

After interacting with the buddy or reading the text, participants were asked to rate their agreement to seven statements on a 5-point scale (items: relevance, trustworthiness, and understandability of the information; the extent to which the advice would be followed, the information was geared towards the situation, and feelings were taken into account; and perceived support; with 1=completely disagree and 5=completely agree). In order to gather subjective feedback, the questionnaire also contained two open questions: *How useful do you think the buddy is?* and *How can the buddy be improved?*

3. Results

3.1. Statements

Table 1 shows the scores for each of the seven statements. Both the text and buddy were evaluated positively on all statements; average scores range between 3.64 and 4.75. Scores for the buddy were consistently higher than scores for the text. The difference was significant for the feelings statement ($t(28)=2.05$, $p=0.03$). This indicates that the target audience recognizes the emotional cues emitted by the buddy.

Table 1. Average scores and standard deviations for the seven statements (1=completely disagree and 5=completely agree).

Statement	Control		Experiment		
	M	SD	M	SD	*p*
Relevance	4.50	1.05	4.75	0.56	0.43
Trustworthiness	4.21	1.08	4.44	0.70	0.60
Understandability	4.14	1.30	4.69	0.58	0.16
Follow advice	4.36	1.04	4.40	0.71	0.90
Geared towards situation	4.00	0.85	4.13	0.99	0.72
Feelings	3.64	1.17	4.44	0.61	0.03
Perceived support	4.07	0.80	4.44	0.70	0.21

3.2. Usefulness

Answers to the open questions also demonstrated the participants' positive attitude towards the buddy and the text. Ten out of 14 participants in the control group and 8 of 16 in the experimental group used the argument that information and tips were given to substantiate the usefulness of the buddy or text. Three participants in the control group stated that they think a text alone will not help to stop cyberbullying. Two participants in the experimental group liked the fact that users can tell their story to the buddy. One participant was impressed by the buddy's social skills:

> *He gives good advice. He really wants to know how you feel, what you think about it. And he has clear answers and asks follow up questions.* (P21)

However, the user experience clearly varies, as another participant said the buddy should empathize better with the victim's situation.

A participant in the experimental group saw the fact that nobody could read along with the conversation as an advantage. Some concerns were also expressed: two participants refer to the lack of context when discussing upsetting events:

> *You don't know what other things some one may have experienced* (P5)

Only one participant was explicitly negative about the buddy, he suggested victims of cyberbullying should talk to a person instead of a computer program.

3.3. Improvements

Two participants in the control group and one in the experimental group mentioned the language used by the buddy or in the text was too difficult. Simplifying the language is

therefore an obvious improvement of the buddy or text. Other suggested improvements concerned the amount of information or tips (three participants wanted more information or tips) and one participant suggested to include an explanation why bullies bully. Also spreading the word about the buddy and educating people in schools were mentioned as improvements.

4. Conclusion

Interaction with the buddy was rated at least as high as reading an informative text with the same information content. Also the subjective feedback gathered from open questions was generally positive for both the buddy and the text. Based on these results we conclude that the target audience generally has a positive attitude towards the idea of a virtual empathic buddy against cyberbullying. The significant difference between the buddy and the text on the feelings statement indicates that the emotional cues emitted by the buddy are recognized, thus validating our approach. This result also provides evidence for our hypothesis that ECAs are able to provide social support.

The high scores and positive feedback for both the buddy and the text might also indicate the participants' appreciation for the information on cyberbullying (regardless of how this information was presented). Possibly, schools do not educate students on cyberbullying, even though there is a need for more knowledge. Some answers to the open questions pointed in this direction; for example, a participant in the control group suggested that schools should provide education on cyberbullying. This is consistent with findings from Sharples et al. on e-safety education in the UK; only 11% of the teachers interviewed by the researchers said they frequently taught students about online safety issues [5]. More research is needed to investigate this issue.

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Virtual Representations of the Self: Engaging Teenagers in Emotional Regulation Strategies Learning

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Abstract. The aim of this paper is to present digital representations of humans (i.e., avatars) that look like the self, applied to the Mental Health (MH) field. Virtual Representations of the Self (VRS) are in our opinion a tool with a great potential for engaging teenagers in emotional regulation strategies learning and an excellent example of new technology application to the basic concept in psychology field such as Bandura's modeling [1]. VRSs have already demonstrated their potential on human behavior modification (e.g. modification of physical activity; eating habits) in general population [2]. Thus, the same technology can bring in our opinion a lot to the Mental Health field, especially in emotional regulation learning. This paper presents a theoretical background and describes the methodology that we plan to apply in order to validate the efficacy of VRSs in clinical settings. Also, the implications of such technology and future research lines are discussed.

Keywords. Virtual Reality, Avatars, Emotional regulation, phobia

Introduction

Mental Health disorders are currently the leading cause of disability in developed countries [3] and young people have been identified as a particularly vulnerable population [4]. Lately, the increase in indiscipline and physical and psychological violence has been noted in teenagers' population [5]. Therefore, learning program of adaptive emotion regulation strategies is of great interest in our society. Indeed, an important aspect of child development is the ability to regulate his/her emotions. Emotion regulation includes learning to recognize, monitor, evaluate, and modify emotional reactions. Since the presence of dysfunctional emotional regulation strategies is a common element related to numerous psychological problems, from

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which suffer adolescent population; learning of adapted emotional regulation strategies can have a great impact on variety of disorders.

Although new technologies have been identified as a potential tool for increasing engagement in the therapy and accessibility of the treatment [6], many teenagers still find therapeutic face-to-face interventions difficult [7]. Thus, new channels that offer ability of increasing motivation and engagement of this type of population in the therapeutic process are needed. A possible channel corresponds to introduction of avatars in the therapeutic environment.

Modeling Therapy (MT) presented by Bandura [1] states that people can change their behavior by observing models of other people successfully cope with the problems they face. Therefore, a teenager that has some issues with regulation of his/her emotions can observe someone dealing with the same issues in a more productive way and learn from this model. Even though the modeling therapy is powerful, it presents some limitations. First, this type of therapy and its preparation can be time consuming. Second, it can present some logistic difficulties (i.e., difficulties to get the space, the context of the specific situation to model, and actors). Finally, the factors such as identification with the observed model (i.e., the actor should have the same sex, same physical characteristics, etc.), that improve the probability of performing the behavior by the observer, is an additional difficulty.

In the last decade, innovative technologies brought a new light to Bandura's theory. By applying Virtual Reality (VR) with its realistic and immersive graphics, different factors that influence likelihood of behavioral change (i.e., similarity of the model, self-efficacy belief, and vicarious reinforcement) can be easily recreated. VR has been used to create avatars that look like the self, namely, Virtual Representations of the Self (VRS). According to Bailenson and his colleagues [8], VRSs can be an ideal model by customizing the VRS's behavior to show an optimal performance that the physical self (e.g. an actor) cannot yet achieve. Indeed, VRSs can be very useful models since they can be manipulated to demonstrate a range of desirable behaviors that may be difficult to enact in the real world. For instance, VRSs can represent the highest level of similarity (e.g. same age, sex, skill level, emotional state) as the observer. Such similarities allows the individuals to develop feelings of identification with the VRSs and empathy towards them [9], which correspond to the identification factor that according to Bandura increases the effectiveness of VRSs as models and persuasive agents. Moreover, VRSs can represent the effects of one's behavior in the short time period (i.e., demonstrating the reward or punishment for ones behavior in acceleration). For instance, in a short time period VRSs can demonstrate different levels of attainable or ideal states (e.g. physical states such as losing weight or an emotional state such as being proud of achieving the goal).

The usefulness of VRSs has been supported by empirical data. Indeed, recent series of studies performed by Bailenson and his team (see [2] for a review) have demonstrated the powerful influence of VRSs on human behavior (e.g. modification of physical activity; eating habits, financial decision making). For instance, in a recent study [10] participants were taught a single arm exercise, than were assigned to three different groups: (a) a control group in which participants observed an immersive virtual reality environment without any VRS, (b) an experimental group in which the participants observed an immersive virtual reality environment with his/her VRS that adapted its behavior with respect to the participants behavior (i.e., when participants performed the arm exercises, their VRS gradually lost weight, and when participants

did not perform exercises their VRS gradually increased weight), and (c) an experimental group in which the participants observed an immersive virtual reality environment with his/her VRS that did not change its behavior with respect to the participants behavior. The results show that participants in the experimental group, in which their VRS adapted its behavior to the participants' behavior (i.e., application of vicarious reinforcement concept), completed significantly more exercises then participants in other groups. Moreover, the VRSs influence was maintained during 24 hours after the experiment.

Since numerous studies demonstrate that VRSs allow the modeling and change of human behavior in non-clinical population, it can bring a lot to the MH field. Following these findings, VRSs can provide an interesting tool for learning emotional regulation strategies and engaging teenagers in therapeutic process.

1. Method

A between-subjects design will be employed for each experiment. 40 teenagers will be randomly assigned to one of two conditions: (a) Virtual Representations of the Self of participant (see Figure 1); and (b) Virtual Reality Avatar with neutral appearance, different from participants'.

Figure 1.   Virtual Representations of the Self. Photographs of participant (top right and left) are used to create a VRS, which can express different emotional states such as anger (bottom left) or sadness (bottom right).

The participant in each group will observe on the plasma screen a virtual scenario in which an avatar experiences a frustrated interaction with his/her computer, after which the avatar will apply an emotional regulation strategy (i.e., deep breathing). The only difference in both groups will correspond to the avatar type factor (VRS vs VRA).

The following quantitative measures will be used in this pilot evaluation: pre-session emotional regulation questionnaire as a control measure; pre- and post-session adapted self-efficacy belief measure; and post-session questionnaire evaluating the participants' satisfaction and perceived usefulness of this type of exercise. Moreover, physiological measures (i.e., heart rate) will be applied in order to follow the temporary evolution of participants' emotional response.

2. Results

It is hypothesized (H1) that observing a VRS being frustrated will provoke a significantly greater arousal of heart rate compared with the group that observes a VRA. It is also hypothesized (H2) that observing a VRS applying an adapted emotional regulation strategy will provoke a significantly greater stabilization of heart rate compared with the group that observes a VRA. Finally, it is hypothesized (H3) that observing a VRS applying an adapted emotional regulation strategy will allow the participants to significantly improve their self-efficacy belief regarding the emotional regulation.

3. Discussion and Conclusions

This paper presents the possible application of VRSs in MH field. The main conclusions and their implications for MH care are discussed below.

In our opinion integration of VRSs as a part of the therapy may provide numerous advantages to the field. First, it may represent a response to one of the main challenges of the MH field, i.e., engagement in the therapy. Indeed, the large scale international studies have demonstrated that the majority of people suffering from mental health disorders do not receive the required treatment (WHO, 2004). In our opinion, the introduction of VRSs in the therapeutic process (prior to the traditional treatment phase, as a homework assignment, or as a therapeutic game) may allow to increase patients' engagement and in turn decrease the number of drop-outs. Thus, by allowing a wider acceptance of treatment, the risk of considerable economic costs related to untreated MH disorders can be reduced.

Second, research on avatars would yield a comprehensive understanding of the influence of VRSs on the behavior modification of clinical population. The confirmation of our hypothesis in the context of emotional regulation strategies learning would allow a new research line of VRSs applied to different MH disorders. For instance, the applications of VRSs in eating disorders, in which the body-image disturbance and self-efficacy issues are dominant, or in treatment of small animal phobias seem to us very promising.

The next step is to validate the concept of VRS with empirical data, and develop a series of applications in which each teenager has its own VRS hero to learn how effectively deal with emotions.

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Analysis of Online Social Networking Peer Health Educators

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Abstract. This study seeks to determine whether peer leaders can be recruited to deliver a community-based health intervention using social media. African American and Latino men who have sex with men (MSM) were recruited as peer leaders for either an HIV prevention or general health intervention using social networking technologies. Peer leaders attended 3 training sessions on how to use social media for health behaviour change. Baseline and post-training questionnaires were given to ensure that peer leaders were qualified in using social media to communicate health information. Repeated measures ANOVA models and χ^2 tests assessed differences in peer leader knowledge and comfort using social networking technologies pre- and post-training. Post-training, peer leaders were significantly more comfortable using social media to discuss sexual positions. Almost all peer leaders reported being comfortable using social media. There were no significant pre- and post-training differences on other knowledge or comfort measures. Results suggest that peer leaders can be recruited to conduct health interventions using social networking technologies. The discussed training plan can be adapted to health domains to ensure that peer leaders are qualified to conduct health interventions using social media.

Keywords. Online social networking technologies; peer leader intervention; health behaviour change

Introduction

Community peer leader interventions have been used for promoting health behaviour change throughout the world [1-3]. These interventions involve recruiting and training peer leaders and sending them into the community to change social norms and behaviour [4,5]. Peer leaders, especially influential popular opinion leaders, are able to connect with participants by communicating information and feelings in a culturally and socially appropriate manner [3]. Peer health interventions have been successfully used in areas as diverse as bicycle safety [6], drug prevention [7], and sexual attitudes and behaviours [3]. An HIV prevention peer leader intervention increased condom use up to 16% and decreased unprotected anal intercourse up to 25%, with sustained behaviour change up to 3 years later [8,9]. While peer leader interventions are effective health interventions, they can cost considerable time and money.

Online social networking technologies can be used for scaling community-based interventions, especially interventions that use of social networking principles. The earliest social networks began in 1997 and quickly began attracting millions of users. As of 2010, there are over 2.1 billion online social network profiles, and this number is expected to reach over 3.6 billion by 2014 [10]. People from all racial, sexual, and economic backgrounds are increasingly using the Internet and social networking

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technologies [11-13]. Due to their popularity and the ability for rapid and widespread communications, online social networking technologies might be particularly well-suited for scaling peer leader health interventions, including programs that target ethnically and racially diverse populations.

Because of the success of HIV-related peer interventions, there is a need to determine the feasibility of recruiting peer leaders to use social networking technologies to promote HIV prevention. For example, peer leaders in a community-based HIV prevention intervention are typically recruited, receive training in HIV prevention, and are sent out in the community to promote HIV prevention communication and behaviour change. If this process could be conducted through an online community (such as through an online social networking technology), then the time and resources needed to deliver such an intervention could be reduced considerably. If peer leaders could be recruited without needing face-to-face interviews, then this process could be made even more efficient.

This paper uses data from the HOPE UCLA study, the first NIH-funded study to scale a community-based HIV prevention intervention using social media, to explore whether peer health experts can be recruited to use social media for delivering a peer health intervention.

1. Methods

Sixteen African American and Latino men who have sex with men (MSM) were recruited as peer health educators from referrals from community-based outreach organizations and online social networking groups. Recruitment fliers provided information that UCLA is conducting a health-related study and needs peer health outreach workers who: 1) are over 18 years of age, 2) are male, 3) are interested in educating others about health through online social networks, 4) are existing popular opinion leaders or capable of being leaders in their community, 5) are African American or Latino, 6) have had sex with a man in the past 12 months, 7) live in the Los Angeles area, and 8) are experienced using Facebook.

According to the HOPE UCLA randomized, controlled trial protocol, peer leaders were randomly assigned to be a peer health educator who would deliver either HIV prevention or general health information to participants. While all peer leaders were initially expected to have expertise in HIV/general health knowledge and be comfortable using social media technologies, we set up 3 training sessions (carried out over a 3.5 week period) for the HIV group and 3 sessions for the general health group to ensure peer leaders would have the skills needed to be certified as social media peer health educators. Each of the training sessions lasted 3 hours, provided food for the peer leaders, and was based at UCLA. Peer leaders were given a peer leader training guide at the first training session, with an overview of topics and logistical information about the study and how to be an effective peer leader. The first training session covered essentials of epidemiology and public health (e.g., HIV incidence/prevalence and risk factors was taught to the HIV group peer leaders; obesity, nutrition and stress were taught to the general health group peer leaders). The second training session for both groups covered methods of communicating sensitive topics that were specific to their group. The final training session for both groups focused on ways to use social media for communication, along with general study logistics. Each peer leader was then evaluated through both surveys and observation to make sure he was qualified to receive certification as a HOPE UCLA peer leader.

The primary purpose of the surveys was to inform as to whether peer leaders were qualified and ready to use social media to communicate health information. A questionnaire was given to peer leaders at the start of the training to assess whether they possessed all the skills that had been stated in the inclusion criteria. No differences were expected for participants who already had the skills stated in the inclusion criteria, however, the post-training survey was provided to ensure that any participants who were not prepared would receive the skills or comfort they had lacked prior to training. The questionnaire was the same for both the HIV group and general health group. Questionnaires were designed to ensure proficiency in: general knowledge about HIV and general health (measured with a series of true/false questions to assess HIV and general health knowledge), experience using social networking technologies (through yes/no questions on whether they have ever sent messages or wall posts on Facebook), and comfort using these technologies for health outreach. Comfort questions were measured with 5-point Likert scales (1= very uncomfortable, 5= very comfortable) assessing their comfort (such as how comfortable they would be to use social networking technologies to talk to another person about sexual risk behaviours or nutrition principles). For peer leaders to receive certification that they were qualified to conduct the intervention, they needed to have a passing score (above 70%) on the health and HIV knowledge questions, report being comfortable or very comfortable using social media for health communication outreach, and receive approval from the peer leader trainer that they were prepared for social media health outreach.

2. Statistical Analysis

Mean and standard deviations of the test scores for general health and HIV knowledge were calculated for each peer leader group out of a possible 100 points for each exam. Repeated measures ANOVA models were used to assess differences in the mean scores for each exam before and after training and to detect any differences based on peer leader training assignments. Peer leader comfort levels were recoded into dichotomous outcomes combining responses of "very comfortable" and "comfortable" into one category, and "very uncomfortable," "uncomfortable" and "average" into another category. The proportion of peer leaders indicating comfort on each topic was compared before and after the training program using χ^2 tests (McNemar's test).

3. Results

All peer leaders were living in Los Angeles, over 18 years old, African American (n = 5), Latino (n = 8), or unreported (n=3) males who had had sex with a man in the past 12 months. All participants reported having extensive offline health outreach experience as well as at least basic experience using online social networking technologies. Peer leaders were primarily from the Western United States, and all had completed at least a high school education.

Table 2 shows the results of the HIV and general health knowledge scores. The test scores overall were above a passing level both before and after training. There were no significant differences found in the scores on either the general health or HIV knowledge tests before and after the training program. There were no significant differences between people's knowledge about HIV or general health within groups. Most peer leaders gave the same responses on the exam before and after the training program.

Most of the peer leaders displayed comfort using social media before the training program. The proportion of peer leaders who were comfortable using each of the social media tools did not significantly change after the training program. After the training program, all peer leaders described themselves as at least comfortable using each social media device (Table 3).

After the training, the majority of peer leaders also rated themselves as comfortable discussing each of the topics (Table 4). There was a significant increase in the proportion of peer leaders who felt comfortable discussing sexual positions after the training (p=0.0313). There was no significant change after training in the percentage of peer leaders who felt comfortable discussing other topics. After training, over 85% of peer leaders were comfortable using social media to discuss each health-related topic.

4. Discussion

Results suggest both that peer health educators can be recruited and trained to use social media for health behaviour change, and that peer leaders can be recruited without needing extensive training. Using very focused inclusion criteria, peer leaders were recruited who already had extensive knowledge about health communication and social media outreach. Focused training sessions ensured that peer leaders who were not already qualified were ready to be peer leaders by the end of training, as at post-training over 85% of peer leaders were comfortable using social media to discuss every health related topic.

It is possible that the lack of statistical differences between pre- and post-training may be related to the small sample size of the peer leader group rather than a ceiling effect that recruited peer leaders were already qualified. However, data suggest that recruited peer leaders can, at the very least, be qualified and comfortable using social media for health communication methods after the proposed training. Pre- to post-training comfort levels using social media for health outreach increased for every topic. While most changes between comfort levels before and after the training program failed to be significant, this was likely due to the already high proportion describing themselves as comfortable discussing the topics before the training.

The study is limited by the small sample size and by the specialized sample of peer leaders who were recruited based on already being experienced in health communication outreach and social media. With a larger sample, we might have recruited peer leaders who were less specialized in social media and health behaviour change and had more varied experience. In this case, our results may have differed as we could have observed pre- and post- training differences in knowledge and comfort using social media for health behaviour change. However, because the peer leader training combined traditional evidence-based peer leader training with innovative social media methods, we believe that focused inclusion criteria combined with social media health communication training would be enough to ensure that peer leaders would be qualified to deliver an online social networking-based health intervention. Another possible limitation is that while this study may have shown that peer health educators are comfortable and knowledgeable using social media for health behaviour change, the success of the intervention is still unknown. Future analysis will describe results of whether social media can be used to deliver a peer-led health intervention. The present methods might be particularly important for informing future work, as the target populations for this study have been difficult to recruit for online studies.

5. Conclusion

Peer health educators can be recruited and trained to deliver health intervention using social networking technologies. Peer leaders will not need extensive training due to the prevalent use of social media. Integrating social networking technologies and evidence-based community health interventions can improve population-focused health delivery.

Table 1. Demographics of peer leaders, Los Angeles, CA (2011)

		N
Origin		
	Northern United States	4
	Southern United States	0
	Eastern United States	1
	Western United States	10
Spanish primary language		
	Yes	2
	No	13
Education		
	Less than High School	0
	High School	6
	GED	2
	Associates	3
	Bachelors	3
	Graduate degree	1
Race		
	Black	5
	Latino	8
	Other	2
How often online each day		
	Never	0
	0-1	1
	1-2	8
	2-4	4
	4+	2

Table 2. Mean and standard deviations of HIV and general health test scores by assigned peer leader group (out of 100 possible points).

	Mean Pre-Training Test Score (SD)[1]	Mean Post-Training Test Score (SD)
HIV Knowledge – HIV Peer Leader Group	89.63 (8.16), n=9	89.44 (5.41), n=8
HIV Knowledge – General Health	88.57 (6.47), n=7	89.52 (8.77), n=7

Peer Leader Group

General Health Knowledge – HIV Peer Leader Group	72.84 (9.80), n=9	73.61 (8.27), n=8
General Health Knowledge – General Health Peer Leader Group	72.22 (7.17), n=7	76.98 (7.47), n=7

[1]SD refers to standard deviation

Table 3. Percent of peer leaders responding "Comfortable" or "Very Comfortable" to using specific social media tools before and after training

Social Media Tool	Percent Comfortable Using Tool at Baseline	Percent Comfortable Using Tool Post-Training
Chatting on Facebook	93.75%	100%
Posting on a Facebook wall	93.75%	100%
Sending a Facebook message	93.75%	100%
Sharing a link on a Facebook wall	87.5%	100%

Table 4. Percent of peer leaders responding "Comfortable" or "Very Comfortable" discussing various topics before and after training

Question	Percent Comfortable Discussing Topic at Baseline	Percent Comfortable Discussing Topic Post-Training
Talking about cultural barriers in HIV prevention	93.75%	100%
Talking about Sexually Transmitted Infections (STIs)	68.75%	93.33%
Talking about sex with men	68.75%	100%
Talking about sex with women	68.75%	100%
Talking about sexual health	93.75%	93.33%
Talking about sexual partners	62.5%	93.33%
Talking about sexual positions	43.75%	93.33%*
Talking about stigma against HIV/STI	87.5%	100%
Talking about alcohol or drug use during sex	62.5%	86.67%
Talking about condom use	81.25%	86.67%

*Indicates significant difference at $p<0.0$

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Section IV

Clinical Observations

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The Use of VR Distraction to Decrease Pain After Laparoscopic Bariatric Surgery: A Case Study

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Abstract. One of the advantages of laparoscopic bariatric surgery is the reduced level of postoperative pain. In some cases, however, the pain level may be high. This is a challenge for specialists. This case study explores the use of VR distraction in an 18 year-old patient who had undergone laparoscopic bariatric surgery and who reported pain during the postoperative period. The study was conducted in a Level III Private Hospital in Mexico City where the patient was hospitalized. The patient was administered standard analgesic during VR distraction, which lasted a total of 40 minutes divided into two sessions. The scores of three visual analogue scales and catastrophism were the dependent variables of this study. The scales were administered before and after the VR distraction intervention. The patient reported lower pain levels after VR distraction and reductions in some components of catastrophism. This study proves that VR distraction can be effective not only in reducing the physical component of pain (a notion that is already well established) but also the cognitive/affective component. More controlled studies of the issue are required.

Keywords: Virtual Reality, Pain

Introduction

The World Health Organization reports that obesity rates have doubled worldwide since 1980. It is a problem that has reached epidemic proportions; at least 2.6 million people die due to obesity-related causes each year. By 2015, it is estimated that there will be 1.5 billion obese people around the world [1]. One of the medical interventions currently available to deal with the problem of obesity is bariatric surgery.

Laparoscopic bariatric surgery is a procedure that has the advantages of a shorter hospital stay, less postoperative pain compared with the open alternative [2] and lower levels of interference with pulmonary mechanics [3]. However, some patients may experience high levels of pain after surgery, resulting in a high intake of extra analgesics, longer hospitalization, and a slower recovery.

Recent reviews recommend the use of VR distraction for patients who are undergoing painful medical procedures [4, 5, 6, 7]. It has also been shown that Virtual Reality can be used in a sustained manner with good results. Virtual environments do not create dependence and do not cause side effects like nausea or dizziness [8].

This case study explores the use of VR distraction in a patient with pain after having undergone laparoscopic bariatric surgery. We hypothesized that: 1. VR distraction would be useful for reducing pain intensity and the time spent thinking about it, as well as increasing the sense of control. 2. VR distraction may have a modulating effect on the catastrophic thoughts involved with pain.

1. Method

1.1. Pre-surgery

Before surgery, the patient was informed orally and in writing of the purpose of study. The study was approved by the Ethics Committee of the participating universities and by the hospital.

1.2. Patient and setting

Female patient, 18 years of age, who had undergone laparoscopic bariatric surgery (gastric bypass) and was hospitalized during the study. The study was conducted in a private Level III Hospital in Mexico City. The patient was not paid for her participation.

1.3. Design, procedures and measures

Uncontrolled, pre/post study. Six hours after surgery, pain was evaluated by means of three 10-point visual analogue scales (intensity, pain control and time thinking about pain) and level of catastrophizing with the Pain Catastrophizing Scale (PCS) [9]. The patient reported a score above 3 (mild pain) on the pain scale and so the VR distraction was administered in accordance with the study protocol. After the VR distraction intervention, the scales were applied again in order to compare the results. Two 20-minute VR distraction sessions were applied. There was a 12-hour interval between sessions.

1.4. VR distraction

The VR distraction procedure was performed with "Surreal World", an interactive 3D environment, which presented objects that were not part of the real world and defied the laws of physics. Moving pictures were accompanied by changing sounds that sought to generate surprise and capture attention. The patient was instructed to generate multiple interactions in the virtual environment with the aid of a mouse. The product offered the patient the possibility of changing the scene so as to avoid habituation, following the guidelines suggested in the literature [4].

Figures 1. and 2. Some of the scenarios in Surreal World.

2. Results

The patient was administered two sessions of VR distraction. The first session was administered six hours after surgery; in this session, the patient reported a 25% reduction in pain severity, a significant increase in the sensation of pain control and a 20% reduction in the time thinking about pain. Eighteen hours after surgery the second session of VR distraction was conducted. The patient reported a decrease in pain intensity of 50%. As for the sensation of control, no differences were found between pre- and post-surgery. Time spent thinking about pain fell by 20% after administration of VR distraction. (See Table 1).
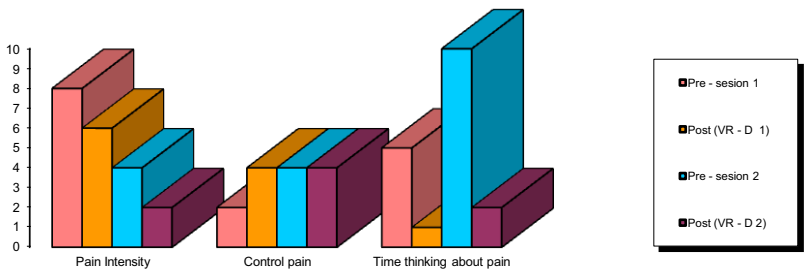
Table I. Visual Analogue Scale scores before and after VR distraction sessions.

In relation to catastrophism, the scores for the subcomponent Hopelessness fell after each VR distraction session. The same happened with the Rumination subscale, in which the most significant reduction (40%) was achieved after the first session. However, the Magnification component was not modified by the intervention. These results significantly lowered the total score of catastrophism after each VR session. (See Table 2).
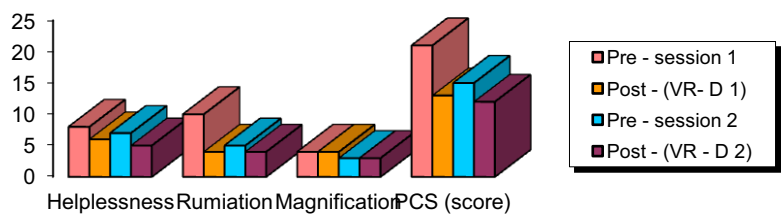
Table II. Catastrophic thoughts scores before and after VR distraction.

3. Discussion

Research has shown that VR distraction is useful for modifying cognitive strategies (e.g. by reducing anxiety and distress during painful medical procedures, [8, 10, 11, 12]) and that it has an enormous potential for increasing motivation [13]. Our results corroborate these reports, showing that VR distraction can be effective in reducing the catastrophizing that derives from pain. It is agreed that catastrophizing plays a key role in the prognosis of pain in general [9, 14]. A reduction in catastrophizing is probably related to a more positive and less exaggerated vision of the experience of pain [15]. These findings constitute a further step on the way to the understanding of pain as a complex entity.

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PHIT for Duty, a Mobile Approach for Psychological Health Intervention

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Abstract. The goal of this effort is to support prevention of psychological health problems through innovation in mobile personal health assessment and self-help intervention (SHI). For the U.S. military, we are developing and evaluating a field-deployable personalized application, PHIT for Duty™, to help build resilience in healthy troops and support prevention in high-risk personnel. PHIT for Duty is delivered using any smartphone or tablet with optional nonintrusive physiological and behavioral sensors for health status monitoring. The application integrates a suite of health assessments with an intelligent advisor that recommends, tailors, and presents self-help advisories. PHIT for Duty is intended for secondary prevention of psychological health problems in persons who have been exposed to psychological trauma and may be showing some symptoms of distress, but have not been diagnosed with any psychological disease or disorder.

Keywords. Psychological health monitoring, mobile devices, intelligent advisor

Introduction

Psychological health problems, including major depression, sleep disturbances, generalized anxiety, and posttraumatic stress disorder (PTSD), have an estimated prevalence rate of 16-17% in post-deployed soldiers and Marines three to four months upon their return from Iraq [1]. This rate increases to 19% at one year after deployment [2]. In addition to these human costs, it is estimated that the financial costs for PTSD and depression after two years for the troops who have deployed since 2001 could reach $6.2 billion [3].

To cope with stress, some military personnel are provided psychological training, including stress relaxation breathing [4] and mindfulness training [5]. Studies have shown that enhanced stress resilience is associated with a protective physiologic stress response: A reduction of anxiety within 72 hours of exposure to a traumatic event is associated with lower risk of PTSD and greater effectiveness of debriefing [6]. It follows that deployed individuals must recall and apply these stress coping skills shortly after exposure if they are to be of benefit. By using PHIT for Duty for self-help stress relaxation, as one example, we expect to mitigate post-exposure anxiety, return personnel to duty more rapidly, and support PTSD prevention.

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After deployment, personnel are periodically evaluated using multiple health assessments and are referred to clinical care as indicated. However, individuals with subclinical findings are not likely to be referred and may not avail themselves of psychological care or interventions that may prevent the development of PTSD or other disorders. Those individuals who do not get well on their own must cope with episodic and varying symptoms, such as anxiety, that affect their operational performance, relationships, and reintegration.Symptoms may progress to chronic psychological disease or risky behavior, such as substance abuse. Many could benefit from low-cost SHIs, thereby mitigating early symptoms and improving quality of life. Furthermore, the majority with PTSD do not seek treatment, or drop out before they can benefit [7]. The PHIT for Duty application supports at-risk populations by monitoring health and behavior in a private, personal way, offering SHIs, and advising those who need professional help to seek help.

SHIs can be defined as a standardized psychological process, therapy, or treatment that the patient works through independently at home using print or multimedia [8,9], over the Internet [10,11], or using mobile health (mHealth) technologies. Most self-help approaches have been developed for patients with a specific disorder, such as depression, panic disorder, social phobia, or PTSD, and are based on cognitive behavioral therapy [12] as a means of treatment. These SHIs are treatment oriented; PHIT for Duty will take a similar approach but will be prevention oriented.

1. Personal Health Intervention Tool (PHIT)

Our PHIT development framework [13,14] allows applications such as PHIT for Duty to integrate a suite of health assessments with an intelligent advisor that recommends, tailors, and presents self-help interventions. The framework (Figure 1) is flexibly designed to collect health data from many different sources, have runtime intelligence for dynamic data analysis, be customizable, work offline when connectivity is unavailable, and run on multiple mobile devices. All systems are configurable using XML, making it easy to configure, and reconfigure, the data input instruments and advisory components. Instrument XML contains logic to perform dynamic lookups, validate data, and modify data collection sequencing.

PHIT for Duty integrates mobile software and physiological sensors for health assessment. Periodic psychometric assessments of stress, depression, anger, anxiety, alcohol use, and sleep quality are made using self-report forms and questionnaires. Additional data are acquired via interactive exercises and sensors. To assess arousal, stress reactivity, and sleep quality, wireless sensors for heart rate variability (HRV) and body motion are used. These assessments are analyzed to recommend activities designed to reduce symptoms and prevent disease, such as stress relaxation, mindfulness meditation, progressive muscle relaxation, behavior therapy, health messaging, and links to professional care.

The architecture is designed for multimodal data collection and presentation. These options include self-report form-based instruments (e.g., surveys, patient histories); scheduled, repeated measures (e.g., daily, weekly); in-the-moment diaries over weeks or months; cognitive tasks; health measures via Bluetooth-linked tools (e.g., HRV, accelerometry, geolocation); and varied content for instruction, reporting, and feedback.
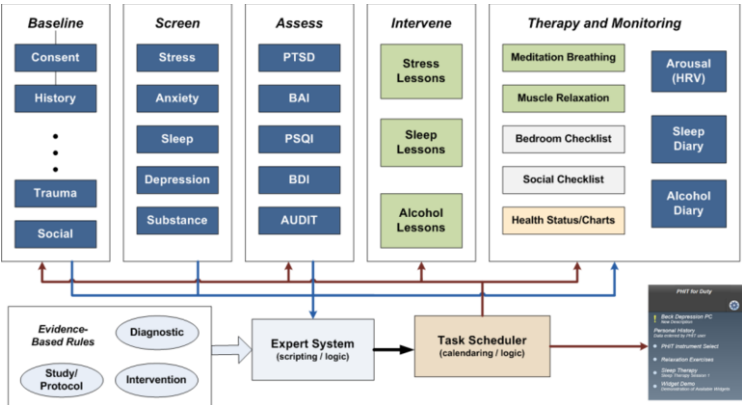
Figure 1. Overview of PHIT framework as configured for the PHIT for Duty application.

The PHIT approach mimics the SOAP notes (i.e., subjective, objective, assessment, plan) workflow model commonly used in primary care settings [15]. This process model, coupled with self-help resources for prevention and treatment, provides a facilitated paradigm for personal health assessment and management. Subjective psychometric measures (e.g., sleep quality, mood) and self-reported behaviors (e.g., alcohol use, exercise) are combined with objective measures (e.g., HRV arousal measures) to form an overall health status assessment. An intelligent advisor uses the assessment to plan self-administered interventions, such as sleep hygiene education, stress relaxation exercises, and substance use reduction skills acquisition.

2. Intelligent Advisor

After the system collects data via the various instruments, an intelligent advisor processes the data by applying rules to the collected data, tailored to the user [16]. The advisor decides if further data need to be collected or if the user should perform a series of activities. For instance, anxiety or stress data might be collected using external sensors. The advisor, after analyzing the data, might recommend relaxation activities. In contrast, should any assessment (via survey or physiological instrument) indicate risk, such as a referral threshold that is reached given the user's responses to a depression survey, the user is advised to seek professional care.

The intelligent advisor is the central health assessment processor, activity manager, and performance data logging subsystem of PHIT for Duty. Central to the assessment of psychological health status is a Patient Health Status Model (Figure 2). Overall health status comprises a suite of health state clusters (e.g., hyperarousal, depression), each set to one of several health states (normal, suspect, subclinical, or clinical). The health state cluster concept permits SHIs to be aligned with individual psychological health concerns rather than simply linked to categorical diagnoses (e.g., PTSD).

Criteria and validation of the decision rules that transition among health states are managed by staff psychologists and reviewed by an expert advisory board of military mental health professionals. For standardized psychometric tests (e.g., PCL-M or PSQI), clinical diagnostic cut-offs that are well known in the literature are used to define the clinical states. Criteria and logic for normal, suspect, and subclinical health states, and state transitions, are determined from published validation studies for each of the psychometric measures.
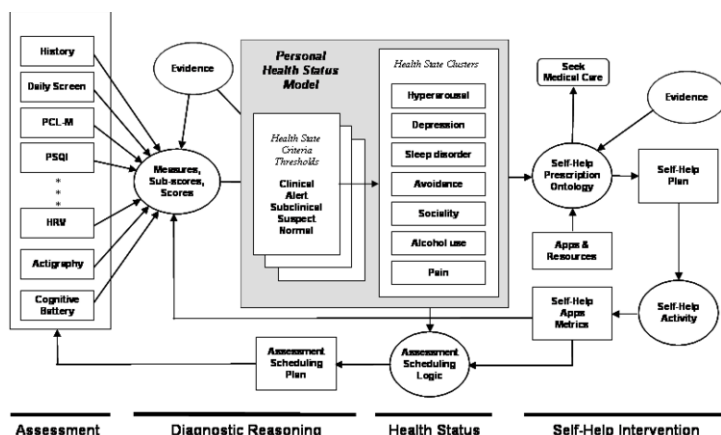
Figure 2. Preliminary patient health status model and executive processing schema.

A diagnostic reasoning subsystem periodically assesses health status and makes recommendations for changes in assessment and SHI strategies based on these health data. The intelligent advisor manages and schedules user activities, including assessment and SHI, via the device's built-in notification schemes (tone alerts, visual prompts). At baseline, over the course of several days at initiation, a host of assessments are administered. Subsequently, standardized screening assessments are administered at regular intervals (weekly, biweekly, monthly, depending on the instrument), with more full-scale instruments administered when screening thresholds are reached and at shorter intervals when the advisor has identified potential health concerns through sub-threshold scoring on full-scale instruments. SHIs are scheduled according to their individual paradigm, as indicated by health status and symptomatology. When an SHI is indicated and added to the current activity list, execution of that SHI may be done once or multiple times, again according to its specific design. Whenever the user activates and performs an SHI, a record of that activity and any SHI-derived data is saved in a secure, encrypted database for subsequent off-loading and data analysis.

As an example, while completing a sleep assessment log the user might note periods of anxiety and insomnia. The intelligent advisor would score these assessments and recommend several SHIs, such as stress relaxation training and sleep hygiene therapy, to improve sleep quality. If the user continued to report sleep problems, the application might request that actigraphy and HRV sensors be used during several subsequent nights to acquire objective measures of sleep quality. Further reported sleep problems would then lead to referral to a clinician. All of these data would be logged for quality assurance review by study personnel, and subsequent data analysis.

3. Discussion

PHIT for Duty has been developed for Android and iOS smartphones and tablets, and currently includes over 25 psychometric, combat and trauma exposure, and other data collection instruments and evaluations. Self-help interventions are being developed for stress, sleep problems, and alcohol abuse, including multimedia-based learning modules, stress relaxation breathing exercises, and muscle relaxation exercises. The application is currently being evaluated in usability and other validation studies, and will be used in a randomized controlled trial of post-deployed military personal.

PHIT for Duty is being developed primarily as a preventive methodology, to reduce the impact of traumatic and operational stress exposures in deployed personnel. The application provides psychological health assessment in a personal platform to provide privacy, encourage assessment, and offer preventive interventions. This self-management of early symptoms offers a new approach to secondary disease prevention.

Acknowledgements

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An Online Emotional Regulation System to Deliver Homework Assignments for Treating Adjustment Disorders

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Abstract. Adjustment Disorders (AD) is a very common mental health problem in primary care. Only general treatment guidelines are available for its treatment. Our research team has developed a cognitive-behavioural treatment (CBT) supported by Virtual reality (EMMA system) that has shown its utility in the treatment of AD. EMMA is a VR adaptive display that adapts its presentation to the patient' therapeutic needs. So far, researchers have been centered on how to use the Information and Communication Technologies to deliver treatment within the therapeutic context. TEO is a completely open Online Emotional Therapy web-based system that allows creating personalized therapeutic material. The patient can access this material over the Internet. Preliminary data about the acceptability of TEO system in a case study has already been obtained. The aim of the present work is to describe the session protocol regarding the homework assignments component in the treatment of AD designed in TEO system. Also, data about preferences and efficacy of TEO system versus traditional homework assignments implementation in a single case study with AD are presented. A web-based system of this kind increases the possibilities for therapy.

Keywords. Cognitive-behavioural treatment, online therapy, Internet, Homework Assignments, Adjustment Disorder

Introduction

Adjustment Disorders (AD) is a very common mental health problem in primary care, ranging the percentage of adults suffering from AD in this setting from 5% to 21% [1], [2]. In the literature only general guidelines for the treatment of AD are available. Our research team has developed a cognitive-behavioural treatment program for AD [3], which includes 6-8 weekly therapy sessions and uses an adaptive Virtual Reality system (*EMMA's World*) to conduct the exposure/processing therapeutic component. This system can adapt its content to every patient's needs with the aim of reflecting and evoking emotional responses in him or her to allow the emotional processing to occur. This treatment protocol has already showed its efficacy in several preliminary studies with participants diagnosed of stress related disorders (including AD) [4], [5], [6]. So far, research has been centred on how to use the Information and Communication Technologies to deliver treatment within the therapeutic context. TEO is an Online Emotional Regulation System, which permits the patient to do the homework

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assignments at home over the Internet. This web-based system allows in a simple and effective way to create personalized therapeutic material to present to the patient [7]. Preliminary data about the acceptability of TEO system has already been obtained in a case study [8]. The aim of this work is to describe the session protocol designed in TEO system as homework assignments for AD. Also, data about preferences and efficacy of TEO system versus traditional homework assignments in a single case study with AD will be offered.

1. Method

1.1 Participant

The participant was a single 21 year-old woman. She was studying Tourism at the university. The stressful event was the death of her sister 8 months ago. She met the criteria for Complicated Grief [9].

1.2 Measures

- *Homework Assignments Preferences Questionnaire* [10]. Before starting the treatment, the patient was given a brief explanation about the two ways of applying the homework assignments (using TEO or Traditional). Then, she answered 4 questions concerning her preferences regarding her homework assignments (which one she would choose, which one she considers more effective to overcome her problem, which one she considers more aversive and which one she would recommend to a friend who had the same problem).
- Pre-post homework session (TEO and Traditional) assessment. The participant assessed relevant clinical variables before and after practicing the homework assigned at the end of each session in both conditions (TEO and Traditional): 1) *Mood state* (assessed on a 7-point *Likert* scale using faces reflecting different mood states); 2) Perceived *self-efficacy* to cope with her problem (assessed also on a scale from 1= "*Nothing at all*" to 7= "*Totally*"; 3) Negative and positive emotions using Visual Analogue scales (also on scales from 1 to 7). Furthermore, the participant assessed the *change experienced in mood and self-efficacy* after each homework assignment was completed, on a scale from 1 to 7 (1= *Much worse*, 2= *Worse*, 3= *A little worse*, 4= *No change*, 5= *A little better*, 6= *Better*, 7= *Much better*).
- *Satisfaction with the homework assignments*. After practicing the homework assigned at the end of each session the participant assessed her level of satisfaction with both ways of applying the homework. She answered 2 questions on a 0-10 scale: 1) *To which extent did you like the activity you've done today?*. 2) *To which extent do you belief that the homework session today was useful?*.

1.3 Design and Treatment

The participant received the homework assignments in both modalities and in a counterbalanced way (first, traditional and second, TEO) in the period between

sessions. After each session, she practiced the homework first in the traditional way, and then using TEO system. After these 2 practices she could choose the way she preferred to practice the homework for the remaining days of the week until the next therapy session. A CBT program consisting of 6 weekly sessions (and 2 additional ones depending on the patient's needs) with the following main therapeutic components was used: educational component, exposure/processing of the stressful event with *EMMA's World* (see a full description in [6], [11]), and relapse prevention. A detailed description of the CBT program can be found in [3].

1.4 TEO System

TEO is a system based on Web technology (http://www.psicologiaytecnologia.es/teo) and it includes 2 platforms: 1) *Therapist platform* (see Fig 1): The therapist can manage and administer the users and the results of treatment of each user, create sessions and customize treatment protocols using multimedia materials included in the TEO multimedia base (pictures, texts, narratives, music, and videos), view the content, and assign sessions as well as treatment and assessment protocols to the patients. 2) *Patient platform:* Patients can complete the pre-session assessment protocol, they can visualize the homework sessions assigned by their therapist and move around a virtual environment (they can choose a beach or a forest environment) at the end of each session to reflect on the session and their experience (see Fig 2).
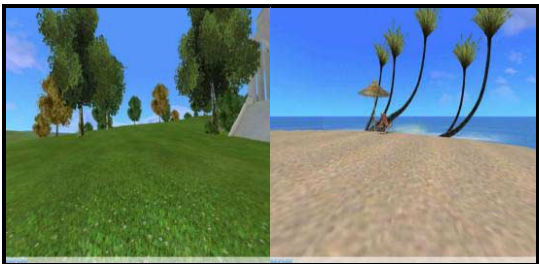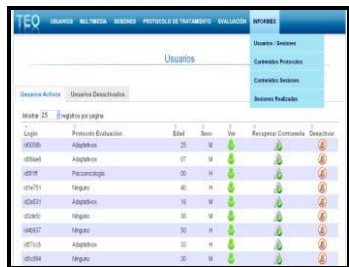
Fig 1: Screen shot of the therapist' platform   **Fig 2**: Virtual Environments displayed in the patient platform.

Tables 1 and 2 show the therapeutic contents and multimedia contents included in each TEO homework session included in the protocol.

Table 1. Therapeutic and multimedia contents included in the TEO sessions protocol for AD (SS1-3)

Sessions	Multimedia contents	Therapeutic Contents
S1	Videos/images + narratives/texts	-Treatment rationale: techniques and strategies included in the protocol -Psychoeducation about negative emotions that are present in AD -Cognitive model I: Factors that are in the base of the emerging and maintenance of AD (see Figure 3). -Book of Life and *EMMA's World* tools rationale.
S2	Videos/ narratives/ images +music/texts + music	-Exposure/processing rationale. -First metaphorical description of the stressful event (see Figure 3) -Processing I – Acceptance I: To be aware of the thoughts, emotions and sensations evoked by the symbols and related to the problem.
S3	Narratives/ image + music/ image + narrative / texts + music/ videos	-Processing I - Acceptance II: the same work as in S2. -Psychoeducation problems I: The relevance of solving problems in the evolution of the human being is analyzed.

Table 2. Therapeutic and multimedia contents included in the TEO sessions protocol for AD (SS 4-6)

Sessions	Multimedia contents	Therapeutic Contents
S4	Narratives/ Image + music/ Texts + music/ Text/Videos	-Processing II – Coping I: Reflection on the meaning that the problem has to the patient: learning and positive aspects, changes in her values, etc. -Strengths and virtues that the patient can train or develop, which will help him/her to promote positive emotions. -Psychoeducation problems II: Introduction of Popper's (1995) teachings (problems are necessary, to live is having problems, and they allow us to progress).
S5	Narratives/ Image + music/ Texts + music/ Image + Narrative/ Video	-Processing II- Coping II: The same work as in S4. -Cognitive model II: Adoption of a different attitude towards problems (problems are inbuilt with everyday life and they are a chance to learn and promote psychological growth and self-efficacy). -Projection letter to the future: This task requires patients to write a letter to themselves from the future. Later analysis of the letter will focus sections, which reveal the patients' ability to see "beyond" the current negative situation.
S6	Narratives/ Images + music/ Texts + music/ Image + narrative/ Videos	-Processing III - Change of meaning: Reflection on the meaning the negative event has to the patient at this moment and the changes produced regarding the first metaphorical description (changes in thoughts, emotions, acquired learning and the future) -Heuristics exercise: The system presents a list of heuristics (proverbs, statements, life guidelines and the patients has to choose those which they consider helpful in maintaining and promoting the changes achieved in their lives.

Figure 3. Screenshots session 1 (psychoeducation) and session 2 (processing)

2. Results

This work is still in progress. We expect an improvement in the efficacy measures (mood, self-efficacy, emotions) in both modalities of delivering homework assignments. In addition, we expect that the TEO condition will be better assessed by the participant; she will prefer this way of practicing homework over the traditional way and will have a better opinion of it.

3. Conclusion

The session protocol presented in this work for AD is the first homework assignments component completely self-administered over the Internet that has been developed. In addition, a system such as TEO offers a great adaptability and flexibility to adjust the therapeutic homework on every patient's characteristics and needs, attending to the specific meaning of their problem.

Furthermore, as TEO is a web-based system, it increases the possibilities for therapy: it can be used in blended mode complementing therapy or in tele-assistance mode being the own self-administered therapy.

Finally, if TEO system is well accepted as previous preliminary results indicate [8], it might also facilitate the patient's treatment adherence and the therapist's work in designing homework assignments.

In summary, the advantages and versatility of TEO system open new possibilities to the clinicians. First, as it has been described in this study, it permits the design of personalized homework assignments to practice at home what they have worked during the therapy sessions in a self-applied way using a computer. And, second, it would also allow the design of entire therapeutic sessions or parts of sessions that can be self-applied resulting in a reduction of the costs and, then, an improvement in the efficiency of the treatment.

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Virtual Reality in the Treatment of Body Image Disturbances after Bariatric Surgery: A Clinical Case

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Abstract. Bariatric surgery is an operation on the stomach and/or intestines that helps patients with extreme obesity to lose weight. Even if bariatric surgery, compared with traditional obesity treatment, is more effective in reducing BMI, this approach does not achieve equal results in every patient. More, following bariatric surgery common problems are body image dissatisfaction and body disparagement: there is a significant difference between the weight loss clinicians consider successful (50% of excess weight) and the weight loss potential patients expect to achieve (at least 67% of the excess weight). The paper discusses the possible role of virtual reality (VR) in addressing this problem within an integrated treatment approach. More, the clinical case of a female bariatric patient who experienced body dissatisfaction even after a 30% body weight loss and a 62% excess body weight loss, is presented and discussed.

Keywords: Bariatric Surgery, Body Image Dissatisfaction, Virtual Reality, Allocentric Lock Theory, Clinical Case

Introduction

Bariatric surgery is an operation on the stomach and/or intestines that helps patients with extreme obesity to lose weight. The results of this approach are very promising: Padwal and colleagues [1] found that, compared with traditional obesity treatment, bariatric surgery is more effective in reducing BMI. Nevertheless, all roses have thorns, and this is true for bariatric surgery, too. In particular, a common problem is body image dissatisfaction: as underlined by Kali and colleagues [2] there is a significant difference between the weight loss clinicians consider successful following bariatric surgery and the weight loss potential patients expect to achieve. As a general guideline, bariatric surgery is considered successful when 50% of excess weight is lost and the weight loss is sustained up to five years. However, most obese patients have different expectations: in the previous study patients declared to be "happy" after a 77% +/- 9% excess body weight loss and considered "acceptable" a 67% +/- 10% excess body

weight loss. A 49% +/- 14% excess body weight loss, the gold standard for clinicians, was considered "disappointing".

In this paper we discuss the possible role of virtual reality (VR) in addressing this problem within an integrated treatment approach. As recently noticed by Ferrer-Garcia and Gutierrez-Maldonado [3] Virtual Reality (VR) is emerging as a technology that is especially suitable not only for the assessment of body image disturbances but also for its treatment. But how VR can be used to improve body image? According the "Allocentric Lock Hypothesis" [4-6] body image disturbances related to eating disorders may be the outcome of a primary disturbance in the way the body is experienced and remembered: individuals with body image disturbance may be locked to an allocentric (observer view) negative memory of the body that is no more updated by contrasting egocentric representations driven by perception.

Psychology and neuroscience indicates that our spatial experience, including the experience of the body, involves the integration of different sensory inputs within two different reference frames: *egocentric* and *allocentric* [7; 8]:

- *egocentric frame*: it is referred to the body of the observer and allows him/her to locate objects relative to the body centre. When we adopt an egocentric stance we represent the object relative to ourselves

- *allocentric frame*: it is referred to space external to the perceiver. When we adopt an allocentric stance the object is represented independently of our own current relation with it.

As suggested by Byrne and Becker [9] the transformation from egocentric to allocentric representations of space is done by neurons in different medial temporal lobe structures. If, for some reasons, this transformation is impaired, the egocentric perception-driven experience of the real body does not modify the allocentric memory-driven experience of a negative body: patients are locked to an allocentric negative representation of their body [5]. This is what may be behind the problems experienced by the obese patients after bariatric surgery: the impossibility of using sensory inputs for updating the allocentric representation of the body – patients hate their body even after the surgery and a significant weight loss - locks the patients into an unsatisfying body that may explain their depression and low quality of life [10; 11]. As noted by Gallagher [12], "[different] studies indicate that changes in various aspects of body schemata have an effect on the way subjects perceive their own body." (p. 237). Following this vision it is possible the use of VR to induce a controlled sensory rearrangement that facilitates an update of the locked allocentric representation of the body. For further details see [13]. To test this approach, the clinical case of a female bariatric patient who experienced body dissatisfaction even after a 30% body weight loss and a 62% excess body weight loss, is presented and discussed.

1. The Clinical Case: Patricia C.S.

The patient is a 44-year old woman, who entered in the bariatric protocol with a weight of 114 kg., 1.55 m. height and a B.M.I. of 47. After reaching the weight of 80.2 kg (a 30% body weight loss and a 62% excess body weight loss) she was contacted by the researchers to enter in the experimental protocol. The patient reported at the screening interview that she was interested in the protocol because she was frustrated by the actual weight, higher than the one achieved after the bariatric surgery. She also noted that main reasons for losing more weight were: to improve self-esteem, be more

attractive, and also be more attractive to others. The clinical data collected during the interview matched the inclusion criteria and she accepted under informed consent to participate in the study.

1.1. Assessments instruments

The following psychometric test was obtained at entry to the study and at the end of the protocol

- Spanish version of the Beck Depression Inventory (BDI);
- Spanish version of the State-Trait Anxiety inventory (STAI).
- Spanish version of the Body Shape Questionnaire (BSQ)
- Spanish version of the Bulimia Test (BULIT);
- Spanish version of the Three Factors Eating Questionnaire (TFEQ).

1.2. The protocol

Developed by Giuseppe Riva and his group, the Experiential Cognitive Therapy is a relatively short-term (15-session in 6 weeks), patient-oriented approach that focuses on individual discovery [14; 15]. The protocol includes 5 weekly group sessions aimed at improving motivation to change and assertiveness, and 10 biweekly virtual reality sessions. The VR sessions are based on the NeuroVR 2.0 software (free download from: http://www.neurovr.org). NeuroVR is an enhanced version of the original Virtual Reality for Body Image Modification (VEBIM) immersive virtual environment, previously used in different preliminary studies on non-clinical subjects [16].

NeuroVR 2.0 is composed of 14 virtual environments, used by the therapist within a 60-minute session with the patient [17]. The environments present critical situations related to the maintaining/relapse mechanisms (e.g., Home, Supermarket, Pub, Restaurant, Swimming Pool, Beach, Gymnasium) and two body image comparison areas. In the VR sessions the therapist uses the "20/20/20 rule". During the first 20 minutes, the therapist focuses on getting a clear understanding of the patient's current concerns, level of general functioning, and the experiences related to food. This part of the session tends to be characterized by patients doing most of the talking, although therapist guides with questions and reflection to get a sense of the patient's current status. The second 20 minutes is devoted to the virtual reality experience. During this part of the session the patient enters the virtual environment and faces a specific critical situation. Here the patient is helped in developing specific strategies for avoiding and/or coping with it. In the final 20 minutes the therapist explores the patient's understanding of what happened in VR and the specific reactions – emotional and behavioral - to the different situations experienced. If needed, some new strategies for coping with the VR situations are presented and discussed.

1.3. Results

At the end of the protocol the patient experienced only a slightly reduction of her weight: 79.800 Kg. However, more relevant differences can be found in the psychological profile (see Table 1). Clinical data showed a significant improvement in both the level depression and anxiety – measured through the BDI and STAI

questionnaires - and body image – measured through the BSQ questionnaire. This change produced a reduction in the number of avoidance behaviors as well as an improvement in the number of adaptive behaviors as showed by the outcome of the BULIT and TFEQ questionnaires.

   In the clinical interview at the end of the treatment, Patricia reported an improvement in her physical and emotional well-being: she felt safer, had better skills in dealing with situations that previously caused her anxiety (social eating) and experienced more control over food because she was able to control herself. More, she reported relevant behavioral changes in her personal and social daily life: she started putting limits on her partner, had better communication and support from her daughters, maintained with more facility the diet that the nutritionist gave her.

Questionnaire	Pre	Post
BDI	4	1
STAI *Trait Anxiety* *State Anxiety*	39 35	28 29
BSQ *Body dissaticfaction*	133	95
BULIT *Bulimia Questionnaire*	84	80
TFEQ *Disinhibition* *Food Restriction*	17 28	10 23

Table 1. Pretreatment to Post-treatment Assessment ratings

2. Conclusions

For its efficacy in producing weight loss, bariatric surgery is becoming the treatment of choice for morbid obesity. Unfortunately, this approach does not achieve equal results in every patient. Specifically, a common problem is the body image dissatisation that affects bariatric patient even after a significant weight loss. In this paper we discussed the possible role of virtual reality (VR) in addressing this problem. Specifically, we reported the clinical case of Patricia, 44-year old woman, who entered in the bariatric protocol with a weight of 114 kg., 1.55 m. tall and a B.M.I. of 47. Even if at the start of the VR protocol her weight was 80.2 kg (a 30% body weight loss and a 62% excess body weight loss) the weight loss achieved after the surgery was unable to modify her negative experience of the body: she expressed the need to improve self-esteem, be more attractive, and also be more attractive to others. More, the clinical data underlined a moderate level of depression matched by a high level of body dissatisfaction. The clinical data after the treatment showed a significant improvement in all the psychological variables matched both by an improvement in the subjective physical and emotional well-being, and by relevant behavioral changes in the personal and social daily life.

   In conclusion, the results show the added value of ECT as part of an integrated obesity treatment based on the experiential approach allowed by virtual reality. Longer follow-up data and multi-centric trials are required to investigate the possible effects of the behavioral and body image changes on the long-term maintenance of the weight

loss. To reach this goal, the "Laboratorio de Enseñanza Virtual y Ciberpsicología" at the School of Psychology of the Universidad Nacional Autonoma de Mexico, in cooperation with the Obesity Unit of the Medica Sur Hospital in México City, have recently started a controlled clinical trial, recently approved by the US ClinicalTrial.gov database (Virtual Environments For Supporting Obesity Treatment – AVATOB - NCT01394393). The trial, that will include 30 morbid obese patients treated with bariatric surgery, started its work in June 2011 and is expected to complete in fall 2012.

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Improving Social Behaviour in Schizophrenia Patients using an Integrated Virtual Reality Programme: A Case Study

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Abstract. Social skills training programmes are among the treatments of choice in schizophrenia. Virtual reality (VR) can improve the results obtained with traditional social skills programmes by helping to generalize the acquired responses to patients' daily lives. We present the results of a case study involving the application of an integrated VR programme for social skills training. A 30-year-old woman with a well-established diagnosis of schizophrenia was enrolled in the study. She completed four baseline sessions, 16 treatment sessions and four follow-up sessions three months after the end of the treatment. Using a multiple baseline across-behaviours design, three target behaviours were analysed: facial emotion recognition, social anxiety and conversation time. Symptoms and social function variables were also assessed. The results showed a positive change in the three target behaviours and improvements in interpersonal communication, assertiveness and negative symptoms. The VR programme proved useful for training the patient's social behaviour and, consequently, for improving her performance.

Keywords: schizophrenia, virtual reality, social behaviour, training.

Introduction

Previous studies have demonstrated that structured social skills training (SST) programmes are effective in improving social competence and interpersonal behaviour in patients suffering from schizophrenia [1]. After these programmes, social stressors are less likely to elicit exacerbations, social decompensations or withdrawal. Most studies published to date have applied SST to inpatients. However, it is with outpatients, and during periods of stability, that SST and other group-based social interventions will be most effective and will be most likely to enable individuals to correctly implement and practise their social competence.

Despite their potential, the application and consolidation of programmes of this kind in mental health centres is often hampered by a lack of resources. The patients concerned often have high levels of social anxiety and may refuse to participate because these treatments are usually applied in a group format. Furthermore, assessing and modifying patients' social behaviour in their naturalistic and daily environment is a complex task. Virtual reality (VR) may overcome some of these limitations [2]. The

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numerous possibilities offered by 'first-person' environments and interactions that can exercise control over behaviour mean that individual treatment and personalized training programmes in social skills can benefit from VR. Researchers such as Park et al. [3] have also shown how VR can improve conversational skills and assertiveness in schizophrenia inpatients. The objective, therefore, is to help people with schizophrenia to overcome everyday social difficulties via the use of new technologies.

An integrated VR programme for social skills training (called *SOSKITRAIN*) was developed based on the target behaviours proposed by Kopelowicz et al. [4]: social perception, processing of social information, responding and sending skills, affiliate skills, interactional skills and behaviour governed by social norms. The programme comprises seven activities in which the therapist can modulate the patient's behaviour using cognitive-behaviour techniques. It also allows users to practise social interactions with virtual avatars, and encourages progressive learning of the social skills repertoire.

1. Method

The study used a multiple baseline across-behaviours design comprising three target behaviours: facial emotion recognition (measured by errors made in a VR facial recognition task), assertive behaviours (measured by a specific social interaction activity) and time spent on conversation (measured by a VR conversation activity). The application of the programme in relation to the target behaviours is staggered, such that the baseline period for each behaviour overlaps the previous target behaviour.

1.1 Participant

The participant was a 30-year-old woman with a well-established diagnosis of schizophrenia. She was recruited from a mental health centre in Igualada (Catalonia, Spain), and at the time of recruitment she was in a stabilized period (> 6 months). Before starting the programme the patient was assessed in different domains.

1.2 Clinical Outcomes

- Symptomatology: PANSS (Positive and Negative Symptoms Scale [5])
- Social anxiety: SADS (Social Anxiety and Distress Scale [6])
- Social functioning/social behaviour: SFS (Social Functioning Scale [7]), AI (Assertion Inventory [8])

1.3 Treatment

The treatment consisted of 16 twice-weekly sessions: one session to discuss content (following Kopelowicz et al.) and the other for assessment and practice with the VR programme. The patient was able to practise specific behaviours in simulated environments representing daily situations, such as going to the supermarket, dealing with an angry security guard in a museum or trying to negotiate with a manipulative friend over who would drive a car to a party. These are complex situations, which require the application of assertive behaviours and conversational and instrumental skills, and they are directly trained in social skills programmes [3,4]. Facial emotion recognition and social information processing were addressed in the first stage of the treatment. In the second stage the therapist and the patient dealt with social anxiety and

interpersonal interactions, before finally addressing communication and conversational skills.

2. Results

Visual analyses revealed positive changes in the three target behaviours. Statistical analysis also showed significant differences between baseline and post-treatment for facial emotion recognition ($Z=-3.09$; $p<0.05$), as well as an increase in the frequency of assertive behaviours ($Z=-3.28$; $p<0.05$) and the time spent on conversation ($Z=-3.71$; $p<0.01$). The pattern of change was maintained in the follow-up period.

Table 1. Scores for the three target behaviours during the case study (multiple baseline across behaviours design)

TBs	BL	Treatment	Follow-up
FER	60-75-80-75	60-55-40-40-30-30-40-30-20-20-20-30-30-20	30-30-20-20
AB	2-3-3-3-3-0-2	2-4-4-4-4-6-7-8-6-8-10-11	6-4-6-8
TC	14-16-21-16-12-30-21-22-22-26-26-21	32-34-44-45-47-58-92-90	62-64-68-76

Note: TBs: target behaviours; BL: baseline; FER: facial emotion recognition (% of errors made); AB: assertive behaviours (total correct score for the activity); TC: time spent on conversation (seconds spent on conversation)

The post-treatment results also showed a decrease in negative symptomatology (pre=25; post=15), general psychopathology (pre=36; post=19), social anxiety (pre=23; post=14) and social discomfort (pre=93; post=43). The self-reported score for assertiveness (AI) also showed an improvement in terms of the likelihood of behaving assertively during social interactions (pre=89; post=68 (reverse subscale)). Furthermore, there was a significant increase in the patient's social functioning (pre=133; post=153), specifically on the level of interpersonal communication.
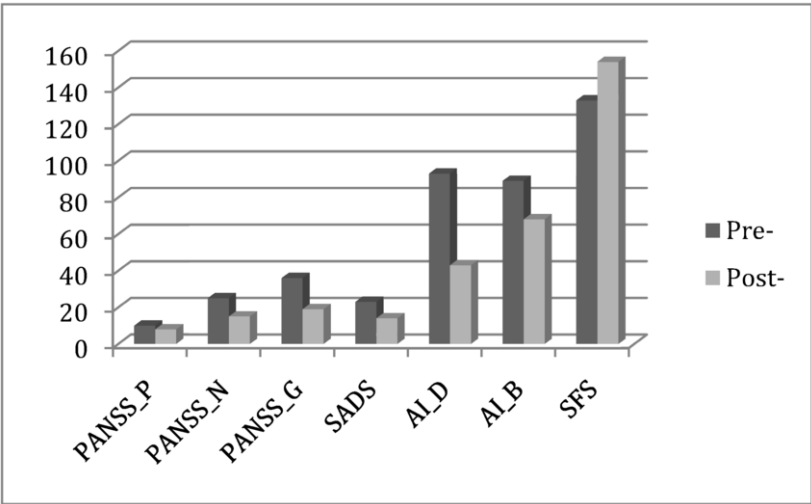
Note: PANSS_P: PANSS positive subscale; PANSS_N: PANSS negative subscale; PANSS_G: PANSS general psychopathology subscale, AI_D: Assertion Inventory, social discomfort subscale; AI_B: Assertion Inventory, probability of assertive behaviour subscale (reverse subscale: high score means poor performance); SFS: Social Functioning Scale.

3. Conclusion

The results indicate that the integrated VR programme was useful for training the patient's social behaviour and, consequently, for improving her performance. Post-treatment scores on the social functioning scale and the Assertion Inventory showed a generalization of the learned skills to the patient's daily life. The decrease in self-reported social anxiety reflects the potential of the VR programme to habituate the patient to personal interactions with others and to progressively extend the time spent on conversation. Regarding symptomatology, the improvement in social behaviour may be associated with the reduction in negative symptoms and general psychopathology. Moreover, the participant claimed that it was very useful to practise all the contents of the programme first in order to build up confidence with regard to their implementation in the real world.

The novel aspect of the present study is the application of a VR programme to a stabilized outpatient who was able to generalize the improvements made to her daily life and to exert some control over the target behaviours acquired during the training. This VR programme may enable clinicians to reinforce the primary treatment as often as a particular case requires.

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Real-time Monitoring of Behavioural Parameters Related to Psychological Stress

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Abstract. We have developed a system, allowing real-time monitoring of human gestures, which can be used for the automatic recognition of behavioural correlates of psychological stress. The system is based on a low-cost camera (Microsoft Kinect), which provides video recordings capturing the subject's upper body activity. Motion History Images (MHIs) are calculated in real-time from these recordings. Appropriate algorithms are thereafter applied over the MHIs, enabling the real-time calculation of activity-related behavioural parameters. The system's efficiency in real-time calculation of behavioural parameters has been tested in a pilot trial, involving monitoring of behavioural parameters during the induction of mental stress. Results showed that our prototype is capable to effectively calculate simultaneously eight different behavioural parameters in real-time. Statistical analysis indicated significant correlations between five of these parameters and self-reported stress. The preliminary findings suggest that our approach could potentially prove useful within systems targeting automatic stress detection, through unobtrusive monitoring of subjects.

Keywords. Behavioural parameters, gestures, real-time monitoring, stress

Introduction

The automatic detection of psychological stress is a significant and challenging issue for the research community. Psychological stress is a factor that can lead to major risks for well-being and for the life itself; for instance, acute stress episodes or chronic stress are known to be connected with cardiovascular disorders [1]. The automatic early prediction of stress symptoms can lead to avoidance of situations that pose a risk to the human life [2][3]. In this line, a significant amount of work has been paid during the recent years, towards enabling computer systems to automatically detect stress. Most commonly, such attempts have utilized biosignals such as the Galvanic Skin Response

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or the Electrocardiogram [3][4][5], or features derived from further monitoring modalities, such as the Electroencephalogram [5].

Utilizing a video-based, less obtrusive monitoring technology than biosignals, we have developed a system, allowing real-time monitoring of human gestures, which can be used for the automatic recognition of behavioural correlates of psychological stress. As described below, our system is capable to extract in real time eight parameters, which express kinematic characteristics of the subject, such as the overall activity energy, the randomness of activities, the occurrence of activities with increased energy, as well as the occurrence of specific activities that match pre-defined templates (e.g. a hand raised towards the head so as to scratch it).

1. Online monitoring of behavioural parameters

Our developed system is based on processing of MHIs [6], which are calculated from video sequences of the subject's upper body (Figure 1), recorded from a Microsoft Kinect camera (http://www.xbox.com/en-US/kinect). MHIs are spatio-temporal templates, where the intensity value (MHI_T) at each point is a function of the motion properties at the corresponding spatial location in an image sequence, according to:

$$MHI_T(x,y,t) = \begin{cases} \tau & , \text{if } D(x,y,t)=1 \\ max(0, MHI_T(x,y,t-1)-1) & , \text{otherwise} \end{cases}$$

where τ is the number of frames contributing to the MHI generation and $D(x,y,t)$ equals to 1 if there is a difference in the intensity of a pixel between two successive frame. The older a change is, the darker its depiction on the MHI will be, while changes older than τ frames faint completely out.

Figure 1. A Motion History Image (MHI)

Through the processing of MHIs, several parameters of the subject's activity are calculated in real-time. The calculation of these parameters is mainly based on the proportion of non-black area within MHIs (k), which is calculated for each MHI as:

$$k = \frac{A_{nb}(t)}{A} = \frac{\sum_x \sum_y MHI_T(x,y,t)}{W*H}$$

where A_{nb} is the non-black area of the MHI of the t timeframe, A is its whole area, W and H stand for the width and height of the MHI, respectively.

1.1. System Architecture

The overall architecture of our system is illustrated in Figure 2. It consists of four threads that run simultaneously and three buffers:

The *Video Recording Thread* is responsible for capturing image sequences from the Kinect camera, which are stored within the *Frame Buffer*.

Once τ frames have been recorded, the *MHI Calculation Thread* calculates their corresponding MHI. The MHI is passed to the *MHI Buffer* and the *Activity Detection Thread*. The former is a buffer where MHIs are stored, so as to allow further processing by the *Behavioural Parameters Calculation Thread*, as explained in the following

The *Activity Detection Thread* is responsible to detect whether within each MHI, activity that matches the pre-defined templates of activities of interest exists. The activities of interest have been defined in our case as the "Right hand raised towards the head" and the "Left hand raised towards the head. Activities are detected within the MHIs through the algorithm of [7], using for head detection the method of [8], enhanced with a mean-shift algorithm [9]. Once the processing of the MHI based on the above is finished, the result of whether activity of interest existed within the current MHI is stored within the *Detected Activities Buffer*.
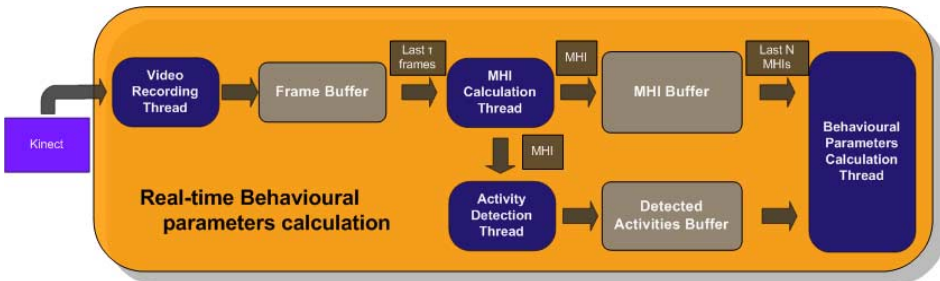
Figure 2. Architecture of our real-time behavioural parameters calculation system

Finally, at the end of a period with pre-defined duration, the *Behavioural Parameters Calculation Thread* takes as input 1) the *N* MHIs that have been stored within the MHI buffer during this period and 2) the result of activity detection over these MHIs, and calculates eight different behavioural parameters as explained below. It should be noted that the time period for the calculation of behavioural parameters through this thread (30 secs, 1 min etc.) can be adjusted from the user of the system.

1.2. Behavioural Parameters Calculation

Within the *Behavioural Parameters Calculation Thread*, the following eight behavioural parameters are calculated:

The average of k, taking into account all *N* MHIs that have been recorded during the monitoring period: *Avg(k)*.

The average and standard deviation of k, taking into account only the MHIs of the monitoring period that have a k-value above an experimentally set threshold, set so as to identify MHIs indicating "Increased Activity Level" (IAL). These parameters are encoded as $Avg(k_{IAL})$ and $SD(k_{IAL})$.

The average and standard deviation of k, taking into account only the MHIs of the monitoring period that have a k-value above an experimentally set threshold, which has been set so as to identify MHIs depicting activity that is above an energy threshold lower than the one used for IAL detection, namely IAL-S. As a result, this subset of MHIs does not include MHIs that depict activity of extremely small scale, such as for instance the micro-movements occurring during the subject's interaction with a PC mouse. These parameters are encoded as $Avg(k_{IAL-S})$ and $SD(k_{IAL-S})$.

The frequency of IAL occurrences (*F(IAL)*) is calculated as the ratio of the number of seconds that contain at least one MHI with activity level above the IAL threshold, to the total duration of the monitoring period (in seconds).

Finally, by taking into account the content of the *Detected Activities Buffer*, the frequency of specific activities occurrence within the period is also calculated, as the number of seconds where at least one MHI depicting the specific activity exists, to the total number of seconds. These parameters are encoded as *F(RHH)* and *F(LHH)*, for the "Right Hand on Head" and "Left Hand On Head" activities respectively.

2. Performance Analysis

Preliminary tests were performed over our system, so as to evaluate its efficiency in calculating behavioural parameters that can be used for the automatic recognition of behavioural correlates of psychological stress. Pilot trials were conducted with three participants, who were monitored through our prototype during stress induction. Similarly to [10], stress was induced through playing of a video game, which was based on the stroop color-word test paradigm [11]. In our case, we used congruent and incongruent versions of the stroop test, following [10]. We also used two different versions of the same stroop application; the first was the typical with button-press, whereas the second utilized speech recognition (SR), thus the subject had to speak out the correct color.

Each subject participated in seven trials. During the first trial, s/he was presented with a relaxing video. Then, during trials 2 and 3 (SR), the subject played an easy (congruent) version of the stroop, consisting of sixty questions each. During trials 4 and 5 (SR), which lasted for five minutes each, the subject played the typical (incongruent) stroop test. During trials 6 and 7 (SR), the subject played more difficult variations of the stroop, with a reduced time limit for answering each stroop question (2 secs). In trial 6, the ordering of the buttons changed after each question. In trial 7, the subject was presented with three different color words, and had to find the more dominant color. At the end of each trial, subjects answered a Likert-scaled question in the range [1-5], which directly asked them whether they felt stressed during the last trial.

During each trial, the subject's upper body was monitored through our developed prototype, via the Kinect camera. During monitoring, the aforedescribed behavioural parameters were calculated in real-time. Using a PC with Intel i5 – 2500k processor and 4GB RAM, our system was found capable to achieve an average frame rate of 10 fps, regarding the MHIs that were extracted from the video sequences. As a result, the *MHI Buffer* was updated in real time at a rate of 10Hz. The behavioural parameters were calculated once, at the end of each trial. In total, 21 trials were recorded.

2.1. Behavioural Parameters Correlation to stress

We used the Kendall's tau correlation coefficient (τ), so as to examine correlations between the calculated behavioural parameters and stress, as the latter was reported in the questionnaires, in the scale [1-5]. Table 1 summarizes the results of this analysis. As it is evident from Table 1, five out of the eight behavioural parameters extracted in real time from our system during the pilot trials, showed significant correlation to stress at the $p < .05$ level.

Table 1. Correlations between Behavioural parameters and stress. Significant (p < .05) correlations are marked with asterisks.

Parameter	Avg (k)	Avg (k_{IAL})	SD (k_{IAL})	Avg (k_{IAL-s})	SD (k_{IAL-s})	F (IAL)	F (RHH)	F (LHH)
Correlation (τ)	0.433*	0.381*	0.589*	0.297	0.316	0.496*	0.390*	0.088
Significance (p)	<.011	<.024	<.001	<.077	<.053	<.004	<.025	.065

3. Conclusions

We developed a system allowing real-time monitoring of human gestures that can be used for the automatic recognition of behavioural correlates of psychological stress. Based on video recordings and the theory of MHIs, the system calculates in real time a set of behavioural parameters that express kinematic characteristics of the monitored subject. This unobtrusive, real time behavioural monitoring system has been evaluated over a limited set of pilot trials. An average frame rate of 10fps was found for MHI calculation and real-time behavioural parameters estimation. From the data of these trials, statistically significant correlation was found between five of the behavioural parameters and stress. These preliminary findings are promising and suggest that our approach could potentially prove useful within systems targeting automatic stress detection, through unobtrusive monitoring of subjects. By providing the means for early detection of stress symptoms, such systems could in turn prove significantly helpful within a variety of applications, such as psychotherapy, physical rehabilitation, gaming and training.

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Virtual Reality for Smoking Cessation: A Case Report

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Abstract. This study presents a case report describing the use of Virtual Stop Smoking (VSS) program. The VSS includes a multicomponent behavioural approach and a Virtual Reality graded exposure technique. The subject was a 22-year-old female who smoked 20 cigarettes per day. Six weekly 90-minute sessions were conducted once a week over a 6-week period. Measures of efficacy included the number of cigarettes smoked, breath carbon monoxide levels, and self-reported subjective craving. The results obtained supported the efficacy of VSS for smoking cessation.

Keywords. Virtual Reality, cue exposure treatment, smoking.

Introduction

Smoking behaviour is strongly associated with specific stimuli and contexts[1,2]. Exposure to smoking-related cues can elicit tobacco craving and trigger cigarette use[3-5]. Relapse prevention training (RPT) and cue exposure treatment (CET) may be two effective techniques for smoking cessation treatments[6]. RPT focuses on enhancing patients' skills in order to prevent relapse after quitting smoking. CET exposes the smoker to drug-related cues aimed to reduce cue and context reactivity by extinction processes. As a treatment for addictive behaviours, CET has various modes of exposure, one of the most innovative being the use of Virtual Reality (VR)[7].

The aim of the present study was to test the Virtual Stop Smoking (VSS) program; a multicomponent behavioural treatment for smoking cessation[8] that integrates a module of VR graded exposure[9] in a 22-year old female smoker.

1. Method

1.1 Participant

The subject, recruited through advertisements in Barcelona, Spain, was a 22-year-old female who had smoked an average of 20 cigarettes per day over the previous seven years. She reported health-related reasons as her motivation for quitting. She had

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attempted to stop smoking twice in the past, but she had been unable to maintain abstinence for more than a couple of days.

1.2 Instruments and measures

During the intake session (Table 1) the patient completed a questionnaire on her patterns and history of smoking, the Structured Clinical Interview (SCID) for the diagnosis of nicotine dependence, the Fagerström Test for Nicotine Dependence (FTND), and the Nicotine Dependence Syndrome Scale (NDSS). Breath carbon monoxide (CO) levels were assessed in the intake session and at each treatment session. Eight previously tested virtual environments[4] were used in the study. Self-reported subjective craving was evaluated on a visual analogue scale (VAS) from 0 to 100, build-in the virtual environments. Environments were presented with a virtual reality eyewear Vuzix iWear VR920 with 3 degree of freedom head tracker.

Measures	
Age at onset of smoking	17
Cigarettes per day	20
Nicotine per cigarette (mg)	.8
CO	10
SCID	5
FTND	4

Table 1. Intake assessment results.

1.3 Treatment

The Virtual Stop Smoking (VSS) treatment involved one weekly session (90 minutes long) for six consecutive weeks. The VSS included: contract, self-monitoring, graphic representation of cigarettes, nicotine and cigarette fading, information about smoking, stimulus control procedures, strategies for relapse prevention, problem solving procedures, strategies to cope with withdrawal syndrome, physiological CO feedback, and virtual reality exposure (from the second to the sixth session).

The virtual environments were selected according to a hierarchy drafted during the first session and based on self-reported craving levels for each of the eight situations. Tables 1 and Table 2 show the results of the intake assessment and the specific hierarchy for the subject. On the basis of this hierarchy (Table 2), the five environments that trigger the highest levels of craving were selected for the graded exposure.

VR environments	Craving
Being in a pub	10*
Watching TV at night	9*
Lunch at restaurant	8*
Lunch at home	7*
Coffee in a café	6*
Waiting in the street	5
Having breakfast	4
Museum	0

Table 2. Hierarchy for virtual exposure.

2. Results

The patient successfully quit smoking during treatment. She stopped smoking at session 4 and then maintained abstinence throughout the rest of the intervention. Up to treatment session 4, she gradually decreased the number of cigarettes smoked. The gradual decrease was also reflected in CO levels (Figure 1).
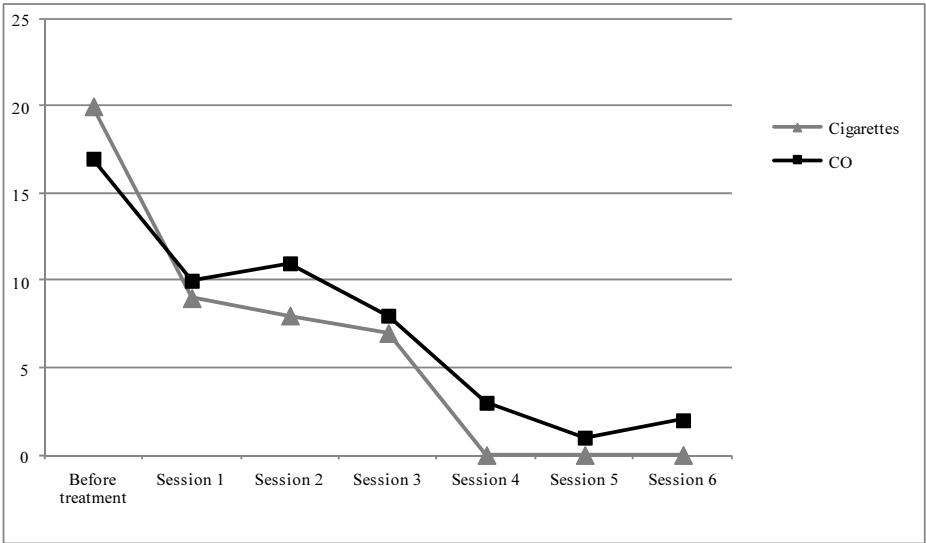
Figure 1. CO levels and number of cigarettes before and during the treatment.

Table 3 shows the evolution of craving scores during each session of exposure. Baseline craving levels were recorded before each session. Extinction was achieved when the patient's craving ratings dropped to baseline levels or lower or baseline levels + 15% when exposure exceeded 20 minutes.

VR environments	Session	Baseline score	Max score during exposure	Extinction score	Duration of exposure (min)
Waiting in the street	2	32	50	35	22
Coffee in a café	3	30	56	1	14
Lunch at home	4	24	31	21	10
Lunch at restaurant	5	31	54	22	14
Watching TV at night	6	1	11	1	12

Table 3. Graded virtual exposure and craving levels

3. Conclusions

This study reflects how a cue exposure treatment approach can be individualized based on the patient's needs.

The patient achieved and maintained abstinence during the treatment. The number of cigarettes smoked, CO levels and self-reported craving decreased as the sessions progressed.

The post-treatment results suggest that virtual reality environments may improve CET for tobacco dependence. Nevertheless, clinical trials with a more robust design and longer follow-ups are necessary to determine the efficacy of this treatment program.

Limitations of use case studies are well known[10]. In research, case studies involve only a single person or just a few, and so it may not be possible to generalize the results to other populations. Sometimes, replication is impossible and the reliability of measures is too low**.**

This study is an effective example of the use of virtual reality in smoking cessation programs. The results should be interpreted with caution; nevertheless, this is the first study to show the usefulness of integrating VR in a multicomponent behavioural treatment for smoking cessation, and for this reason more controlled and larger clinical trials using VSS should now be carried out.

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Therapeutic Effectiveness of a Virtual Reality Game in Self-Awareness after Acquired Brain Injury

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Abstract. Self-awareness deficits can manifest as a consequence of acquired brain injurydecreasing the motivation and the adherence to the treatment. We present a multitouch system that promotes the role-playing and the self-assessment strategies and challenges the participants in a competitive context. This paper presents aninitial clinical trial to study the effectiveness of the virtual system in the rehabilitation of the self-awareness skills.According the evolution of the participants in the Self-Awareness Deficits Interview and in the Spanish Social Skills Scale, the participants improve the perception of their deficits and disabilities.

Keywords. Self-awareness, virtual rehabilitation, acquired brain injury

Introduction

Acquired brain injury (ABI) produces a heterogeneous combination of deficits involving motor, cognitive, and psychopathological skills.The knowledge of the ABI patients about their own impairments and their implied limitations is known as 'self-awareness'.The self-awareness disorders can have implications in motivation, social integration, and professional reinsertion [1, 2],which can dramatically affect the rehabilitation process. The aim of the holistic rehabilitative strategies is therefore not only to restore or compensate the deficits derived from the injury but also to instill awareness of them, in such a way that the patients know their own limitations. The rehabilitation of self-awareness focuses on pedagogic lessons to awaken in the patients

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the self-assessment ability [3] or in role-playing strategies to evidence their limitations[4].

In the last decade, there are an increasing number of studies reporting the clinical benefits of introducing virtual reality (VR) systems in the rehabilitation programs of cognitive and psychological deficits[5]. VR can provide motivating and controlled environments with enhanced and multiple sensory feedback[6]. The benefits of the VR have been combined with traditional rehabilitative strategies with promising results. However, the great majority of the VR systems are single user and do not consider the self-awareness deficit.

In this paper, we present a new tool to treat the self-awareness deficit in ABI patients. The system uses VR multitouch technology to allow patients to interact with others using natural interactive metaphors.

1. Methods

1.1. Participants

10 ABI patients from the total pool of patients that were attending a neurorehabilitation program at a large metropolitan hospital were considered in this study. Inclusion criteria were: 1) age≥18 and≤75 years; 2) chronicity>6 months; 3) Mini-Mental State Examination[7]>23; 4) Fairly good language comprehension: Mississippi Aphasia Screening Scale[8]<45. Patients with severe dementia or aphasia were excluded.

The final sample included 7 males and 3 females with a mean age of 41.10±15.29 (mean±std), a chronicity of 402.20±147.68 days and 11.80±4.26 years of education.

1.2. Instrumentation

The developed system consists of a 42" LCD television that has been horizontally fixed in the top of a table-like structure. A multitouch overlay, which transforms the television into a multitouch screen, is mounted over the screen. The structure has 4 legs without stretcher to allow wheelchair users to interact with the system.

Figure 1. Different views of the developed multitouch table.

All the participants are distributed in groups of one or two participants, up to a maximum of 4 groups, corresponding to the 4 sides of the table. The session is conducted by a therapist. The software application consists of a board game where the participants compete for reaching the top in first place. To move forward in the game, the participants throw a virtual dice, move their counter and then are required to answer a question, which can be related to knowledge (anatomical and pathological matters, red cards), reasoning (situational exercises, blue cards), action (role-playing exercises, green cards), or cohesion (jokes and sayings, yellow cards) (Figure 2).

Figure 2.Snapshots of the self-awareness game. The left image shows the board of the game. The right image shows a question card with the text "Imagine that after a stroke you have problems to move the left side of your body (left arm and leg). How would you put your sockets on?"

1.3 Intervention

All the participants underwent one hour session per week during 8 months and were assessed at the beginning and at the end of the program with the Self-Awareness Deficits Interview (SADI) [9] to know the participants' awareness of their deficits, functional limitations, and the implications in their future plans, and with theSocial Skills Scale (SSS)[10], which is a Spanish scale that assesses the participants' behavior in specific situations.The SADI is a 3 items questionnaire and the SSS is a 33 items questionnaire. Both testsare formulated like a 4-point Likert scale.

2. Results

With regards to the SADI, at the beginning 4 participants had problems perceiving their deficits, 7 participants had difficulties perceiving their disability, and 7 participants had difficulties in making future plans. After the treatment, all the participants perceive their deficits properly, only 2 participants still had difficulties perceiving their disability, and 5 participants (50%) had difficulties establishing realistic goals.

Regarding the SSS, at the beginning 6 participants showed altered levels in social skills (one of them showeda specially altered level). After the rehabilitation program only two participants showed altered levels, while the rest of the participants presented normal skills.

Table 1. Results of both scales expressed in number of participants

Scale	Initial assessment		Final assessment	
SADI	Altered	Normal	Altered	Normal
Difficulties perceiving deficits	4	6	0	10
Difficulties perceiving disability	7	3	2	8
Difficulties making realistic plans	7	3	5	5
SSS				
Percentile < 2 (Very altered)	1		0	
Percentile > 2 and < 16 (Altered)	5		2	
Percentile > 16 (Normal)	4		8	

3. Conclusions

This paper describes a virtual board game to rehabilitate the self-awareness deficits produced by ABI. The game combines anatomical, situational, role-playing, and cohesion exercises within a competitive context. The game runs on a big multitouch screen that enables multiuser practices. The system also allows the therapists to supervise and guide the sessions, and to involve all the participants in a discussion after each question. The design of the system is based on the basis that social interaction should facilitate general cognitive functioning [11]. The system also provides objective data of the evolution of the patients.

According the scores in the SADI and the SSS tests, the system has provided successful results inthe rehabilitation of the self-awareness and the social cognition deficits, which makes the system a valid and useful therapeutic tool. However, the realistic future planning is still a therapeutic challenge in the rehabilitation therapy.

Even though the results in both scales support the clinical effectiveness of this new virtual therapy, new studies must be carried, either controlled or comparing with other rehabilitation programs. Future studies will take this consideration into account and will also address the usability of the system for both therapists and patients.

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Section V

Work in Progress

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Use of a Virtual Integrated Environment in Prosthetic Limb Development and Phantom Limb Pain

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Abstract. Patients face two major difficulties following limb loss: phantom limb
pain (PLP) in the residual limb and limited functionality in the prosthetic limb.
Many studies have focused on decreasing PLP with mirror therapy, yet few have
examined the same visual ameliorating effect with a virtual or prosthetic limb.
Our study addresses the following key questions: (1) does PLP decrease through
observation of a 3D limb in a virtual integration environment (VIE) and (2) can
consistent surface electromyography (sEMG) signals from the VIE drive an
advanced modular prosthetic limb (MPL)? Recorded signals from the residual
limb were correlated to the desired motion of the phantom limb, and changes in
PLP were scored during each VIE session. Preliminary results show an overall
reduction in PLP and a trend toward improvement in signal-to-motion accuracy
over time. These signals allowed MPL users to perform a wide range of hand
motions.

Keywords. Phantom limb pain, upper extremity amputation, virtual integration
environment, prostheses, computer-assisted rehabilitation, systems integration

Introduction

Almost immediately after the loss of a limb, approximately 98% of all patients
experience a vivid phantom sensation, such as warmth, cold, itching, pressure, and
sense of position [1]. When a sensation becomes intense enough to be painful, it is
termed phantom limb pain (PLP). PLP occurs in up to 80% of amputees and usually
appears immediately following awakening from anesthesia after the amputation, but
may be delayed up to days or weeks in 25% of patients [2].

Although pharmacologic management of PLP has been tried, it typically is
ineffective [3]. Visual feedback treatment such as mirror therapy, in which the patient
looks at the moving reflection of an intact limb, and motor imagery, which involves a

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mental representation of an actual sensation or movement, have been demonstrated to be beneficial in decreasing PLP intensity and duration [4-6]. The positive effect of the two therapies reinforces the theory that vision is a key component mediating the relief of PLP. Thus, it is possible that observing the movements of a "virtual arm" could also be effective in decreasing PLP.

This paper focuses on the influence of a virtual integrated environment (VIE) system on decreasing PLP and on accomplishing the movement goals of the volunteer subjects using an advanced modular prosthetic limb (MPL) with 22 degrees of freedom. The VIE was developed by Johns Hopkins University Applied Physics Laboratory (JHUAPL) as a flexible virtual reality system that represents upper extremity movements with a 3D virtual arm (Figure 1) while simultaneously capturing real-time surface EMG (sEMG) activity from the residual limb corresponding to the movements.

1. Methods

In our experimental design for the VIE, we analyzed four parameters: the self-reportedintensity of PLP over time, and the distinction, consistency, and accuracy of sEMG patterns across single and multiple sessions. Each session involved subjects directing their "phantom limb" to follow the virtual arm's preprogrammed movements.

1.1. Subjects

Up to 18 unilateral trans-radial or trans-humeral amputees will be enrolled in the study. All subjects will have experienced PLP at least three times a week at the time of enrollment. Exclusion criteria included the following: presence of mild to severe traumatic brain injury, known uncontrolled systemic disease, significant Axis I or II diagnosis in the six months prior to enrollment, and a score lower than 42/50 on the Test of Memory Malingering (TOMM).

Figure 1. Visual representation of arm and hand movements on VIE computer screen.

1.2. System Components

1.2.1. Hardware system

The system hardware consists of: one standard "real-time" PC to process signals and models in closed-loop control; one standard "visualization" PC to render the 3D virtual environment; one small "operator" PC to collect signals and translate them into a uniform input; and eight bipolar Duo=Trode electrodes.

1.2.2. Software system

The software used to design the virtual environment was programmed in MATLAB by JHUAPLand visualized using Musculoskeletal Modeling Software (MSMS).

1.3 Procedure/Protocol

All subjects were screened by a member of the research team. After enrollment and consent, each subject began a 20-day period of virtual therapy. Training to use the system was included as part of the first session.

Each session consisted of two, ten-minute visualization periods interrupted by a five minute break to prevent muscular fatigue. The first visualization period consisted of consecutive movements—wrist flexion and extension, wrist pronation and supination, and opening and closing of the hand to form a fist—while the second visualization consisted of these movements in random order. The subject observed the virtual arm perform the series of movements while simultaneously attempting to imitate the same movements with his phantom limb. To capture sEMG signals, eight bipolar electrode pairs were situated circumferentially around the residual limb (Figure 2). One ground electrode was placed on the olecranon of trans-radial amputees or on the acromion of trans-humeral amputees.

Following the visual therapy sessions, each subject completed a detailed questionnaire about the nature of his or her phantom limb pain. The questionnaire included a 100-mm Visual Analog Scale (VAS) to record changes in PLP intensity over time.
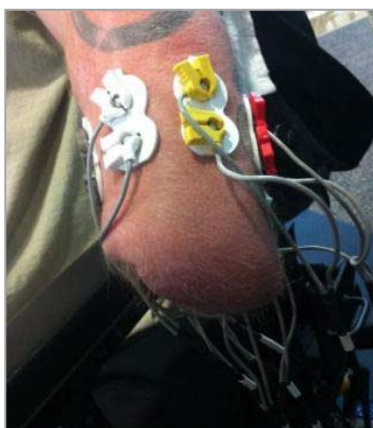
Figure 2. Bipolar electrode pair placement around the residual limb.
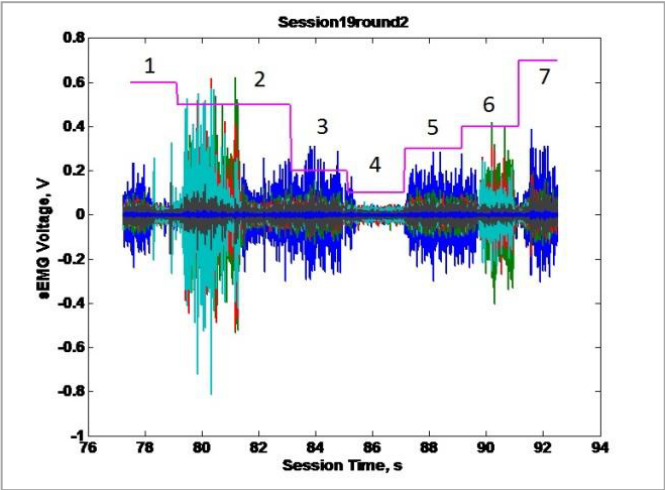
Figure 3.sEMG signals recorded from the triceps/biceps muscle groups of a trans-humeral amputee performing the following movements: (1) wrist extension, (2) wrist flexion, (3) elbow flexion, (4) elbow extension, (5) hand close, (6) hand open, and (7) wrist rotation to the left.
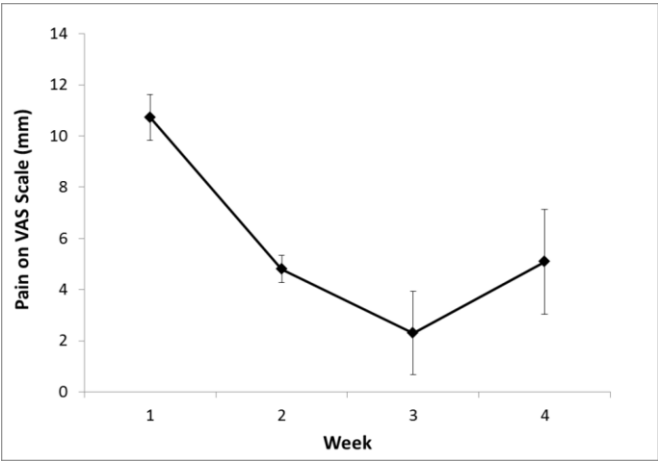
Figure 4. Average levels of PLP per week for subjects 1-3.

2. Preliminary Results

Three complete data sets have been analyzed to date using Linear Discrimination Analysis (LDA).The sEMG waveform has consistently shown seven distinct movements of the phantom limb between subjects and across sessions (Figure 3). Additionally, the number of training sessions positively correlated with signal accuracy in two out of three subjects (data not shown). One subject with greater than 90% signal accuracy was able to initiate wrist flexion/extension, wrist rotation, tip grasps, spherical grasps, and hand opening motions using the MPL.

Data from the VAS scale shows that on average, the intensity of PLP decreased as the number of VIE sessions increased (Figure 4). These results are consistent with patient reports that they were easily able to move their phantom at will during VIE sessions and that less pain occurred over time.

3. Discussion and Conclusions

The VIE was developed to acquire and interpret user-generated sEMG signals and to match those signals to movements of a "virtual arm." Thus far, the ability of the system to distinguish betweenpatterns of movements indicates that it has the potential to classify these movements and to de-code these signals to control movements of an advanced prosthetic device. Furthermore, the quality of the signals has shown improvement over time as subjects become familiarized with the system and movements. These findings suggest signal coalescence into discreet patterns over the training period and that, with adequate signal cataloguing by the VIE, subjects may be able to drive the MPL with minimal training or effort.

Although the limited sample size precludes a definitive association between virtual therapy and decreased PLP, current data indicate a reduction in PLP with successive VIE sessions. Thus, the VIE enables investigators to test the acquired sEMG signal quality (i.e. distinctive, consistent, and accurate) using the "virtual arm" before development of the actual mechanical arm systems for advanced function. The initial results have proved promising and may offer a new treatment approach for rehabilitation with an advanced prosthesis and also management of PLP in patients.

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EARTH of Wellbeing: A Place to Live Positive Emotions

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Abstract. EARTH of Wellbeing is a technological application to induce and train positive emotions and enhance different psychological strengths. The system contains 3 modules of activities: Park of Wellbeing, Wellbeing in the Nature and Book of Life. The objective of this paper is to describe the system and to offer data about its efficacy to induce positive affect in a sample of 30 participants who use EARTH three times a week along one month. This is a work in progress.

Keywords. ICTs, Positive Emotions, Positive Psychology, Positive Technologies

Introduction

As the field of positive psychology has matured, research on positive emotions has been increasing. Existing evidence supports the importance of addressing positive emotions in order to enhance people's mental and physical health. Several scientific studies have shown that experience positive emotions and exercise psychological strengths, such as enthusiasm, courage, etc., are useful psychological reserves that function as protective factors towards adversity or facing difficulties [1][2]. The Information and Communication Technologies (ICTs) are an attractive solution for the design of applications that provide training in positive emotions and psychological strengths. Our team designed EARTH of Wellbeing: a self-applied system aimed to promote those characteristics. The system include a series of psychological strategies validated by the scientific community which have been designed for the training of the positive emotions and fortresses The objective of the present paper is to analyse the efficacy of the EARTH of Wellbeing system to generate positive affect in users.

System description:

EARTH of Wellbeing is a technological platform designed to train positive emotions and regulation emotional strategies (see Figure 1 and 2). The system contains 3 modules of activities.

First module: Park of Wellbeing

This module offers the opportunity to learn and experience positive emotions through two virtual environments, one to feel joy and another to feel calm and relaxation. Park of Wellbeing uses different emotional induction procedures (MIP) in order to elicit a

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certain emotion such as joy and relaxation (see Figure 3 and 4). MIP are experimental procedures that are intended to provoke in the individual a transitory emotional state in a non- nature situation.

In order to build the different environments in the Park of Wellbeing, variations of every one of the following elements were included: music, narratives, self-statements related with positive moods [3] pictures (selected from International Affective Picture System IAPS) [4], movies, and autobiographical recalls. A previous study [5] has proved that this MIP included in both virtual environments is able to induce positive moods in their users.

Second module: Walking through nature

This module it is compose of two virtual environments, two specially designed landscapes to experience joy and relaxation (see Figure 5 and 6). In each of these landscapes, the system teaches various psychological techniques that facilitate proper emotional regulation. Virtual environments allow you to learn and practice these techniques in a systematic and self-applied way.

Third module: The book of life:

The Book of Life is a personal diary made up of several chapters. Each chapter offers a psychological exercise where the user must write and attach multimedia elements like images, music and video (see Figure 7 and 8). Each exercise intended that the user focus on important moments of their life in order to train different psychological strengths. The focus of the activity is the remembrance of important life moments and past achievements. Scientific studies indicate that this activity is associated with many psychological benefits such as improved mood state and increased self-esteem.

Figure 1 and 2 EARTH of Wellbeing

Figure 3 and 4 Park of Wellbeing

Figure 5 and 6 Walking through Nature

Figure 7 and 8 Book of Life

1. Methods

1.1. Participants

Sample will be composed around 30 participants (18-40 years old). All participants are volunteers and are being recruited from Valencia University and Jaume I University (Spain).

1.2. Measures

Overall Anxiety Severity and Impairment Scale (OASIS) [6] questionnaire assesses anxiety and impairment. It is composed of 5 items, with a Likert scale of 5 points (from 0 to 4, whose labels vary in each item).

Patient Health Questionnaire (PHQ-9) [7] questionnaire assesses health and depression, and it is composed by 10 items, with Likert scale of 4 valuables (from 0=Never, to 3=Almost all the days.

The Visual Analogic Scales (VAS) [8] assess the degree to which users experience different emotions (joy, sadness, anxiety and relax), from 1=Not at all, to 7=Totally.

The Mood State Scale (MS) is a visual analogue scale, which assesses mood state at the end of the induction session, compared with the initial state.

1.3. Procedure

Once participants voluntarily accept to participate in the study, they complete the OASIS and the PHQ-9 in order to detect clinical scores for anxiety and depression (exclusion criteria). After signing the consent form, they are given a password, and they have to use EARTH of Wellbeing three times a week, during a month (30 days). All experimental sessions lasted 20-30 minutes. Before and after each session participants fulfil VAS, and after session they fulfil MS.

2. Results

Increases in MS and positive emotions (joy or relax) and decreases of negative emotions (sadness or anxiety) are expected after each session of EARTH of Wellbeing.

3. Conclusions

Several empirical studies have shown that mood state has a significant influence on subjective well-being, cognitive processes, immune system and physical health. Recently, Fredrickson and Losada [9] have suggested that for optimal and physical health, attention must also be paid to increase the frequency and duration of positive emotions. Therefore, it is needed to design tools that allow us to train these positive emotions. EARTH of Wellbeing could be a useful "positive technology", aimed to help users achieve positive emotional states and wellness in the short term, and therefore could be labelled as "hedonic technology". However, people who continue to practice positive emotions regularly could increase other positive strengths, becoming EARTH of Wellbeing in a eudaimonic tool. Further research should examine the efficacy and efficiency of these kinds of interventions in greater detail.

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FRIEND: A Brain-Monitoring Agent for Adaptive and Assistive Systems

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Abstract. This paper presents an architectural design for adaptive-systems agents (FRIEND) that use brain state information to make more effective decisions on behalf of a user; measuring brain context versus situational demands. These systems could be useful for alerting users to cognitive workload levels or fatigue, and could attempt to compensate for higher cognitive activity by filtering noise information. In some cases such systems could also share control of devices, such as pulling over in an automated vehicle. These aim to assist people in everyday systems to perform tasks better and be more aware of internal states. Achieving a functioning system of this sort is a challenge, involving a unification of brain-computer-interfaces, human-computer-interaction, soft-computing, and deliberative multi-agent systems disciplines. Until recently, these were not able to be combined into a usable platform due largely to technological limitations (e.g., size, cost, and processing speed), insufficient research on extracting behavioral states from EEG signals, and lack of low-cost wireless sensing headsets. We aim to surpass these limitations and develop control architectures for making sense of brain state in applications by realizing an agent architecture for adaptive (human-aware) technology. In this paper we present an early, high-level design towards implementing a multi-purpose brain-monitoring agent system to improve user quality of life through the assistive applications of psycho-physiological monitoring, noise-filtering, and shared system control.

Introduction

Enhancing human effectiveness through advances in technology is one of the central goals of socio-technical systems research, as people-within-systems represent important "change" agents responsible for goal achievement, decision-making, task planning, and control. The overall effectiveness of such systems require both the social and technical elements to be efficiently aligned, providing mutual support towards achieving system goals. The improvement of these systems depends on advances in technological components (making them more efficient at carrying out tasks) and advances in the "human components" (allowing humans-in-the-loop to perform optimally, despite inherent physical and cognitive limitations). Factors, such as stress, fatigue, confusion (error), and mental overload can negatively influence the

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performance of the individual. Improving these systems from a human social perspective could involve training and improving best practices, however the impact of the human limitations remains central.

This work targets the alternative approach of improving the human perspective through advanced technological support. Such systems must provide monitoring of user psycho-physiological bio-signals, correct classification of states and situations in real-time, matching user context with the technological system, and must also make decisions/actions on behalf of a user. To advance in this area a number of technologies are needed, in order to first detect user bio-signals, classify states, identify situational contexts, make decisions, and actuate these through real-world hardware devices. Although each task represents a significant field of study, these have not traditionally been combined and applied in mainstream applications. Only recently, with advances in wearable sensors and wireless (bodynet) communications has it been possible for practical, real-time adaptation based on psycho-physiological information.

The determination of mental states from brain and body information is still in active research, [1], but technological advances in hardware, and more studies in neurosciences, brain-computer-interfaces, machine learning and multi-agent systems disciplines have made it feasible to consider making user-cognitive states (e.g., attention, workload, and error detection) a key factor in everyday systems interaction. This work targets brain state monitoring as the central theme and provides an early step towards developing an adaptive and assistive agent system for improved human effectiveness. The early designs for this system, known as FRIEND: A Fuzzy Reactive Intelligent Everyday Neuro-sensing Device, [2], are presented as a contribution toward the goal of streamlined technological support for human-social systems.

Section 1 below presents a brief overview of the background literature for this work. Section 2 describes the research method involved in the system design. Section 3 describes the resulting system architecture design in its current form. Section 4 concludes the paper.

1. Background

The primary research related to the development of a brain-monitoring agent for adaptive and assistive systems is a merger of the fields of brain-computer-interfaces (BCI's), soft computing, and multi-agent systems. The proposed system represents a hybrid approach that combines these towards general-purpose brain monitoring for use in practical applications.

In the field of BCI, the techniques for control of devices based on brain state may be considered as active BCI's while the use of BCI's for monitoring and other control oriented applications may be considered as passive BCI's. Active BCI's have been the primary research domain in the field, particularly for rehabilitative uses (such as wheelchair control, P300 spellers, interface controls/mouse input, among others, [1]. However, the use of passive BCI's for applications are more recent, where the focus is human computer interface adaptation, and context awareness applications (see [3] for more). The advances in BCI's provide the tools and algorithms to consider in the design of a brain-monitoring agent.

Soft-computing consists of computational intelligent systems approaches to deal with the uncertainty found in the environments where computer-based systems must operate, and where humans excel. In this field, the use of fuzzy logic and neural

networks are relevant for providing reasoning based on multi-valued variables and soft rules, as well as for robust machine learning. These technologies are relatively mature, and provide the foundations for classifying human bio-signal data, as seen in works like, [4, 5]. In particular a hybrid fuzzy neural network system combines these approaches and has been used successfully in a number of application domains.

The multi-agent systems approach is useful in providing the foundational frameworks for the communication of multiple intelligent systems, allowing these to work in tandem to achieve a shared meta-level goal/objective. This is important for brain-monitoring agents as they must have accurate situational context in order to function effectively on behalf of a user. The beliefs-desires-intentions agent design, [6], among others has been shown to be useful for a number of similar applications, including wireless sensor networks, [7], where communication is essential among nodes.

2. Method

This work develops a novel architecture for making use of brain cognitive context in multiple applications. The approach involves measurement of brain contexts, pattern inference, situation assessment, application design, and a means of evaluating the FRIEND system. Measurement involves mobile EEG headsets, and processing involves a merger of machine learning and agent intelligence in a general-purpose design. See, [2], for more. The early design of the FRIEND architecture is shown as an overview in Figure 1.
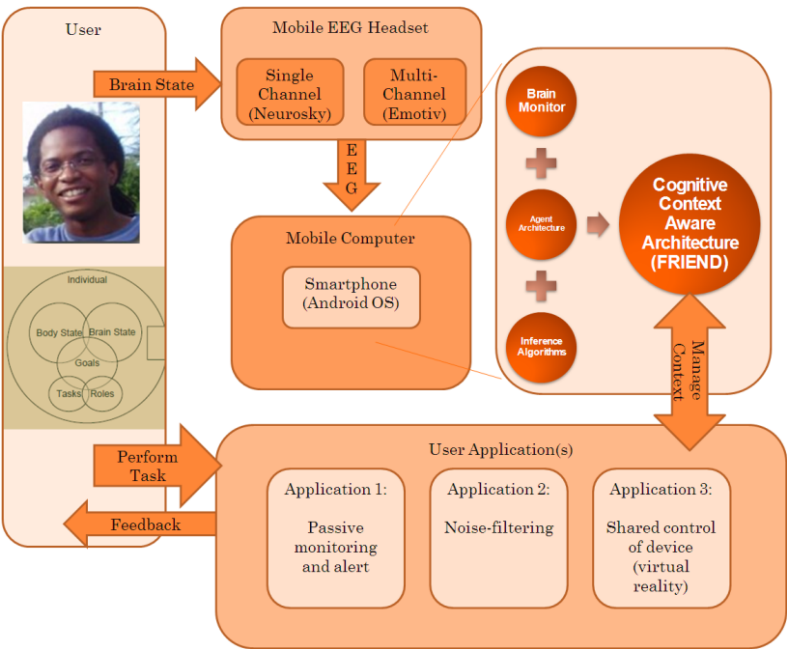
Figure 1. The early FRIEND architecture for brain monitoring agents.

This shows a user interacting with three kinds of applications and receiving feedback. During this interaction the user's brain state is determined by the FRIEND system via a mobile EEG headset and a mobile computer for processing. FRIEND monitors the brain EEG data, infers states, and interacts with user applications as a brain context agent (depending on predetermined protocols). This allows applications to adapt, and will be expanded, implemented, and tested, particularly for cases of mental fatigue and overload.
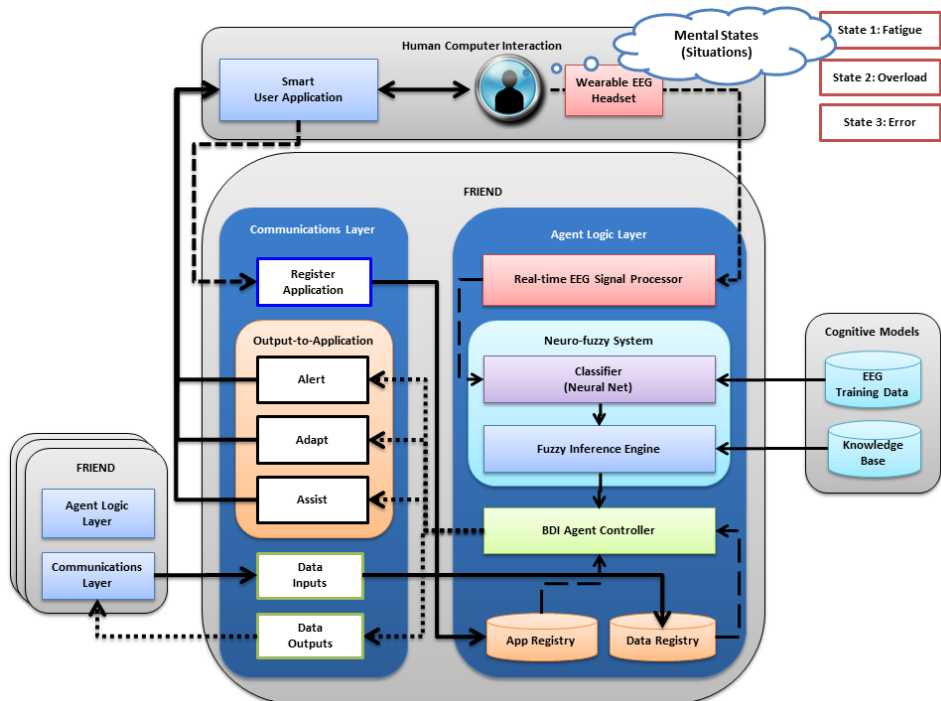
Figure 2. The early FRIEND architecture for brain monitoring agents, in more detail.

3. Results

The methods described above are shown in more detail in Figure 2. A user interacting with a smart application (such as a vehicle) performs typical tasks and receives direct feedback. However, this user is subject to mental states such as fatigue, overload, and error (or confusion). To make use of these states to assist the user, the application is FRIEND enabled. By registering with FRIEND for brain monitoring services the application can receive human context signals without having to specialize in this area directly. The wearable and wireless FRIEND system receives EEG data from the user (via EEG headsets) in real-time. The agent logic layer processes raw EEG signals to reduce noise artifacts and classifies state features from raw EEG data through the use of a hybrid neuro-fuzzy system (artificial neural network classifier and fuzzy inference system). This component makes use of cognitive models from literature; including raw EEG training data and expert knowledge on cognitive state features input beforehand.

These state features classified by the neuro-fuzzy system are used by a real-time belief-desires-intentions (BDI) agent architecture to update the user's current state, making decisions based on the applications registered to the service. This registration process records the information for each smart user application requiring brain context information, as well as the alert, adapt, and assist levels of interest required by each. FRIEND can now instruct the application based on real-time context outputs, whether to alert the user, adapt the interface, or assist the user with a predetermined action.

Additionally, it is possible for the same FRIEND agent service to request information from other FRIEND agents for use in multi-agent applications involving teams of individuals, by providing data requests and response activities. In this way the designed system will be able to allow smart user applications to streamline to user context in a general-purpose fashion, while simultaneously allowing users to interact with multiple smart applications using only a single FRIEND agent.

4. Conclusion

Systems must adapt to brain state as a central factor for smarter human-machine-technologies. The proposed FRIEND architecture aims to combine soft-computing and agent-based techniques with brain-monitoring towards a general-purpose system for adaptation, alert, and assistance. Health and wellbeing of the future is likely to benefit from such smart, human-aware systems in ways that are only beginning to be realized. Future work will involve the implementation of the system as a proof-of-concept and experiments to investigate the effective usage of brain-monitoring agent technologies.

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A Motor Imagery Based Brain-Computer Interface for Stroke Rehabilitation

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Abstract. Brain-Computer Interfaces (BCIs) have been used to assist people with impairments since many years. In most of these applications the BCI is intended to substitute functions the user is no longer able to perform without help. For example BCIs could be used for communication and for control of devices like robotic arms, wheelchairs or also orthoses and prostheses. Another approach is not to replace the motor function itself by controlling a BCI, but to utilize a BCI for rehabilitation that enables the user to restore normal or "more normal" motor function. Motor imagery (MI) itself is a common strategy for motor rehabilitation in stroke patients. The idea of this paper is it to assist the MI by presenting online feedback about the imagination to the user. A BCI is presented that classifies MI of the left hand versus the right hand. Feedback is given to the user with two different strategies. One time by an abstract bar feedback, and the second time by a 3-D virtual reality environment: The left and right hand of an avatar in the 1st person's perspective in presented to him/her. If a motor imagery is detected, the according hand of the avatar moves. Preliminary tests were done on three healthy subjects. Offline analysis was then performed to (1) demonstrate the feasibility of the new, immersive, 3-D feedback strategy, (2) to compare it with the quite common bar feedback strategy and (3) to optimize the classification algorithm that detects the MI.

Keywords. 3-D Feedback, Brain-Computer Interface (BCI), Motor Imagery (MI), Stroke Rehabilitation.

Introduction

For stroke survivors, there are two ways a Brain-Computer Interface (BCI) could be helpful [1]. The first one is using a BCI for bypassing neuromuscular pathways that are damaged by stroke. So, for example a user can send control commands to a wheelchair [2] or prosthesis or orthosis [3]. But the main goal for each patient is, of course, to restore normal or more normal motor functions, for not being dependent of any artificial device in everyday life. The second approach for BCIs helping patients suffering stroke is therefore to utilize the BCI for a better rehabilitation.

The main idea is to use a BCI to restore motor functions by inducing activity-dependent brain plasticity. Stroke is followed by extensive plasticity in the cortex and

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elsewhere, activity-dependent plasticity can positively or negatively affect the nervous system [4]. According to Grosse-Wentrup and colleagues the Hebbian plasticity may be a crucial concept for motor rehabilitation; that is the coincident activation of presynaptic and post-synaptic neurons reinforces synaptic strength, resulting in increased and more reliable communication between the activated neurons [5].

In this paper, a BCI is presented that shows virtual reality based online feedback to the user when a motor imagery (MI) is detected. By showing this feedback online the Hebbian plasticity is induced. The detection of MI is done by the method of common spatial patterns (CSP) [6]. To evaluate the control accuracy of this new, immersive feedback strategy, it is compared with a standard approach that is quite common for MI-based BCIs. This second evaluated feedback strategy consists of a bar that always starts in the middle of the screen and extends either to the left or right side of the screen, according to the classified MI. Data from three healthy subjects was recorded, each subject performed one session with the immersive feedback and one session with the standard feedback. In offline analysis the parameters were tuned to find out the best settings for future studies with patients.

1. Methods

1.1. Data processing

EEG was measured on 63 position of the scalp using a multichannel EEG-amplifier (g.HIamp, g.tec medical engineering GmbH, Austria), sampling with 256 Hz. The raw data was bandpass-filtered between 8 Hz and 30 Hz before the spatial patterns were applied. On this spatially filtered data the variance (with a window length of one second in the online runs) was computed, before it went into a linear discriminant analysis. For more information about the methods of CSP, one may read the article of of Blankertz and colleagues [6]. The classification accuracy was several times offline calculated, using different time-windows settings for CSP calculation and different length of windows for calculating the variance.

1.2 Paradigm and sessions

Before the tests started, the users were trained on motor imagery tasks to achieve constant performance. After that, the two sessions with different feedback were executed. The workflow can be seen in Fig. 2 on the left. Each session consisted of seven runs; each run included 20 trials for left-hand movement and 20 trials for right-hand movement in a randomized order. The first run (run1) was performed without giving any feedback. With the data of this run a first set of spatial filter (CSP1) and a classifier (WV1) was computed. Before that, a visual inspection of the data and a manual rejection of trials containing artifacts were completed.

With this first set of spatial patterns and classifier, another four runs (run2, run3, run4, run5) were performed while giving online feedback to the user. The merged data of these four runs (run2345) were used again to set up a second set of spatial filters (CSP2) and a classifier (WV2) that used a higher number of trials and was thus more accurate. Again, artifacts were manually rejected from the data before continuing with the calculation of CSP2 and WV2. Finally, to test the online accuracy during the feedback sessions, two more runs (run 6, run 7; merged data: run67) were done.

The timing of one single trial is shown on the right side of Fig. 1. The whole trial lasted eight seconds, between each trial there was a random inter-trial interval between 0.5s and 1.5s. After two seconds, a beep demanded the user's attention to the upcoming cue. The cue-phase, where the subject was told to perform either an imagination of the
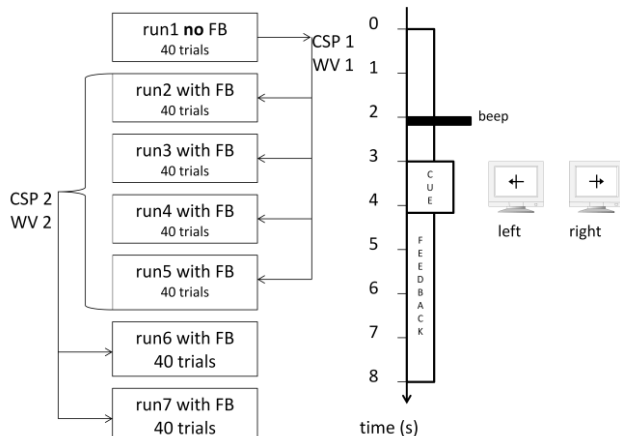
Figure 1. Workflow within one session. Left: After the first run, a set of spatial filter (CSP1) and a classifier was calculated that was used to give feedback during the following 4 runs. The next set of spatial filters and weight vectors (CSP2, WV2) was then used for run 6 and 7. Right: timing within one trial. A beep indicates the start of the trial after two seconds. Then, a visual cue is presented. At the end of the cue phase at 4.25 seconds, a second beep can be heard. From second 4.25 until the end of the trial (8s) online feedback is presented.

left or right hand started at 3s and stopped at 4.25s. The end of the cue-phase was marked again by a second beep. The feedback-phase started at 4.25s and lasted until the end of the trial (8s). The user was asked to perform the MI from the beginning of the cue-phase until the end of the feedback-phase.

Comparing the presented cue and the classified movement, an error rate can be calculated. The error rate, as displayed in Table 1, was calculated by applying CSP2 and WV2 onto the merged dataset run67. The classifier and the errors were calculated using signal fractions of half a second. For every fraction the classifier was applied on the features and the classification result compared to the cue, resulting in the error rate that was averaged over all trials.

1.3. Simple feedback (Bar feedback)

Feedback strategy number one (bFB) is quite common for motor imagery tasks. A bar, beginning in the middle of the computer screen expands either to the left or the right of the screen. If a left-hand movement is detected, the bar grows to the left, for a right-hand movement it extends to the right side. The length of the bar is proportional to the classified LDA-distance. During the cue phase, in addition to the bFB a red arrow points to the left or to the right side of the screen indicating the user which MI he or she should perform.

1.4. Immersive feedback (VRFB)

Within the VRFB task, a virtual reality research system (g.VRsys, g.tec medical engineering GmbH, Austria) is used. The user sits in front of a 3D-PowerWall wearing shutter glasses. The size of the PowerWall is 3.2m x 2.45m, and the distance between PowerWall and user is about 1.5m. The user sees the left and right hand of an avatar from a subjective point of view (see Fig. 2). The only movement the avatar performs is
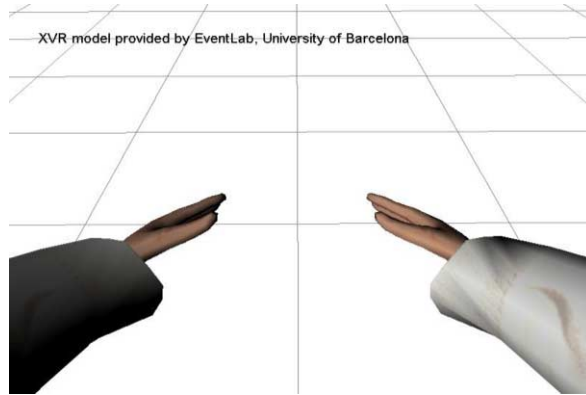
Figure 2. Virtual reality feedback. During the feedback session, the fingers of either the left or the right hand are closing and opening according to the classified movement.

the continuous opening and closing of either the left or the right hand. No modulation of the speed of the movement is done. During the cue-phase (from second 3 until second 4,25 of the experiment), the user needs to know which MI has to be performed. In the VRFB task, the opening/closing of one of the hands provides this information. After second 4.25 of the experiment, a second beep appears, and the observed movement of the avatar is the feedback to the performed MI.

2. Results

Table 1 summarizes the results of the online runs of the three subjects. For each session the averaged error rate over all trials and over the single time-steps starting from 3.5s until 8s is shown. These values reflects the accuracy of applying CSP2 and WV2 (both were created with data run2345) onto the data of run67 and shows therefore the online accuracy that the users experienced during these runs. The number in parenthesis shows the minimum error for the single time-steps

Exemplarily, Fig.3. shows the error rates of subject S1 during the two sessions, when doing offline analysis with different settings. The solid line represents the mean error and the dashed line the minimum error. Both, the mean and the minimum error get more constant and decreases for higher window length. A similar analysis was done for all six sessions, revealing that a window length of four seconds for calculating the CSP yields to the lowest error rate. Also the influence of the window length for calculating the variance was evaluated, showing that when choosing 1.5 seconds the error rate decreases considerably. For both effect the number of participants was too small to calculate any statistic tests.

Table 1. Results of the six sessions. The first number in each cell shows the mean error rate beginning from 3.5 seconds until 8 seconds. The number in parenthesis shows the minimum error rate within this time.

Subject	bFB	VRFB
S1	7.4 (4.0)	6.3 (4.0)
S2	19.9 (5.0)	19.2 (5.9)
S3	5.7(1.3)	3.2 (0.0)
mean	11.0(3.4)	9.6(3.3)
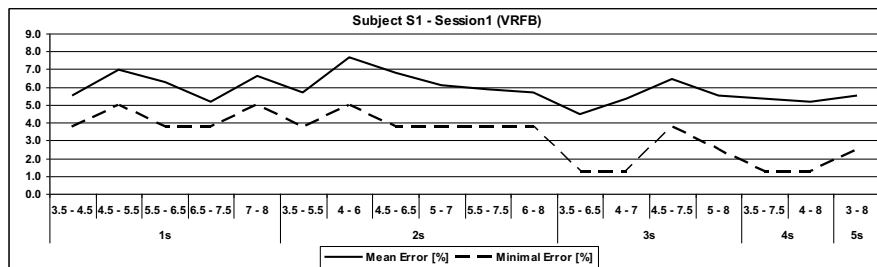
Figure 3. Mean and minimal errors calculated for different CSP time windows for subject S3

3. Discussion

Results showed good classification accuracy for both feedback strategies. The mean classification error for the 3-D feedback over all sessions and different classifiers was at 9.6% versus 11.0% for the bar feedback. Users reported that a 3-D feedback presented for the wrong hand (caused by misclassification) also directed the user's attention to this hand so it was quite hard to further concentrate on the correct (other) hand. We think that this could cause a problem especially for users with bad performance, for them it could be better to start the training with the bar-feedback until their control is considerably good. This effect is on the other hand an advice that in the 3-D feedback task the users really felt as if the presented hands were their own ones.

The offline analysis of time-windows revealed an optimal window length of four seconds for CSP calculation and 1.5 seconds for the calculation of variance for the given paradigms. For more accurate data further tests with the given device will be done in future.

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A Robotic & Virtual Reality Orthopedic Rehabilitation System for the Forearm

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Abstract. We describe a robotic and virtual reality system for the rehabilitation of the forearm. It consists of a robotic arm and VR scenarios with a dynamic model of the human upper limb. The system allows to assign specific tasks to perform within the virtual environments. The system simulates the actions of the patient limb and allows exhaustive exercising and motor control, giving visuomotor and haptic feedback and trajectory positioning guidance. The system aids to evaluate the mobility condition of the patient, to personalize the difficult level of the therapy and provides kinematic measures of the patient evolution. The patients recruitment phase has already started for clinical pilot studies.

Keywords. Virtual Reality, Robotics, Orthopedic Rehabilitation, Forearm, Elbow, Wrist

Introduction

Severe traumas of the wrist and elbow may occur from a forceful injury of the arm. Orthopedic rehabilitation includes periodically strengthening exercises and Range-of-motion (RoM) training for regaining the mobility, minimizing loss of tissue flexibility, contracture formation, and muscular strengthening and control [1]. Passive RoM (PRoM) activities are used when the subject is not able at all to move his own limb. Active RoM (ARoM) approach is used when the patient is able to control any limb part. Active-Assistive RoM (A-ARoM) is preferred if the muscles are weak and can not perform all of the work on its own.

Robot-aided-therapy allows intensive and repetitive training and higher level of improvement of motor control if compared to conventional therapy ([2,3,4]). Robotic systems allow objective assessment, facilitating the observation and evaluation of the rehabilitation progress. Virtual Reality promote the patient's interest and intensive training on specific deficits with multisensory feedback ([5,6,7]), by assigning engaging activities in several conditions, preventing counterbalancing adaptation ([8]). The complexity of the therapy can be progressively increased and personalized [9].

In this work we describe an orthopedic rehabilitation system of the forearm, consisting of the integration of virtual training environments with a 6 DoF robotic device. The

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system allows the patient to train PRoM, ARoM and A-ARoM task-oriented exercises within physical-based simulated virtual environments. The system reproduces the patient arm movements in first perspective and assistance/resistance force feedback.

1. Robotic & Virtual Reality Rehabilitation System

1.1. Robotic Rehabilitation Device

The BRANDO rehabilitation system developed at PERCRO (Fig.1), consists of a 6DoF robotic arm: 1) 3 DoF required to track the position of the end-effector in the space (within a box workspace of $600x400x500mm$), consisting of two orthogonal and incident rotational joints and one prismatic joint; 2) 3 DoF defined by an spherical joint that allows the orientation of the handle mounted on the end-effector. The handle includes two sensorized buttons that let the patient to trigger simple commands during the interaction. The first 3 DoF are actuated in order to provide force-feedback at the hand of the patient, while the last 3 DoF are passive to record the orientation of the subject hand in the space. The robot provides a maximum continuous force of $10N$ and a peak force of $20N$. A security software module disable the robot if a velocity more than $1\frac{m}{s}$ is achieved (See [10] for more technical information). The robotic arm is mounted in a platform with a balancing column composed of a 2 DoF passive arm that allows to balance the patient arm weight through an industrial tool (with a maximum payload of $4kg$).

Figure 1. BRANDO system: the robot device mounted on the mobile platform.

1.2. Human Upper Limb Virtual Simulation

The VR upper limb model simulates in real time the right upper extremity of the patient and the virtual physical interaction with virtual objects, providing visuomotor and proprioceptive feedback to the patient. The virtual human arm was modeled as a 7 DoF serial kinematic mechanism ([11]). The physical arm model consisted of a multi-body rigid dynamic system, where the rigid bodies are serially interconnected spring-dampers at each joint ([12]). The joint angles of the patient arm are estimated by the inverse kinematics algorithm and then the dynamic simulation makes the model to match the estimated tracked joint angles of the patient, and computes the reacting responses due to the collisions detected with other virtual objects in the scene. The resulting haptic collision forces are rendered to the patient for enhancing the realism of the simulated therapy task. The model was implemented on XVR (www.vrmedia.it) and C++ with the nVidia PhysX SDK for the physics engine simulation.

1.3. Force Feedback and Control

The haptic force feedback is exerted to the patient as: 1) assistance forces for performing PRoM or A-ARoM, to follow the predefined trajectory in the operational space for achieving the desired task; 2) resistive forces for demanding ARoM strengthening exercises by making opposition to the patient's movements.

Positioning the patient wrist in both modalities is done by a PD controller and a smooth dynamic trajectory generation. The assistance feedback could be enabled/disabled and the intensity of the interacting forces can be set up manually by the therapist. Gravity compensation of the robotic arm avoids the user to carry the load on and to feel the weight of the device. Manually locking the end-effector position by the therapist is also possible at any moment, which is useful for accurately registering the motion limits of the patient at the beginning of the session.

1.4. Virtual Environments for Orthopedic Rehabilitation of the Forearm

Two specific simple games were developed, for the pronation/supination (PS) of the wrist and for the flexion/extension (FE) of the elbow. Training parameters can be adjusted by the therapist depending on the observed patient's skill. The motion workspace can be augmented further up the registered limits in order to progressively increment the patient RoM. Knowledge of performance (sound and score) is given to the patient after an error or hit during the game.

(a)   (b)
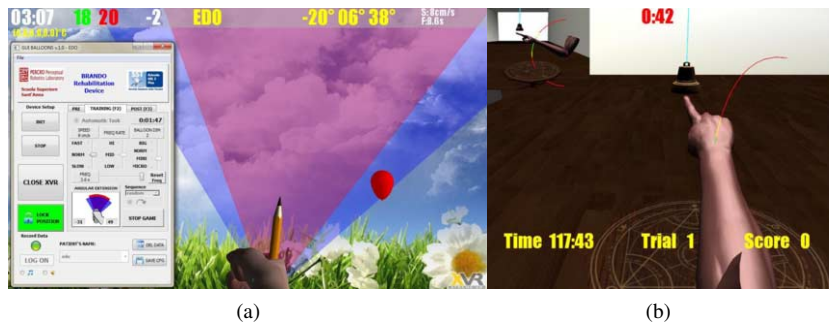
Figure 2. Training scenarios with the implemented tasks. A) Game application and a view of the therapist GUI for the Wrist training. B) Game application for the Elbow at vertical posture.

The first game (Fig.2a) is based on active PS movements of the wrist and uses only the robotic handle DoF. The task consists of hitting with a virtual pencil every balloon that approach radially to the virtual hand. The frequency of balloons increases with the score of the patient. The frequency increment rate, speed and size of balloons can be modified by the therapist in order to demand precision, velocity and attention. Depending on the therapist choice, the balloons can appear in an ordered sequence, at random, or in the RoM limits, preventing boredom and adaptation.

The second game (Fig.2b) uses the 3 actuated DoF of the robot, and allows active or passive FE movements of the elbow. The task consists of ringing every bell that appears on the patient RoM. The game brings visuomotor and haptic force feedback to the patient. The adjustable parameters are the number and size of the objects, the time

of the task, the sequence of appearance of the objects, and the force resistance level for demanding strengthening. The therapist can enable/disable the haptic guidance and the visual feedback of the performed trajectories (ideal and real). At the end of each session kinematic statistic data of the current and past sessions are shown graphically to the therapist, which includes the score, RoM achieved, the task time needed, the elbow angular velocity, and wrist linear velocity.

A GUI was also developed for registering the patient RoM and velocity; monitoring the performance of the patient; reporting objective the kinematic indices of the patient; personalizing the difficult level of the training sessions; showing graphical reports of the therapy evolution and managing the patient database.

2. Results

Fig.3 exemplifies the kinematics data of the wrist graphically shown after the training session, which allows the therapist to evaluate the evolution of patient's RoM.

| (a) | (b) |
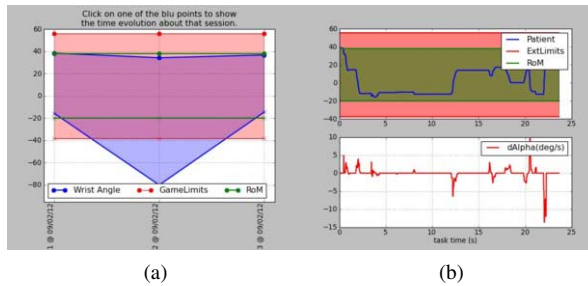
Figure 3. GUI graphics reports of the recorded data for the Wrist training of a healthy subject. A) RoM evolution during the pasts sessions. B) Wrist angular displacement on a single training session.

We carried out an experiment on a healthy subject, consisting of performing FE elbow movements and touching six randomly positioned bells near the extremes of a RoM of 13°. The task time was $1.5s$, and the subject received assistance, resistance or zero forces feedback. Fig.4 shows more regular performed trajectories under force assistance, while shows better motor control during force assistance and more activity in the joints different than the elbow (Q4). Besides the score and the RoM achieved, this indicates us that the difficult level can be effectively adjusted by the modification of the training parameters.

3. Conclusion and Future Works

The system allows exhaustive rehabilitation training of the forearm in engaging task-oriented VR scenarios, under multimodal feedback, positioning assistance or resistance. With the system the therapist can personalize the difficult level, manage and control the therapy and monitor the patient evolution, in terms of performance and kinematic indices. The patients recruitment phase has already started at the USL 5 Rehabilitation Centre at Fornacette, Italy.

(a) A-ARoM +force assistance.   (b) ARoM+zero force.   (c) ARoM+force resistance.

(d) A-ARoM+force assistance.   (e) ARoM+zero force.   (f) ARoM+force resistance.
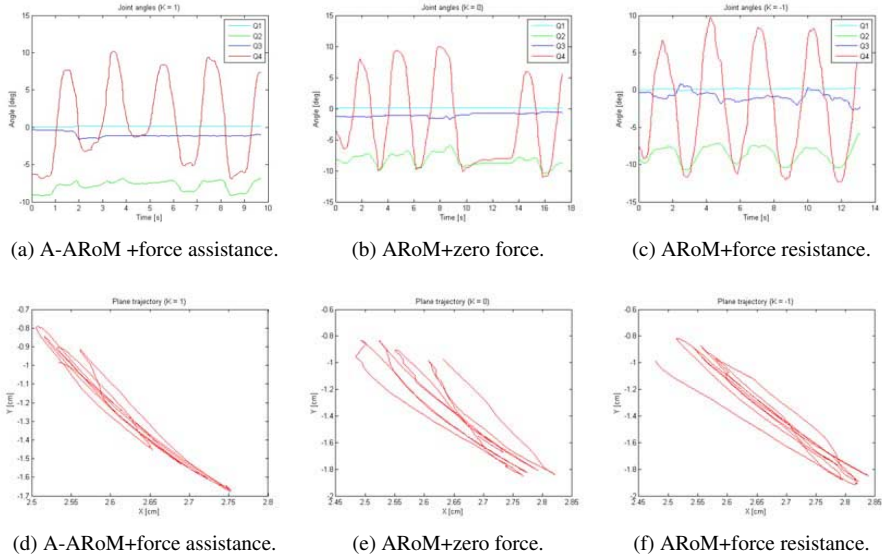
Figure 4. Experiment of a healthy subject exercising FE elbow movements during virtual task performing. A-C) Joint angles kinematic estimation D-E) Performed trajectory at the Sagittal plane.

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Psychosocial Implications of Avatar Use in Supporting Therapy for Depression

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Abstract. Help4Mood is a novel intervention to support the treatment of depressive disorder using an embodied communicative agent (Avatar) to engage the user with therapy tasks. We conducted 10 focus groups with patients and mental health professionals, in the UK, Spain and Romania, in order to explore issues around usability and contextual fit. Emergent themes related to the design and use of Avatars indicated the value of configurability for optimising personalisation and perceived trustworthiness; the importance of supplementing rather than replacing face-to-face interaction, and perceptions of the agent as therapeutic ally or supportive friend. The use of Avatars in psychotherapy is relatively new and its acceptability, value and risks are unknown. These results indicate that users wish to engage with Avatars that meet their personal preferences and fit appropriate role expectations. The perception of Avatar as colleague or friend raises conceptual and ethical issues which merit further research.

Keywords. Depression, embodied communicative agent, avatar,

Introduction

Depression affects around 120 million people worldwide, yet fewer than 25% of sufferers have access to effective treatment.[1] This is due to a combination of factors, including the somewhat hidden nature of psychological conditions, social stigma as a barrier to help-seeking, and the lack of training for professionals in diagnosis and management of depression. This situation is compounded by the time and expense required to deliver psychological interventions for depression. For this reason drugs are often the first line treatment option, sometimes with negative side effects and typically without the necessary behavioural support needed to maximise their effectiveness.

The economic and societal costs associated with depression are as significant for populations as the morbidity and mortality impacts are for individuals.[2] As with other chronic illnesses, it is vital that new ways are found to manage an increasing health burden with finite resources and ICT-based interventions have been proposed as a way of filling the gap. Cognitive behaviour therapy is as an effective treatment for

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depression involving therapist-guided exercises that encourage the patient to recognise self-critical or fatalistic thought patterns, reinterpret life events in a more positive light and engage in goal-directed actions.   Computerised Cognitive Behaviour Therapy (CCBT) is designed to support the patient with such exercises between clinic sessions or, in some cases, as an alternative. It is one of the most well-researched online health interventions and has been shown to be useful in symptom reduction, although ideally when delivered as part of a therapist-supported package of treatment. [3]

Adherence with online CCBT is affected by both the inertia that characterises depression and the initial reduction in symptoms that it can bring, but failure to persist with and complete a course of CCBT can greatly reduce its effectiveness. [4]   Agent-based approaches, which enable responsive tailoring of services and feedback to input-defined user needs, offer one means of addressing this problem, through reducing repetition and personalising the user experience. With advances in computer-generated humanoid mediators (Avatars), speech recognition, speech synthesis and affective computing, the possibility of simulating therapeutic encounters is coming closer to reality. Although the prospect of a convincing 'AI-therapist' is some way off, there are aspects of online treatment packages for which embodied communicative agents may be useful, such as in guiding the user through treatment exercises and prompting self-monitoring. The use of Avatars in online psychotherapy has been demonstrated in the context of virtual worlds, where the characters symbolise the actual therapist or patient, however this presents similar resource challenges to in-person therapy.[5] Their suitability and value in the context of algorithm-driven CCBT packages is unknown.

Help4Mood is a collaborative project supported by the EC Framework 7 programme (www.help4mood.info). It has two aims, firstly to examine new ways of *engaging* patients with online interventions, by using an embodied communicative agent to elicit symptom reporting and encourage CBT task completion, and secondly to manage and relay activity data captured by remote *monitoring* devices, such as movement sensors located in patients' beds or wrist-worn actigraphy devices.   This data is used both to facilitate the patient's between-clinic self-management, and to provide a record that can be used by their therapist to guide or modify treatment in the context of face-to-face sessions. This article describes a formative study with patients and health professionals, which aimed to capture requirements with reference to likely contexts of use. It specifically focuses on issues for the design and use of Avatars within the intervention.

1. Methods

Ten focus groups with patients and health professionals were conducted in three countries; the UK, Spain and Romania. In each country professional participants were chosen to represent the groups that typically provide care for patients with depression (psychiatrists, psychologists, community psychiatric nurses).   In total there were 3 groups of patients (one in each country) and 7 groups of professionals (2 UK, 3 Romania, 2 Spain).

Discussions were facilitated by two researchers and recorded with the participants' permission. Transcripts and field notes were analysed thematically, initially by one researcher in each country and then in consultation with the local research team. While different languages present challenges for qualitative analysis, these were minimised by using a shared analytic framework in order to capture parallel issues across the three

teams, whilst also enabling local issues to be captured. The results across groups were discussed by the international team in order to explore generic and specific issues relevant to the design of the Help4Mood interface and methods for patient monitoring and communication.

The topic guide explored the components of the intervention with the aid of still mock-ups of the interaction and data interfaces. Participants were encouraged to reflect on whether the vision of the R&D team was congruent with the reality of clinical practice and suited to the characteristics of depressed individuals, and its possible benefits and risks. They were also asked to offer suggestions for improvement.

2. Results

Here we report the results specifically related to the design of the Avatars and their use in the therapy process. We have collapsed the responses of participants in the three countries, since these were largely congruent. Six themes related to the Avatar emerged:

2.1. Configurability & personalisation

All groups felt that it should be possible to adapt the Avatar to suit user preferences; for example by changing age, gender or voice, or substituting a hyper-realistic image with a more cartoon-like one, or even with an animal. This recognised that individuals have different styles, preferences and expectations for embodied agents and that children, in particular, might prefer non-human alternatives.

2.2. Trustworthiness:

Patients indicated that the Avatar should look like the type of person they would wish to engage with and be happy to confide in in real life. Interestingly, reactions to the first visual character - a buxom young female – were not as positive as its young male developers had expected, indicating that factors other than physical attractiveness need to be taken into account when designing responsive systems, especially in a sensitive context like psychotherapy.

2.3. Avatar as professional ally:

The responses of health professionals reflected those of the patients, with a heavy emphasis placed on the apparent trustworthiness of the supposed character represented by the Avatar, particularly since it would, in a sense, be acting as a member of the therapy 'team'. It should therefore look like the sort of person they would expect to see in such a setting, someone with whom they would be comfortable working, and who they would feel comfortable about recommending to their patients.

2.4. Functional role of the Avatar:

Professionals believed that the Avatar should be capable of empathic facial expression, as this can encourage patient engagement, but that it should maintain a 'neutral face'

when encountering negative input from the patient, since reflecting this back would be unhelpful. They also felt that the system should generally be 'guiding' rather than 'directive', except where patient responses indicate a possible risk of suicide, in which case it should shift to directive mode. The importance of adaptive interaction (delivering screening questions or advice based on previous answers or patterns) was emphasised as a means of personalising the user experience.

2.5. Avatar as sensible friend:

Patients formed certain expectations of the Avatar, seeing it not just as medium for interacting with the 'system', but as a person. Importantly the view was expressed that it could act as a "sensible friend" in being able to "recognise" times of difficulty and step in to offer wise reflections or recommend a prudent course of action. At the same time, they acknowledged and supported the idea that the system would be used in association with real clinical care.

2.6. Fear of replacing human interaction and support:

Among both patients and professionals there was some anxiety that the system could potentially be used to replace human interaction and support, and it was regarded as essential to emphasise its role as a supplement to existing therapy, rather than a substitute.

3. Discussion

The results of this formative study highlight a number of issues relevant to the design and use of humanoid mediators in agent-based interactions, particularly in the psychotherapeutic context. Some of these challenged the developers' preconceptions, but most are consistent with emerging theory in this area.

In terms of design, the importance to users of being able to tailor the Avatar's physical, vocal and emotional features is perhaps unsurprising [6], although it is interesting that both personal characteristics, such as age, and role expectations based on contextual 'scripts' (e.g. how therapists look and behave), influenced user preferences. The perceived nature of the interaction between human users and humanoid mediators was rather more complex than anticipated, however. While the Help4Mood Avatar is merely a medium for agent-based interactions (semi-autonomous seek and retrieve functions), even at this pre-product stage potential users were beginning to endow it with social (e.g. friend, colleague) and psychological (e.g. trustworthy, honest) characteristics and to form certain expectations related to these characteristics (e.g. for watchfulness, protection, wisdom). Nevertheless participants' insistence that such systems could augment but, never replace, face-to-face care and therapists' caution around the correct balance of 'guiding' and 'directive' support, both indicate a recognition of their limitations.

The use of human-like agents in online business transactions, and 'mini-me' Avatars in virtual worlds such as Second Life, is becoming widespread and anthropologists have speculated on the various ways in which these might be absorbed into our perceptions of the social world. For example, our tendency to anthromorphise non-humans (endow them with human qualities) can produce benefits where value is to

be gained from the social - as in robot pets - but it also introduces risks and uncertainties, particularly where expectations for protection or wisdom are created - as in the case of algorithm-driven monitoring and feedback loops in telehealthcare, or where an embodied software agent is perceived as a therapist or friend. This creates conceptual challenges around the nature of human and non-human relationships and trust, and also ethical challenges around professional substitution and trickery, which need to be addressed if such systems are to be introduced more widely.[7] While appropriate briefing of users can help to avoid possible misapprehensions, it must be recognised that social projection is an inevitable consequence of our human need to understand others, presenting a classic dilemma in social computing - creating things that are real enough to be useful but not too real as to mislead. [8]

The findings of this formative study raise important questions about the nature of users' interactions with embodied communicative agents in the context of online psychotherapy. For example; to what extent are these perceived as 'social' agents, as opposed to instrumental ones; what social or emotional value do users gain from such encounters, what expectations does the technology generate and what implications does this have for the appropriate design and safe implementation of such systems?

4. Conclusion

The use of Avatars in psychotherapy for depression is relatively new and its acceptability, value and risks are unknown. These preliminary results suggest that while such technology offers great potential for engaging patients in the treatment process it is not without challenges. Appropriate choices of Avatars need to be provided and the technology should be introduced sensitively alongside current treatment processes. Users wish to engage with Avatars that meet their personal preferences and fit appropriate role expectations. The perception of Avatar as trustworthy colleague or friend raises conceptual and ethical issues which merit further research.

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GameTeen: New Tools for Evaluating and Training Emotional Regulation Strategies

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Abstract. The aim of this paper is to describe GameTeen, a novel instrument for the assessment and training of Emotional Regulation (ER) strategies in adolescent population. These new tools are based on the use of 3D serious games that can be played under different settings. The evolution of ER strategies will be monitored in two ways depending on the setting where the tool is presented. Firstly, in the laboratory, physiological signals and facial expressions of participants will be recorded. Secondly, in real life settings, ecological momentary assessment tools will be used to obtain answers from the subjects using their mobile phone. The goal is to obtain more attractive and reliable tools to evaluate and train ER strategies.

Keywords. Serious Games, Virtual Reality, Emotional Regulation, Physiological signals, Face Tracking.

Introduction

Emotional Regulation (ER) strategies determine the way in which we feel, express and regulate our emotions [1]. ER strategies influence and control the way of feeling and expressing the emotions that a person is experiencing in any situation. This could be automatic or controlled; conscious or unconscious [2-3]. Deficiencies or deficits in ER are considered to be relevant factors in the origin of numerous behavioral disorders such as depression, anxiety, addiction, aggressiveness, etc.

These deficits are becoming evident in the adolescent population in which they are the origin of many psychosocial problems. The increase of bulling at school, the bad behavior in the classroom and school failure may be due to a deficient ER. Thus, correcting these deficits will help in the prevention of different psychological disorders.

Currently, used ER training and evaluation instruments are based on traditional tools such as oral presentations or subjective questionnaires [4-5] that ask the subjects about the way in which they manage their emotions. Another evaluation method is the

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use of laboratory tests in which the subjects are asked to carry out tasks that generate emotions and thus evaluate the ER strategy that has been used.

Although these types of tools have proven very useful, they are less suitable for the evaluation of ER strategies in adolescents, since this population is particularly reluctant to be assessed. Indeed, motivating the learner continues to be one of the most difficult aspects of teaching.

With the development of new technologies, we hope to overcome these limitations. For this reason, we present, in this work, new tools to evaluate and train ER strategies using virtual reality (VR) based on serious games and new Information and Communications Technologies (ICTs), like smart phones. The use of VR will be very useful also for our purpose. VR is a technology that is very attractive to adolescents, who are accustomed to the simulated environments of videogames.

The evaluation of these tools has been divided in two studies which are described in great detail in the following sections. The first study will be conducted in a laboratory setting and the second study in real world setting (i.e., ecological ER evaluation and training).

In the first study we pretend to carry out the experiment in laboratory controlled conditions. The goal is to evaluate if these tools developed really help to evaluate and train different ER strategies in the participants, and if we can detect significant differences in physiological responses and in gesture responses when a mood has been induced through a game, which has been designed for this propose. The other goal we pursue in this laboratory study is to analyze the influence of different game interfaces in ER strategies. In order to achieve this goal we will compare the traditional game interface (mouse and keyboard) with other more technological and natural interfaces (TOF cameras).

The aim of the second study is to evaluate a friendly platform that allows the therapist to monitor the emotional status of adolescents every day in any moment. This system would be our social sensor.

1. Methods

ER strategies will be trained and evaluated in the context of a VR environment. Two mood induction games, i.e. joy (figure 1a) and frustration (figure 1b) will be developed during this work. Unity3D will be the software used for programming these games.

Figure 1. Games developed for this work. **a)** Joy game **b)** Frustration game

For the first game, a joy game, an attraction park has been developed. In this game, the subject will have to exploit as many balloons as possible. The subjects will also

have to answer questions about their emotional states while they play. The game has been developed for joy induction, for this reason, the colors and music, the encouragement messages, arms, etc. will be chosen consciously for this purpose.

For the second game, frustration game, a new version of "whack a mole" has been developed. In this case, the subject will have to whack several moles as they appear. The game has three levels of difficulty which are related with the velocity and frequency of appearance.

In both games, when the emotional level of the subject, either as a positive emotion (joy game) or as a negative emotion (frustration game), exceeds a threshold, the subject will have to go to a special area of the game, where they will learn to regulate their emotions using different ER strategies designed for each case. If the subjects learn to apply the ER strategies correctly, they will win news skills or news weapons to go continue with the game.

A therapist application has been designed for this study. In this application, the therapist will be able to observe all the movements and the physiological signals of the subjects in real time. In addition, the therapist will have control of the study and positive reinforcements can be sent.

The evaluation of this work has been divided in two studies. The first study will be conducted in a laboratory setting and the second study in a real world setting.

1.1. Laboratory Study

For the Laboratory Study, two different game interfaces for the emotional induction games will be compared. The first interface will consist of a traditional mouse and keyboard. The second one will be a gestural interface based on Time of Flight (TOF) cameras. Changes in the emotions of the subjects will be monitored using questionnaires, physiological signal analysis (ECG, EEG and voice), face tracking and body gesture analysis.

1.2. Real World Study

In the Real World Study subjects will play the mood induction games using another possible game interface, mobile interface on smartphones. Changes in the emotions of the subjects will be monitored through an Ecological Momentary Assessment (EMA) tool [6] that will be developed in the project.

Our EMA will consist in two parts. The first part will be properly "our sensor", where participants will have to answer various questions about their emotional status in the moment they receive a reminder. In this part, the questionnaire will be asked by a custom avatar (Figure 2). If subjects answer all questions every day, they will have points that could be used to buy things for their avatar. The second part of EMA consists of a web platform where the therapist will be able to monitor all the data recorded from the subjects, to program personalized news for the participants and also to draw statistical graphs, in order to facilitate the analysis of data and results.

Figure 2. Caption of the avatar used in the ecological momentary assessment tool.

2. Results

We hypothesize (H1) that the use of serious games in ER strategies learning will allow a greater enjoyment, satisfaction and motivation of adolescents than in the traditional learning context. We also hypothesize (H2) that the use of mobile EMA tools will be more efficient and more precise in terms of emotional state evaluation than traditional tools. We finally hypothesize (H3) that the use of physiological monitoring and face tracking during the exposition could yield information relevant to the early detection of ER problems [7]. Results from the two studies will allow us to evaluate these hypotheses.

3. Discussion and Conclusions

This paper presents the possible application of news technologies in VR and ICTs in ER field. The main conclusion of these tools and their implications for ER are discussed in the below paragraphs.

In our opinion, the use of VR technology based on serious games and ICTs as part of the evaluation and training of ER strategies in teenagers may provide numerous advantages in this field.

Firstly, the use of serious games improves the motivation and helps to catch the attention of subjects that can hardly be attracted by others techniques, such as teenagers. VR technology allows us to simulate any situation in a realistic way that can help us to induce any emotion. These instruments would provide us with tools for the early detection of ER patterns with a high risk of leading to health or behavioral problems. It would enable intervention before these problems worsen. On the other hand, their use as training tools would enable their integration into psychoeducational programs for prevention.

Secondly, combining VR technology with physiological measurement tools will allow us to continue studying the influence of the emotions in our physiological signals and how ER strategies can produce physiological changes that may be measured and quantified.

We think that our tools may allow the subjects become more involved in the evaluation and training process of ER strategies, which will make these strategies more effective and more motivating. In the validation of these tools, we hope to confirm our hypothesis.

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Innovative ICT Solutions to Improve Treatment Outcomes for Depression: The ICT4Depression Project

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Abstract. Depression is expected to be the disorder with the highest disease burden in high-income countries by the year 2030. ICT4Depression (ICT4D) is a European FP7 project, which aims to contribute to the alleviation of this burden by making use of depression treatment and ICT innovations. In this project we developed an ICT-based system for use in primary care that aims to improve access as well as actual care delivery for depressed adults. Innovative technologies within the ICT4D system include 1) flexible self-help treatments for depression, 2) automatic assessment of the patient using mobile phone and web-based communication 3) wearable biomedical sensor devices for monitoring activities and electrophysiological indicators, 4) computational methods for reasoning about the state of a patient and the risk of relapse (reasoning engine) and 5) a flexible system architecture for monitoring and supporting people using continuous observations and feedback via mobile phone and the web. The general objective of the ICT4D project is to test the feasibility and acceptability of the ICT4D system within a pilot study in the Netherlands and in Sweden during 2012 and 2013.

Keywords. depression, self-help, eMental health, mobile phone, ICT

Introduction

Current treatments of depressive disorders, such as pharmacotherapy and psychotherapy, can reduce the burden of these diseases to about one third [1]. Most depressed patients are treated in primary care. However, the treatment options for general practitioners are limited. In most cases, general practitioners prescribe

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antidepressant medication, although the majority of patients prefer psychological treatments [2]. Also, the general practitioner has only limited time for the patient. Therefore, current treatments for depression may be considerably improved using innovative ICT solutions. Meta-analyses demonstrated that internet-based interventions are effective for treating depression [3]. Some studies show promising results using mobile phones to improve treatment of depression [4]. However, these studies are scarce and include no other ICT solutions to improve treatment outcome apart from using Internet and mobile technologies.

In an EC funded project, called ICT4Depression (ICT4D), a system is developed aimed to improve the outcome of treatments for depression. This system supports (guided) self-help depression treatment in primary care via the Internet and mobile phones. The therapies are integrated in an intelligent (self-) support system for patients suffering from depression. The aim of the project is to develop such a system and to study the feasibility and acceptability of it. The ICT4D system will be evaluated in a pilot study within a sample of 25 depressive patients in a primary care setting in the Netherlands and in a similar pilot study in Sweden. This paper will provide an overview of the different components of the ICT4D system.

1. Self-help treatments for depression

Treatment modules that have been developed, transformed and extended for this project are psychoeducation, behavioral activation, problem solving therapy, cognitive restructuring, exercise therapy, medication adherence, and relapse prevention. A description of each of the treatment modules is presented below.

Psychoeducation. A meta-analysis revealed that brief passive psychoeducational interventions for depression and psychological distress can reduce symptoms [5]. The psychoeducation module in the ICT4D project contains general information about (treatment of) depression, exercises about goal setting and will help patients to assess the severity of their problems. The severity of the symptoms, along with other criteria, will be used to give the patient an automatic advise about whether to start another treatment module and which one.

Behavioral activation. Behavioral activation therapy has been found to be effective as a treatment for depressive disorders in a meta-analysis [6]. The behavioral activation module in this project is based on an earlier Internet intervention with mobile phone support [7]. The module focuses on learning to increase the pleasant activity level and to balance the level of necessary activities.

Problem solving therapy (PST). PST has been found to be effective in the treatment of depression [8]. The module has its origins in Self-Examination Therapy [9]. During PST, people learn to get control over their problems by (a) determining what really matters to them (b) investing energy only in those problems that are related to what matters (c) thinking less negatively about the problems that are unrelated and (d) accepting those situations that cannot be changed [9].

Cognitive restructuring (CT). CT in this project builds on existing internet-based interventions for depression from Sweden and The Netherlands, which have been shown effective in the treatment of depression [10]. CT contains information about negative automatic thoughts, how depression is connected to them, ways of discovering negative thoughts, registration of negative thoughts and dealing with negative thoughts.

Exercise. Exercise seems to improve depressive symptoms (11). The exercise module in ICT4D is developed by the project members and entails general information

about physical activity, the relation between physical activity and mood and exercises to increase physical activity level.

Relapse prevention. Research shows that relapse prevention of depression is possible through the use of long-term psychological treatments, and treatments specifically aimed at relapse prevention [12]. In the current project, we developed a relapse prevention module which learns the patient to prepare for future events which can trigger depressive symptoms and to make a plan of action in case depressive symptoms return.

Medication adherence. The medication adherence module aims at providing an adequate and personalized support for the management of patients' drug intakes. The module consists of two sub-modules; the first one aims at identifying barriers to drug adherence. This sub-module is based on the Beliefs about Medicines Questionnaire (BMQ) [13]. Evidence suggests that Measurement-Guided Medication Management (MGMM's) is effective in improving patient's adherence [14]. The second sub-module is an extension of the current implementation of MGMM intervention through ICT-based techniques. In this sub-module, adherence data is collected at the point of need and wirelessly transferred to the adherence sub-system on a regular basis.

2. Mobile phone

The mobile phone has two functions in the ICT4D project. On the one hand, the patient can use the phone for following treatment modules that are shortened versions of the modules available via the web. On the other hand the phone is used to monitor the patients' progress. In order to give a patient appropriate support one needs to be aware of the therapy progress. The ICT4D system gathers information of this progress via ecological momentary assessment (EMA). EMA is an ecologically valid method of gathering real-time data on context, behavior, and mood in natural environments through the use of signaling devices to minimize recall bias [15].

The patient's wellbeing (mood, quality of sleep and distress) is measured on a daily basis. Patients will receive a pop-up message five times a day to rate their mood at that particular moment. Mood is rated on a scale from 1 to 10. The quality of sleep and level of distress are assessed once a day. The patient receives feedback from the reasoning system about the evolution of his wellbeing status.

In addition to the use of EMA, the activity level of the patient is measured through sensors in the mobile phone. Physical activity monitoring provides feedback in relation to the adherence of the patient to the exercise regime for patients doing exercise treatment. In ICT4D exercise activity is measured in terms of time spent lying, sitting, standing, walking and cycling but is also derived from the time spent in locations indicated by the user as those places where they exercise. A daily activity level is also calculated and used by the reasoning system as a measure for generic user activity levels.

3. Wearable biomedical sensor devices

Biosignals have been used for studying physical health problems, but limited research has been done to assess the applicability of these signals to the context of mental health problems. In the ICT4D project, a set of wireless miniaturized and non-intrusive

wearable sensors was developed, taking into account considerations about the usability, portability and comfort for the patient, targeting continuous and ecological monitoring. Due to the requirements of the monitored parameters in terms of anatomical location of the signal sources, two form factors were developed, namely a chest strap to be worn at the chest level, and a glove-like device to be used in the non-dominant hand. The glove allows measurement of electrodermal activity (EDA), and blood volume pulse (BVP) at the hand palm, thus not interfering with the regular tasks performed by the patient, while the chest strap allows measurement of respiration, electrocardiography (ECG) and acceleration. Cardiac parameters, such as heart rate, are extracted from the BVP and ECG, while the sympathetic nervous system activity is assessed with the EDA.

4. Reasoning system

One of the main goals of ICT4D is to provide the patient with a highly personalized and automated treatment based upon the measurements related to how the patient is doing, In order to perform this task, a reasoning engine is part of the system, which incorporates techniques from the domain of Artificial Intelligence, in particular dynamic computational modeling. Essentially, this reasoning engine is composed of four main parts: (1) a component that interprets the sensory information to derive how the patient is doing, and how much the patient is involved in the therapy; (2) a component that derives how the current patient state and involvement is in line with the expectations for this particular therapy; (3) a component that investigates whether another therapeutic module could potentially offer a more successful treatment (by performing simulations) in case the patient is performing worse than expected, and (4) a component to generate feedback to the patient based upon the sensory information and the information derived under (2) and (3). In order to avoid overloading the patient with these messages, a priority-based mechanism has been developed.

The reasoning system provides automated feedback to each patient and the involved primary caregiver. This will give patients a better insight in the progress of their therapy and allows them to increase the effect of their therapy. Feedback will be provided via the smart phone and a personal website.

5. System architecture

From the software architecture viewpoint, ICT4D is a distributed system, bringing together several modules and system components developed by different partners in a seamless yet loosely coupled fashion. It follows a Service Oriented Architecture (SOA), featuring a cohesive business process for the support of therapeutic modules and ecological momentary assessments alike, as well as an Event-driven Architecture (EdA) implementing individual patient progress across therapies and providing users with asynchronous feedback.

Although the treatments in ICT4D enable the user to have a considerable degree of flexibility, a consolidated database model has been devised. This structure associates inter-related concepts in a stepped therapy and maps them to customized lookup tables, which form the basis for the automated interpretation. It is also expected to contribute to a better user experience, e.g. because makes it possible to present the user with suggestions resulting from previous steps in a therapy.

Two client applications, making use of the same underlying secure web services have been implemented: one for the Web, another one for the Android platform. The ICT4D service architecture can be easily extended with other therapeutic modules or new client applications. Furthermore, if availability requirements determine it, the architecture can be scaled by including new application and/or database servers.

6. Discussion

This paper describes a highly automated ICT-based system for the treatment of depression. The therapeutic basis of the system is a set of partly new, partly modified internet-based therapies. Through the use of smart phones, ecological momentary assessments and various sensors, an extensive set of patient specific data is collected and analysed automatically by a reasoning engine. The resulting information is used to provide the patient with tailored feedback and advice. The system will be tested during trials with 25 patients with a diagnosis of depression in the Netherlands and Sweden during 2012 and 2013.

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