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EDITORIAL

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

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

In the first article Wang and Reid explore the application of a virtual reality-cognitive rehabilitation (VR-CR) approach in treating autism in children. In this study, virtual reality (VR) was used as an interactive, cognitive-focused treatment which allowed for greater flexibility than traditional methods for treating autism.

Next, Murray presents research based on the treatment of phantom limb pain in amputees using VR. Studies using research stemming from traditional "mirror-box" methods were conducted and Murray looks closely at three VR systems that were implemented in the treatment of phantom limb pain.

In the third article, Aime, Cotton and Bouchard take a close look at women suffering from eating disorders and implement VR as an experimental new form of treatment for these patients. VR immersions were conducted to assess whether or not treatment was successful in helping women suffering from eating disorders as well as overall concern over their weight and shape.

Bouchard, St-Jacques, Renaud and Wiederhold, in the fourth manuscript, address the side effects of immersions in VR for people suffering from anxiety disorders. In this study, researchers used a sample group of patients suffering from anxieties of various types and measured reports of side effects before and after VR immersions to determine whether or not patients and therapists should be concerned about the lasting complications of side effects.

In the fifth paper, King and Delfabbro present findings on research detailing motivational differences in video game play. Factors that were considered include motivation to play video games, intrinsic and extrinsic motivations, and total time spent playing. These findings can be used to help video game players determine if their playing behavior points to a problematic level of involvement.

In another article addressing video game playing, Wang and Yang explore the relationships between thrill seeking, perceived risk and aggressive tendencies and how these factors relate to the acceptance of playing violent video games. Behavioral intention was also closely studied as well as differences in male and female gaming styles.

Lastly, Fullwood and Wootton examine the possibilities of computer-mediated communication (CMC) to help patients deal with emotionally-sensitive issues. To do so, an online support forum produced by the National Society of Epilepsy was used. Key factors, such as anonymity and willingness for disclosure, were studied and used to determine whether CMC meets criteria for offering support to sufferers.

Future issues of JCR will continue to explore the ways in which healthcare, in Europe and worldwide, can benefit from innovative applications of technology. I would like to sincerely thank the contributing authors for their inspiring work and dedication to this field of research. I also want to thank JCR's Associate Editors – Professor Botella, Professor Bouchard, Professor Gamberini and Professor Riva for their leadership and hard work, as well as our internationally renowned Editorial Board for their contributions. We encourage readers and subscribers to contact us with ideas and manuscripts. Thank you again for your support of JCR. We look forward to providing you with more ways in which technology is contributing to increased quality of life in citizens of the world.

Brenda K. Wiederhold, Ph.D., MBA, BCIA
Editor-in-Chief, *Journal of CyberTherapy & Rehabilitation*
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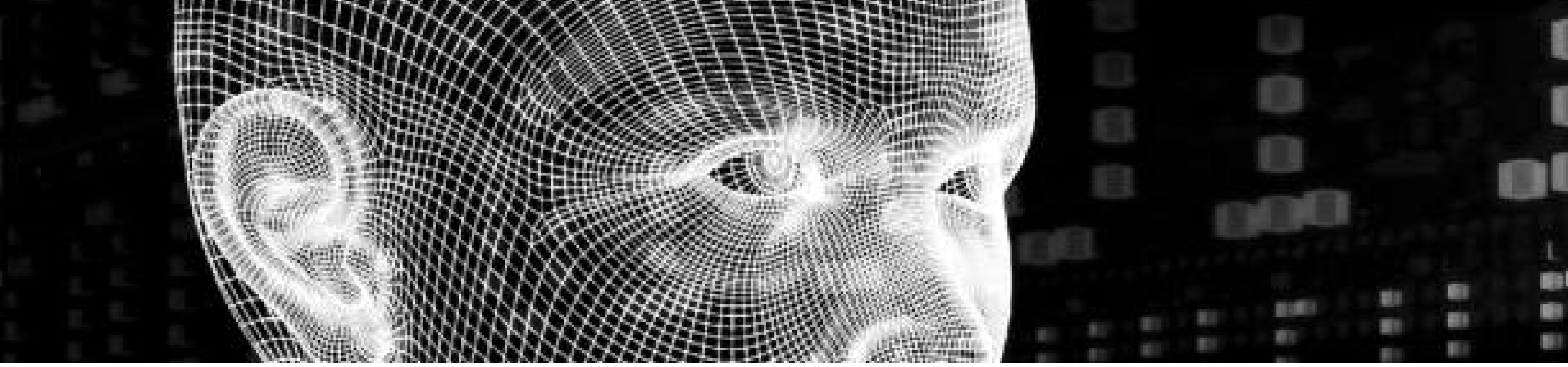

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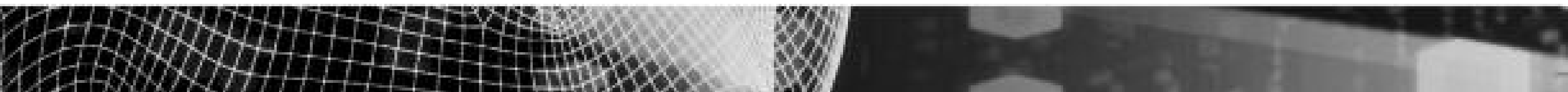

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THE VIRTUAL REALITY-COGNITIVE REHABILITATION (VR-CR) APPROACH FOR CHILDREN WITH AUTISM

Michelle Wang[1] and Denise Reid[2]

Children with autism and their families lack treatment options that directly target the cognitive impairments that are characteristic of autism spectrum disorders. The objective of this paper is to present an interactive, cognitive-focused treatment approach that is suggested to complement current treatments for children with autism. We present a brief theoretical overview of the VR-CR approach, followed by a discussion of how the VR-CR approach can and has been put into practice using autism-specific teaching principles. Recommendations for future research are provided.
Keywords: Autism, Virtual Reality, Cognitive Rehabilitation, Cognitive Education

Introduction

Autism or autism spectrum disorders (ASD) refer to a group of neurological disorders that are characterized, in differing degrees, by three core behavioral elements – impairments in social interaction, deficits in communication skills and the absence of imagination, as manifested in restricted repetitive and stereotypic behaviors (APA, 2000). Research in the field of autism has grown enormously in the past few decades, particularly in generating evidence for underlying cognitive impairments and establishing principles of effective practice. However, current treatments for autism have been slow to adapt and assimilate this knowledge. The majority of current interventions for autism continue to target specific problem behaviors rather than cognitive impairments and often do not adhere to evidence-based practice (Jones & Jordan, 2008).

There is a new treatment approach that has the potential to apply the recent research findings into clinical and educational practice. This approach integrates cognitive rehabilitation with virtual reality technology (Rizzo, Schultheis, Kerns & Mateer, 2004). Traditional theories and programs of cognitive rehabilitation provide the requisite knowledge and strategies to effectively address autism-specific cognitive impairments, while advances in virtual reality technology enable principles of effective practice to be incorporated into the treatment tool itself. Interventions that integrate virtual reality (VR) technology with traditional methods of cognitive rehabilitation (CR) can be considered the "VR-CR approach."

This paper provides an overview of the key principles of the Virtual Reality-Cognitive Rehabilitation (VR-CR) approach and how these principles can be applied to develop a VR-CR application for children with autism. Although the development of a VR-CR application includes purchasing hardware and programming software, this paper will neither discuss the technical aspects of equipment nor programming. This paper focuses primarily on the theoretical and practical concepts behind remediating specific cognitive impairments in children with autism.

The theoretical framework of the VR-CR approach

The Virtual Reality-Cognitive Rehabilitation (VR-CR) approach is an integration of the theoretical framework of traditional cognitive rehabilitation programs and the interactive capabilities of virtual technology (Rizzo, 1997). Traditional cognitive rehabilitation (CR) has focused primarily on retraining and improving the cognitive abilities of individuals with brain injury in areas such as attention, memory and executive functions (Sohlberg & Mateer, 1989). Although the field of cognitive rehabilitation benefited early on from the use of computers, the evolution of virtual reality technology has facilitated even greater user engagement and motivation in cognitive exercises that are typically repetitive and highly structured (Rizzo, et al., 2004).

The 'VR' of VR-CR

Virtual Reality (VR) is defined as a simulation of the real world using computer graphics. Users are able to interact, in real-time, through multiple sensory channels including sight, sound, touch and sometimes even smell (Burdea & Coiffet, 2003; Self, Rosalind, Weheba & Crumrine, 2007). A VR system provides the user with a three-dimensional sense of immersion or "being there" within the virtual environment (Pimental & Teixeira, 1995). Many VR systems require the use of wearable equipment, such as head-mounted devices. Projected VR systems, on the other hand, are able to capture the user's actions with specialized cameras without the burden of such equipment (Burdea & Coiffet, 2003). VR is gaining support as an effective tool in the therapy and rehabilitation sectors because of its potential to engage and motivate users while retaining its therapeutic effectiveness (Harris & Reid, 2005). Rizzo and Kim (2005) offer insight into the potential of VR and said, "[using VR] in the therapy and rehabilitation sciences ... represents more than a simple linear extension of existing computer technology for human use. VR offers the potential to create

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systematic human testing, training and treatment environments that allow for the precise control of complex, immersive, dynamic 3D stimulus presentations, within which sophisticated interaction, behavioral tracking and performance recording is possible" (Rizzo & Kim, 2005, p.119). Its inherent capacity for both structure and flexibility make VR an ideal complement to traditional cognitive rehabilitation.

The 'CR' of VR-CR

The VR-CR approach retains the underlying theoretical principles of traditional cognitive rehabilitation. These principles originate from Luria's theory of brain organization which emphasizes integrated brain function and stresses that various parts of the brain work in coordination rather than in discrete functional units (Luria, 1980). Luria argued that cognitive function as a whole can be restored through repetitive training exercises that specifically target the impaired component processes. This repetition allows the lost connections to be re-learned and re-established (Luria, 1980; Sohlberg & Mateer, 1989). This concept of "neuroplasticity," or the ability of the brain to repair itself and create new connections, forms the foundation of the VR-CR approach (Rizzo & Buckwater, 1997).

There are two general techniques used to rehabilitate cognitive functions – restorative and compensatory (Sohlberg & Mateer, 1989). Restorative approaches focus on retraining specific impaired cognitive processes such as attention, memory or logical thinking. Restorative training involves cognitive exercises that are highly repetitive and often monotonous. These activities are not specific to any one behavior or task. Compensatory approaches, on the other hand, focus on training cognitive strategies that are task-specific. These strategies often recruit other cognitive processes, rather than the impaired processes, as alternatives to complete a particular task. These exercises usually do not improve the impaired cognitive process, however, task performance is generally enhanced (Sohlberg & Mateer, 1989). Both types of cognitive training can be integrated into a VR-CR application. Choosing the type of training will depend on the needs of the individual and the goals of therapy.

Putting it together

Traditional cognitive rehabilitation is widely critiqued for poor ecological validity, which is the degree to which the training situation is similar to the real world (Neisser, 1978). This then extends to poor generalization of skills, or the application of newly-learned skills to situations outside of the training environment. This issue is particularly relevant to cognitive retraining programs, as these programs typically break down target behaviors and skills into small components and teach them in artificial training environments (Rizzo et al., 2004). Integrating virtual reality technology into cognitive programs presents a solution to this problem. VR has the capacity to simulate realistic scenarios in which users can interact, while still allowing the instructor to maintain control over the therapeutic activity. There is growing support from rehabilitation researchers for the use of the combined VR-CR approach (Rizzo et al., 2004; Fidopiastis et al., 2006). This interest has not extended beyond the areas of brain-injury and stroke, yet there is a significant overlap in the cognitive deficits of individuals with brain injury and those with autism, such as deficits in executive functions, problem-solving, language, reading and self-regulation (Cicerone, et al., 2005; Hill, 2004). In addition, there are similarities between traditional strategies of cognitive rehabilitation and autism-specific principles of effective practice, particularly with highly-structured activities (Iovannone, Dunlap, Huber & Kincaid, 2003; Sohlberg, et al., 1989). Virtual reality makes cognitive programs accessible to children with autism through its capacity to engage children, to provide structured yet individualized activities and to address their weaknesses while building on their strengths. The following section discusses how VR-CR applications can integrate rehabilitation and educational strategies that are specific to children with autism.

Incorporating principles of effective practice for children with autism

There are four major principles of effective practice specifically for children with autism –structured environments, systematic instruction, program individualization and an emphasis on generalization (Dunlap, Iovannone & Kincaid, 2008; Hurth, Shaw, Izeman, Whaley & Rogers, 1999; Iovannone, Dunlap, Huber & Kincaid, 2003; Schopler, Mesibov & Hearsey, 1995). These principles are easily incorporated into VR-CR applications due to the flexibility and control with which VR-CR applications are designed.

1. Structured learning environment

Children with autism function best with predictability during their day and thus require additional supports to help them anticipate future events and understand what behaviors are expected of them (Myles, Grossman, Aspy, Henry, & Coffin, 2007). An instructor can create a structured learning environment by modifying both the physical environment and the program itself. A structured physical environment is less cluttered and distracting than a typical environment. Additional supports, such as visual labels and schedules, may also be incorporated, particularly to facilitate changes to or transitions in everyday routines (Dettmer, Simpson, Myles & Ganz, 2000; Rogers, 1999). A structured program requires a defined curriculum with predetermined learning goals and behavioral expectations that are clearly understood by both the instructor and the child (Olley & Reeve, 1997). In a structured learning environment, the child is aware of what they are expected to do during the learning sessions. This maximizes their success on the tasks (Hurth, et al., 1999; Iovannone, et al., 2003).

Cognitive rehabilitation programs are typically highly structured and designed to target cognitive impairments at a fundamental level. The difficulty of each activity is increased progressively until the child performs at a level of "mastery" on the task (Sohlberg, et al., 1989). For example, a series of exercises targeting sustained attention might require the child to attend to a certain scene initially for only five seconds. The activity then requires progressively longer durations of sustained attention until the child has reached the final goal, say five minutes. Such repetition requires the instructor to present the same exercises over and over in a consistent manner, so as not to confuse the child or introduce unintentional variation within the task. Virtual reality can remove this burden from the instructor, as it has the "capacity to systematically deliver and control dynamic, interactive 3D stimuli within an immersive environment" (Rizzo, et al., 2004, p. 211). Having complete control over the design of the VR task allows both physical and program-related structure to be built into the VR-CR application. Visual schedules and supports can be integrated and the environment can be simplified according to the demands of the cognitive training task and needs of the child.

2. Systematic instruction

Systematic instruction requires establishing meaningful goals for the student and creating a specific, direct instruction plan that facilitates the achievement of these goals (Dunlap, et al., 2008). When identifying meaningful goals for a VR-CR program, it is important to distinguish between skills and activities. Skills are considered the general, underlying abilities that allow children to perform a variety of specific activities (Dunlap, et al., 2008). The VR-CR application should focus on teaching the cognitive skills (i.e. planning) that are necessary for everyday activities (i.e. brushing teeth, dressing).

The teaching strategies that are the most effective with autistic children rely on basic behavioral principles, which "represent the standard of a systematic orientation to instruction" (Dunlap, et al., 2008). Children with autism benefit from having an "expert" guide them through the learning process using verbal and nonverbal instruction, prompts, repetition and reinforcement. Guided instruction and step-by-step prompts promote an errorless learning environment (see Wilson and Evans, 1996 for a review of this teaching strategy). The learning process in this environment is not completely errorless per se, but with continuous support from the instructor the child makes fewer errors on the task. Minimizing errors and maximizing success reinforces the child's desire to complete the task accurately and leads to gains in confidence (Myles, et al., 2007; Schopler, et al., 1995). Prompts act as a learning aid and may be physical (i.e. hand-over-hand), verbal or gestural (i.e. pointing). Reinforcement after a task should be immediate and may be given after each correct response or intermittently (Schopler, et al., 1995). The type and intensity of instruction, prompts and reinforcements should be tailored to the individual child. Thus, the instructor must take the time to understand each child's unique motivations. This entire process of instruction, prompting and reinforcement is repeated for each stage of skill learning (Magliaro, et al., 2005).

Having control over the design of the VR-CR application facilitates the incorporation of systematic teaching strategies. Instructions, cues and prompts can be integrated into each stage of the task. The VR-CR application can also provide "immediate performance feedback in a variety of forms and sensory modalities" (Rizzo, et al., 2004). Thus, VR-CR applications are well-suited to providing an errorless learning environment which will serve to facilitate engagement and ultimately, increase learning. However, it is important to note that the VR-CR application is not meant to replace the instructor. Rather, the instructor is essential to guide and monitor the child throughout the entire process. The role of the instructor highlights the importance of "individualization;" ensuring that there is an ideal fit between the child and the activity.

3. Individualization

Each child with autism is remarkably unique, which is why the disorder is defined on a spectrum. Due to the inherent heterogeneity of this disorder, one cognitive program cannot possibly address the needs of all autistic children (Wolf, Fein & Akshoomoff, 2007). Because traditional cognitive rehabilitation programs are typically prescriptive, integrating VR adds the flexibility required to individualize the task for each child. Dunlap and colleagues (2008) emphasize the need for the instructor to take the time to determine each child's profile of strengths and weaknesses so that the program can be tailored for that child.

Individualization of the VR-CR application can be achieved in four ways. First, a battery of neuropsychological assessments should be used to determine the cognitive impairments that need to be addressed in treatment. Second, the child's own interests and preferences should be integrated into the program in order to maximize engagement, which is one of the strongest predictors of successful learning (Hurth, et al., 1999; Logan, Bakeman, & Keefe, 1997; Rogers, 1999). This can be done, for example, by integrating a child's preferred cartoon character or favorite song into the program. Third, the complexity of the virtual environment can be modified. Decreasing the complexity of the environment may serve to increase attention and minimize distractions. In addition, as many children with autism are over or under-sensitive to sensory stimulation, modifying the environmental complexity may increase the comfort and willingness of the child to engage in the activity (Baranek, 1999, 2002; Harrison & Hare, 2004). Finally, autistic children frequently display superior abilities in visual learning and memory (Mesibov, Schopler & Hearsey, 1994). These strengths can be integrated into a VR-CR application through visually-presented activities and the addition of visual supports such as schedules or video-modeling (Darden-Brunson, Green, & Goldstein, 2008). Both visual schedules and video-modeling have been shown to be effective teaching tools for children with autism (Odom, et al., 2003; Thelen, Fry, Fehrenbach & Frautschi, 1979).

As mentioned in the previous section, the importance of the instructor is not to be overshadowed by the VR-CR application (Cicerone, et al., 2000; Cicerone, et al., 2005). The instructor must be present to provide additional scaffolds that may vary according to the child's immediate needs. This may involve integrating other forms of motivation or reinforcement, such as edible rewards or additional verbal feedback. It is the instructor's responsibility to ensure that the fit between the VR-CR activity and the child's cognitive needs and abilities is maximized and that the child is progressing toward his or her goals. However, achieving these goals does not signal the end of the intervention. Facilitating the maintenance and generalization of the newly learned skills is one of the most important, but most difficult, objectives to achieve with children with autism.

4. Generalization

Children with autism are notorious for failing to transfer learned skills to new environments (Howlin, 1998; Iovannone, et al., 2003). Therefore, incorporating specific strategies to maximize generalization is a significant part of intervention planning. Ghezzi and Bishop (2008) offer a few principles of generalization to consider; reinforce the use of the skill in a variety of contexts, use a variety of teaching materials and specific instruction methods, make the teaching environment similar to the real environment, teach the rules and principles behind the skill rather than just the skill itself, and include natural stimuli and reinforcers.

The greatest asset of VR-CR applications is the ease with which they are able to incorporate these generalization principles (Rizzo, et al., 2004). A variety of well-controlled environments can be designed with natural stimuli, cues and feedback. VR-CR applications are fundamentally designed to simulate real-life situations, thus, there is a high degree of ecological validity, which is lacking in both traditional cognitive and behavior-focused interventions. After practicing cognitive skills within multiple, diverse virtual scenarios, the autistic child will be significantly more likely to transfer the new skill set to real situations (Rizzo, et al., 2004). Because cognitive rehabilitation alone is insufficient to promote generalization, VR is the bridge necessary to promote the transfer of skills in children with autism.

The combination of CR strategies with VR technology creates a unique approach that can address the cognitive deficits in autism within an environment that can be tailored to each child's unique learning needs. In the next section we discuss how the VR-CR approach can be used creatively and effectively to address three major cognitive impairments found in children with autism – impairments in imagination, planning, and flexibility.

The VR-CR Approach in practice

There are three strategies through which VR-CR applications can be developed and applied in the field of autism. The first is by modifying existing VR-CR applications created for other special populations. The second strategy is by transforming non-VR cognitive activities into VR-CR applications and thirdly by creating completely novel VR-CR applications specifically for children with autism. This section will briefly describe three key cognitive impairments that are typical of children with autism and will then discuss how the above strategies have been used or can be used to address them.

Cognitive Impairments in Autism

Given the scope of this paper we will address only three cognitive impairments – deficits in imagination, planning and cognitive flexibility. The latter two are often grouped under the umbrella term "executive functions."

A deficit in imagination, or the ability to think abstractly, is one of three core deficits that characterize autism (Wing & Gould, 1979). To think abstractly requires one to think about something concrete in a non-concrete way or in a way that is not explicitly perceivable. Current diagnostic tools for autism tend to define imagination deficits in terms of specific, related behaviors. These include a preference for particular routines and rituals, and the presence of restricted, repetitive and stereotyped behaviors (APA, 2000). In children with autism, this restricted pattern of behavior is often seen in their lack of pretend or symbolic play, as this type of play requires a non-literal way of thinking (Jarrold, 2003).

Executive functions are a collection of mental processes that are believed to be mediated by the prefrontal cortex (Duncan, 1986; Stuss, 1992). These processes are involved in planning and executing goal-oriented behavior. They include abilities such as inhibition of preferred responses, flexibility in thought and behavior, abstracting and generating concepts, working memory and organizing a complex response (Ozonoff, 1991; Ozonoff, Pennington & Rogers, 1991). The similarity between patients with prefrontal brain damage and children with autism initially led to the hypothesis that children with autism may have executive functioning problems (Ozonoff, et al., 1991). These similarities include a need for sameness, a tendency to repeat movements and verbal expression, difficulty in switching attention and an inability to inhibit impulses (Rajendran & Mitchell, 2007). Executive functioning has been shown to predict the severity of repetitive behaviors as well as the level of social understanding in autistic individuals (Berger, Aerts, van Spaendonck, Cools & Teunisse, 2003; Berger, et al., 1993; South, Ozonoff & McMahon, 2007). The two major executive functions that are impaired in children with autism are planning and cognitive flexibility (Hill, 2004).

Planning requires one to carry out a preconceived sequence of actions and to modify this sequence according to changes in the situation. Aside from observing everyday activities that require planning, there are standardized neuropsychological assessments that evaluate planning abilities. These tests include the Tower of Hanoi (Welsh, Pennington, Ozonoff, Rouse & McCabe, 1990) or Tower of London (Shallice, 1988) and require the child to move a prearranged set of disks from one peg to another in as few moves as possible and following specific rules. Individuals with autism perform poorly on these planning tests as compared to normal controls, individuals with dyslexia, ADHD and Tourette syndrome (Ozonoff, 1991, 1995; Ozonoff, Strayer, McMahon & Filloux, 1994).

Cognitive flexibility is the second executive function that is impaired in individuals with autism. Cognitive flexibility is the ability to hold multiple representations of the same object in mind and mentally focus on individual representations according to the situation at hand (Jacques, 2001). Cognitive flexibility can be assessed using the Wisconsin Card Sorting Test (Berg, 1948). This test requires the child to sort stimulus cards based on dimensions of color, shape and number. The child must infer the sorting criteria by using the feedback received from the examiner. The child must be adaptive and flexible in changing his or her sorting strategy when the sorting criteria changes without explicit notice. Individuals with autism, both children and adults, perform poorly on this test as compared to normal controls. Individuals with autism adapt less quickly to changes in sorting criteria and make a greater number of errors (Ozonoff, et al., 1991; Prior & Hoffman, 1990; Rumsey, 1985).

The following studies represent the few studies that adequately demonstrate the three strategies used to translate the VR-CR approach applicable to practice within the field of autism rehabilitation.

Strategy 1: Modifying existing VR-CR applications

Planning

Two recent studies have used the VR-CR approach to address impairments in planning skills in individuals with brain damage or stroke. The VR-CR applications from these studies can be used, with modifications, as VR-CR applications to target planning deficits in autism.

Fidopiastis and colleagues (2006) created a virtual kitchen for a male-patient, aged 48, with frontal lobe damage from an aneurysm and subsequent planning deficits. The patient received instruction and reinforcement for carrying out the correct sequence of steps for making cereal in the virtual kitchen. Significant improvements were found in the speed and accuracy with which the patient was able to locate the desired objects (i.e. cereal, bowl, spoon, milk) and the order with which he performed the action sequence (Fidopiastis et al., 2006). This preliminary case study suggests that planning behaviors can be improved using virtual environments.

Lam (2006) also focused on the ability to plan and execute goal-directed behaviors. Fifty-eight individuals with stroke-related cognitive impairments were taught to use the Mass Rapid Transit (MRT, the subway system in Hong Kong) over 10 sessions in a virtual MRT environment. Overall, the group showed improvements in both their actual MRT skills in the real context, as well as their feelings of self-efficacy of using the MRT (Lam, et al., 2006).

Verification of cognitive changes using neuropsychological assessments as well as generalization tasks should be incorporated into future studies of this type. Overall, these two preliminary studies demonstrate the potential impact that VR-CR applications can have on remediating cognitive planning skills. Future studies focused on children with autism can build on these VR-CR applications by incorporating more child-relevant tasks. For example, children with autism can be taught to perform activities in the virtual kitchen such as setting the table or putting the dishes away. In addition, modifications to the MRT program could be made in order to allow children to practice the planning skills required to use public transit, such as lining up, paying the fare, making a transfer and getting off at the correct stop. Mastering these skills may reduce the burden on parents concerned about their child's safety in such situations. In accordance with the principles of generalization discussed earlier, VR-CR programs should incorporate multiple opportunities to practice planning skills in a variety of virtual environments.

Strategy 2: Transforming non-VR cognitive activities into VR-CR Applications

Cognitive Flexibility

An alternative approach to modifying a VR-CR application is to transform existing non-VR cognitive programs into interactive virtual ones. Pugnetti and colleagues (1995; 1998) did this by creating a virtual-based Wisconsin Card Sort Task. The VR-WCST was created as an ecologically-valid assessment of cognitive flexibility in which the user had to navigate through a virtual building and go through different doors that varied according to their shape, size, color and number of portholes. The users had to choose the correct doorways according to the feedback received from the virtual environment. Similar to the original WCST (Berg, 1948) the user was forced to modify his or her strategies based on the feedback provided (Pugnetti, et al., 1998; Pugnetti, et al., 1995). The next step of this VR-CR application development process is to evaluate the VR-WCST as a cognitive flexibility training tool. Children with autism would be able to learn and practice cognitive flexibility in a realistic and relevant situation. The VR-WCST can also be used as a prototype in designing other similar cognitive flexibility activities, such as decorating a cake. In this hypothetical activity the child would decorate a cake with particular colored sparkles and candy based on the feedback received. Having the child practice their cognitive flexibility in multiple virtual scenarios would increase the likelihood of that child becoming more flexible in natural, everyday situations.

Strategy 3: Creating novel VR-CR applications for children with autism

Imagination

This section presents the only study that effectively and comprehensively uses the VR-CR approach with children with autism. Herrera and colleagues (2008) designed a VR-CR application called "I am going to act as if..." to teach two children with autism, ages eight and 15, the concept of abstract or imaginative thinking. Their VR-CR application simulated a virtual supermarket and was presented using state-of-the-art touch-screen technology. The children were instructed to interact with common grocery items in progressively more abstract ways. First, in a functional or useful way, next in a symbolic or pretend way and finally, in a magical or imaginative way. During each stage, the children witnessed the transformation of the item from its original form to its magical form. After 28 sessions of 20-30 minutes each, over two and a half months, both children showed significant improvements on standardized measures of symbolic play (Test of Pretend Play, structured and unstructured; Lewis and Boucher, 1997), as well as on non-standardized tests of imagination understanding and magic understanding (Herrera, et al., 2008).

This study successfully incorporates the essential components of the VR-CR approach – targeting a cognitive construct and integrating principles of effective practice. The VR-CR application itself was designed specifically to target the cognitive ability of abstract thought. Abstract thought, pertaining to the use of concrete objects, was broken into hierarchical components – functional use, functional play, imaginary play and finally creative use. The instructor worked with each child on each stage progressively using a structured, systematic teaching approach. The visual effects of the VR technology allowed the children to witness and participate in the imaginary and magical transformations of objects, such as a pair of pants transforming into a highway. Being immersed in these transformations facilitated the children's understanding of the concept of abstract thought. Moreover, the instructor was constantly present to monitor the child's progress and provide extra verbal or physical support. Lastly, video modeling was incorporated within the VR-CR application as well. Future studies in the VR-CR field would benefit from using this study as a model when designing VR-CR applications for children with autism.

Cognitive Flexibility

At the University of Toronto, we have designed a VR-CR application for children with autism that targets cognitive flexibility in the realm of object processing. Objects are multi-dimensional, and thus, contextual information is necessary to determine which dimension is relevant in a particular situation (Bar, 2004). In fact, every object is represented in the brain in multiple forms. Each form emphasizes a particular dimension of the object (i.e. color or function). Thus, the brain must be flexible in choosing the appropriate mental representation of the object depending on the available contextual cues (Bar, 2004; Bar & Aminoff, 2003). The VR-CR application in our lab was designed to target the cognitive flexibility required to switch between different representations of the same object. The fundamental principles of effective practice with children with autism have been integrated into the design of this application. Cues and reinforcement have been integrated into the VR-CR application. The instructor is also present to guide each child through the different stages of the activity using verbal and nonverbal instructions, prompts and feedback. During the virtual activity, the child is required to draw associations between common objects and different contexts. Each target object can be matched with multiple contexts and each context may also be appropriate for multiple target objects. The purpose of the activity is to enforce flexible thinking about common objects, in terms of their relative meanings in changing contexts. The efficacy of this VR-CR application is currently being evaluated in a multiple baseline single-subject study with autistic children aged five to ten years old.

Conclusion

This paper provided an overview of the theoretical foundations of the VR-CR approach and described how this approach can be used effectively for children with autism. In addition to the cognitive impairments discussed, there are two additional major theories of cognitive impairment in children with autism – impairments in Theory of Mind (Baron-Cohen et al., 1993; 2000) and Weak Central Coherence (Frith, 1989; Happe and Frith, 2006). These cognitive impairments are unique to autism and at this time, there are no existing VR-CR applications that have been developed to address these types of deficits. Understanding the impairments themselves is a necessary first step to designing any rehabilitative program.

There is much to be gained from using a VR-CR approach. Targeting treatment at a cognitive level using effective teaching strategies may lead to significant gains in the cognitive abilities of autistic children and may facilitate changes at the behavioral level. Designing novel VR-CR applications and evaluating existing ones serve as initial steps toward remediating autism-specific cognitive impairments. Part of this design and development process requires the knowledge of how to target autism-specific cognitive impairments and how to integrate well-established principles of effective practice into the VR-CR application.

In presenting the theoretical background of the VR-CR approach and describing model studies, this paper aimed to facilitate discussion between virtual reality researchers, autism specialists, and cognitive rehabilitation experts. Collaboration between these three groups will greatly facilitate the development and effectiveness of the VR-CR approach in maximizing the cognitive abilities of children with autism. A cognitive-technological approach would complement current behavioral interventions and has the potential to increase the therapeutic impact of intervention programs for children with autism.

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A REVIEW OF THE USE OF VIRTUAL REALITY IN THE TREATMENT OF PHANTOM LIMB PAIN

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This papers reviews the development and evidence for the efficacy of virtual reality in the treatment of phantom limb pain experienced by most people following amputation of a limb. The theoretical and empirical antecedents to this development are outlined, followed by consideration of the characteristics and empirical work of three systems which have been reported in academic literature. The paper concludes with a critique of these systems and offer suggestions for future work.
Keywords: Amputation, Pain, Phantom Limb Pain, Rehabilitation and Virtual Reality

Introduction

In recent years there has been a proliferation of uses in virtual reality to treat a range of physical and mental health complaints. Virtual environments have been used to treat eating disorders and phobias, as well as alleviate various forms of pain. As part of the growth in the clinical applications of virtual systems, a small body of research has emerged in which virtual reality is advanced and empirically tested as a tool in the alleviation of phantom limb pain experienced by people post-amputation in which they feel that their amputated limb is not only still present, but is the source of a great deal of pain.

Within this paper the information presented focuses on the theoretical and empirical antecedents which have led to the advancement of virtual reality as a possible treatment for phantom limb pain. Also presented is an account of the systems which have been implemented to date along with the empirical evidence of the efficacy of these systems. The paper concludes with a critique of this work and offer suggestions for future developments.

Phantom limb pain and the mirror-box

Phantom limb pain (PLP) is one of the most distressing consequences of amputation and affects as much as 85 percent of amputees (Sherman et al., 1984). Usually, phantom sensations and phantom pain occur soon after amputation. At this time, patients feel as if the anatomical limb is still intact, and present in its usual place (Fisher, 1999). The phantom limb is often experienced with the same position and form of the limb prior to amputation (Katz & Melzack, 1990). While burning, cramping and shooting pains are characteristic of phantom pain (Katz & Melzack, 1990), phantom sensations have been described as tingly or itchy (Sherman, 1984).

While a range of pharmaceutical, surgical and psychological interventions are used to treat PLP, the success of these approaches is often limited and short-term (Katz, 1992).

One innovative treatment technique that caused considerable interest when first implemented is the mirror-box (Ramachandran & Rogers-Ramachandran, 1996). According to Ramachandran, when a limb is intact motor commands in the brain instructing a limb to move are usually damped by error feedback, such as vision and proprioception. With a phantom limb such damping is not possible and the motor output becomes amplified which may then be experienced as painful. In order to address this, Ramachandran created the mirror-box, a low-tech device made by placing a vertical mirror inside a cardboard box with the top removed. The amputee places their remaining anatomical limb in the box and views a reflection in the visual space occupied by their phantom limb. Participants are then instructed to make various movements of their anatomical limb whilst focusing on the mirror's reflection and attempting to move their phantom limb in synchrony with the reflected image. For many people this results in a compelling illusion that they have a physical limb that can be willed to move.

In the original study the majority of patients experienced some form of transferred kinesthetic sensations into the muscles and joints of their phantom limb using this equipment. Four out of five patients who experienced involuntary clenching spasms in their phantom hand experienced relief through use of the mirror-box. Subsequently, the mirror-box has been used with lower-limb amputees with similar success. Viewing a reflection of an anatomical limb in the phenomenal space of a phantom limb resulted in amputees reporting a significantly greater number of movements of their phantom limb than with attempted movement alone (Brodie et al., 2003). MacLachlan et al. (2004) have also presented a case study in which the mirror-box reduced PLP in a lower-limb amputee.

While this work indicates that the mirror-box may be an effective treatment for painful and paralyzed phantom limb experience, there are no controlled studies which have explored the number and lengths of mirror-box sessions necessary to effect change,

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how long such change lasts for, which types of amputation and phantom limb phenomenology respond best, which psychological variables predict who will respond best to such therapy and any potential negative responses to mirror-box therapy. However, there is a general consensus in the research community that mirror-box therapy does work in many cases (Phillips, 2000; Ramachandran, 2005; Rosen & Lundborg, 2005; Sathian et al., 2000; Stevens & Phillips, 2003).

Despite the apparent promise of the mirror-box, the treatment presents a number of inherent limitations in treating PLP (Murray et al., 2005). The illusion is tentative, relying on the patient to maintain attentional focus on the reflected image as opposed to the moving anatomical limb. The mirror-box operates within a narrow spatial dimension, requiring the patient to remain in a restricted, fixed position. In addition, the possible movements that can be induced in the phantom limb are often constrained by the need for patients to imagine themselves carrying out two-handed tasks that are concordant with synchronous mirror-image movement—conducting with both hands, for example. Mirror-box work sometimes uses two-handed tasks, or bimanual movements, so that the patient can focus on both limbs (intact and reflected). With single handed-tasks, it becomes more difficult for the patient to ignore the visual information coming from their intact limb.

Research and theory on the mirror-box suggest that other visual therapies that work in similar ways, but which surmount the inherent problems of mirror-based therapy, may also relieve phantom limb pain as well as increasing volitional movement in phantom limbs. This realization has led to three research groups developing similar, but qualitatively different, virtual systems where the intention is to treat phantom limb pain. VR advocates point out VR treat-ments would surpass benefits offered by simpler mirror-box therapy in areas such as the flexibility of the technology to manipulate and present representations of the body, including the phantom limb. This paper will present the development and exploratory findings of three virtual reality systems for the treatment of phantom limb pain, namely, an Immersive Virtual Reality system by Murray and colleagues (Murray et al., 2005; 2006a-c; 2007), a Virtual Agency system by Cole and Colleagues (Cole et al., 2009), and an Augmented Virtual Reality system by the Dublin Psychoprosthetics Group (Desmond et al., 2006; O'Neill et al., 2003).

Immersive Virtual Reality: Murray and Colleagues

Murray and colleagues' system is informed by the principles of mirror-box work in a similar way to that of the Dublin Psychoprothetics Group. The crucial difference to both Cole and Dublin's systems, however, is the immersion of participants within the virtual environment, rather than looking at a screen, so that they feel present and embodied within the virtual scene. A head-mounted display (HMD) is used to present the computer-generated environments to participants and to facilitate immersion. In order to monitor and represent participants' anatomical movements, a data glove and sensors are used for those with upper-limb amputations, while sensors are used for lower-limb amputees. Sensors are attached to the shoulder, elbow and wrist joints or the thigh, knee and ankle joints for upper and lower-limb amputees respectively. A Polhemus Fastrak monitors head movements and arm/leg movements.

This system provides a visual representation of the whole body, as it would be seen from an embodied point of view, and uses algorithms in the software to transpose the movements made by the intact anatomical limb into movements of a virtual limb in the phenomenal space occupied by the phantom limb. Transferring a movement from one limb to another is possible due to the joint angles parameterization. For example, once the joint angles are recovered from the right-arm through inverse kinematics, applying these joint angles to the left-arm results in mirroring of the movement. This method of transferal, as well as other implemented software, generates responsive, fluent, real-time motion, allowing virtual limbs to move in synchrony with anatomical limbs.

The use of immersive virtual reality (IVR) overcomes some of the drawbacks of the mirror-box, allowing the patient to perform tasks without having to remain visually and spatially fixed with a relatively narrow dimension. Furthermore, the use of IVR allows unrestricted movement within the virtual environment (VE). The participant could, if they wished, turn 360 degrees. These actions would not compromise the illusion afforded by the system (i.e. the transposition of movements made by an anatomical limb into movements by a virtual limb in the phenomenal space of the phantom limb, as it would in a mirror-box). The tasks that can be implemented in IVR can therefore be more complex and involve a wider range of anatomical movements than is possible with the mirror-box. A further advantage is the ability of an IVR system to implement single-handed tasks, and the potential to implement tasks similar to those used in normal physical rehabilitation contexts.

A minimal virtual environment (VE) represents the participant within a room, from an embodied point-of-view. Participants are provided with a number of tasks in this virtual environment in order to provide opportunities for hand-eye and foot-eye coordination of their virtual limb. These tasks are similar to the physical therapy and functional rehabilitation exercises previously used in desk-top implementations of VEs (Popescu et al., 2000) and are described below.

Empirical Work with the Immersive Virtual Reality System

The empirical work using Murray and colleagues' IVR system has largely been exploratory, involving a small group of participants and examining qualitatively their phenomenological experience during and following use of the system (Murray et al. 2006c; 2007). Participants were recruited through clinical services on the basis of meeting criteria such as presence of phantom limb and lack of any major visual or cognitive deficits. For upper-limb recruitment, only those with left-arm amputations could be included because the equipment, a right-handed glove, was suitable only for those with a remaining anatomical right arm. Participants with either left or right lower-limb amputations could be recruited. Participants must have had the amputation performed more than 12 months earlier to ensure the phantom pain experience was chronic in nature.

Eight participants were initially recruited for the study and three withdrew from the study after three sessions. One participant was advised by his physiotherapist to withdraw from participation because of weakness in the anatomical limb used to animate the virtual limb. The remaining two participants withdrew due to difficulties arising in transportation to and from the research site. Their ages ranged from 56-65 years old and their length of time since amputation from one to nearly 13 years. All participants had undergone previous varied and extensive treatments for their phantom limb pain. In the case of one (PK), this included the implantation of a deep brain stimulator which had subsequently malfunctioned. Interestingly, three out of five amputees had also been treated using the mirror-box with no success.

Participants used the system on a near-weekly basis, although the precise intervals between sessions were determined by participant availability and reliability in keeping appointments. However, all participants used the system at least seven times, with a maximum of 10 sessions. At each session, participants used the IVR system for a period of 30 minutes and completed four tasks in repetition – placing the virtual representation of the phantom limb onto colored tiles which light up in sequence, batting or kicking a virtual ball, tracking the motion of a moving virtual stimulus and directing a virtual stimulus toward a target.

The small sample size of participants precluded a meaningful, quantitative analysis and the authors also emphasize a qualitative understanding of patients' phantom limb experience and of their own experience using the IVR system. Murray and colleagues' broad approach is a phenomenological one with the aim of understanding patients' own embodied experiences (Murray, 2004). Semi-structured interviews were carried out at each session, lasting about 15 minutes each, and participants were encouraged to mention any part of the experience during use of the system. Alongside this qualitative data, pain diaries were also completed daily throughout the course of the intervention to allow a contextualized analysis of participant's phantom pain experience.

BH is a 56-year-old male with an amputation of the left arm below the elbow. He reported that his phantom pain, in the form of severe cramping in the phantom hand, "doesn't bother me regularly," but had been persistent since the time of the operation nearly 40 years earlier. In the last three weeks of involvement, BH reported no experience of PLP. Previous reports and diaries had shown at least two episodes per week. Although BH could not conclusively attribute this improvement to use of the system he did comment, "I'm not doing anything different from what I've always done… and I've not had the cramp since."

DT, a 65-year-old female, had an amputation performed on the left arm below the elbow one year and three months before taking part in the study. She had no volitional control over her phantom arm and her phantom pain was localized to the phantom hand. She reported vivid sensations of phantom limb movement during the tasks and following the first session, reported that her index phantom finger had been somewhat freed. After the fourth session the phantom pain was reported to have eased overall. She said, "The pain has gone down a bit and the [pain] flashes have gone down a bit… so it's been quite good for the last few days."

One negative aspect associated with DT's participation was that she usually experienced slightly more intense phantom pain for a period immediately after sessions. Despite this fact, by the final session both the phantom thumb and index finger had been released and DT reported having some voluntary control over these digits. DT surmised that this had a positive effect on the phantom pain in general and said, "I think the fact that it's brought my fingers out – at least some of them out – has helped the pain considerably. It feels more comfortable."

PK is a 63-year-old male who had an amputation on the left arm above the elbow performed 12 years and 10 months previous to the study. He experienced severe phantom pain "twenty-four seven," and described it as a "burning, cutting pain – like someone cutting me with a hot knife." He also had a vivid sensation of a strap around his wrist being "pulled really tight" and his hand was paralyzed in a cup position with constant pain in the fingers. PK had little to no volitional control over movement in his phantom limb and could only swing it side to side with movement of the stump.

PK reported vivid sensations of a transferral of kinesthetic sensations into his phantom limb while using the equipment which "allowed me to forget that my [phantom] arm was actually in a fixed position." He also said, "It took away a lot of my phantom pain." For the first few sessions PK, like DT, reported increased levels of phantom pain after sessions. However, PK attributed this to the pain returning after a lull which increased subjective experience of the pain. He said, “Having had nothing [during sessions] and then having the pain, it feels stronger.”

Following four weeks of using the system, PK was very surprised to report his phantom limb moving of its own accord for a period of one hour at home. During this time, he was “virtually pain free.” Towards the end of his involvement PK reported, with some surprise, a number of changes in the phenomenal experience of his phantom limb which improved his phantom pain. The strap around his wrist had loosened and he said, “Before, the strap was so tight that my fingers felt swollen up and really, really painful. Now that strap seems to be not as tight, it feels as if I’ve got circulation.” He could make very small volitional movements of his phantom fingers and had some control over the orientation of his wrist. Finally, he reported the experience of telescoping in his phantom arm which had a beneficial effect on the pain: “My limb actually seems shorter… I don’t know why, it just seems to be shrinking.”

SM, a 61-year-old female with her right leg amputated above the knee, had her procedure performed 11 years and eight months previously. She experienced violent phantom pains on a regular basis which often left her, “passed the screaming stage… you end up crying.” She reported a lowering of PLP during the IVR sessions and said, “It kind of diverts the mind away from the pain.” She also experienced a transferal of sensations into her phantom leg throughout the tasks. She said, “I was moving the limb itself and trying to get into the position you would actually use it – you know, to kick the ball.” She also enjoyed the experience of using the system and said, “The right leg was trying to do it for me. I think it’s a good exercise.” However, her levels of PLP increased following sessions for a period of up to 48 hours, which she attributed to the “stimulation of phantom nerves.” Although SM enjoyed using the system and “exercising” her leg, in general her levels of PLP did not seem to alter much throughout the period of the study.

WW, a 60-year-old male with an amputation of the right leg below the knee performed 12 years and three months previously, experienced intense pain in the sole of his phantom foot on a regular basis describing it, “as if someone’s ramming a knife in.” He also reported experiencing many different kinds of pain in the phantom foot which he could attribute to previous pain experience in the right foot before amputation including a broken ankle, a burn to the top of the foot and even the memory of his toes being tightly squeezed when he was a child due to small shoes, amongst others.

During the second session his anatomical left leg collided with his stationary prosthetic leg which he commented was an “uneasy sensation… it looks on the thing [HMD] like it’s not in the way but then you bang into it and it feels queer.” WW also mentioned his phantom pain increased as a result, which is consistent with research which suggests sensory-motor incongruence as a possible source for painful sensations (McCabe et al., 2005). WW chose to remove his prosthesis during subsequent sessions to avoid this problem which helped him engage more.

During sessions WW reported vivid sensations of movement in his phantom leg and said, “It’s a queer sensation…I’m doing the games with my right leg” and expressed pleasure at feeling as though he was “achieving” something with his phantom limb. After three sessions, WW used his experience of the IVR system to begin self-hypnosis, a technique which he had used previously to aid in control of pain. He would be “imagining myself on this machine and it seems to help a bit that I can look down and see my leg.” It seemed the virtual representation of the body helped WW to focus his concentration. He began self-hypnosis sessions three times a day using this technique, a factor that may confound the findings of this research.

WW reported that as a result of his use of the IVR system “the burning pain is abating a little bit. So it’s improved a little bit.” When reflecting on the experience at his final session, WW referred to an easing in the various different types of pain he experienced and said, “It seems to have taken the edge off them. You know, they’re not as severe.” However, WW’s pain did appear to be the most inconsistent of all participants since he did not suffer with just one type of phantom limb pain. In his case, the pain would come and go at random intervals, making it difficult for him to comment on his pain over any extended period of time because it fluctuated greatly.

Although there is a need to be cautious in drawing conclusions regarding efficacy in case study reports where verbal reports are relied upon (see general discussion later), analysis of the qualitative data does provide opportunities for tentative conclusions to be proposed. All participants made some reference to a transferral of sensations into their phantom limbs during testing. This is a particularly interesting finding when we consider that three participants had paralyzed phantom limbs which could not be moved voluntarily. It may be, in fact, that this treatment would be most beneficial for those with paralyzed phantom limbs as some phantom pain can be directly attributed to the inability to move paralyzed phantoms into comfortable positions.

The reporting of sensations of movement in phantom limbs appeared to be more vivid for upper-limb amputees. This finding could reflect the greater degree of movement afforded by the virtual hand and fingers as opposed to the virtual foot. Feet are less dexterous than hands and this is a situation that is difficult to avoid in virtual reality systems. However, it would be possible to develop specific tasks using virtual lower limbs to encourage the user to manipulate the foot in a more detailed way. For example, tasks could be made more difficult to force participants to use their feet in more dexterous ways. It would also be interesting to use a virtual representation of a foot, as opposed to a shoe, which may make the lower virtual limbs more analogous to the upper virtual limbs and reduce any discrepancy between the experiences of lower-limb and upper-limb amputees when using the system.

DT, the most recent member of a sample to have undergone an amputation, 15 months previously, reported the most drastic change in phenomenological experience of her phantom limb. After the first session, changes in the once-paralyzed phantom limb began to help relieve aspects of her phantom pain experience, as recorded in qualitative reports. A speculative hypothesis could explain this in terms of a greater plasticity in the brain for more recent amputees as it has had less time to redefine the internal model of the body and to cortically reorganize, which is strongly correlated with phantom limb pain. As such, it is possible that this system may be more beneficial for recent amputees. However, PK also reported significant experiential changes in his experience of his phantom limb after over 12 years of paralysis so this could suggest that the system is capable of aiding improvements in those with longer term PLP also.

Three participants experienced an increase in the level of phantom pain which followed sessions. As PK pointed out, it may be that the easing of pain during sessions, that almost all participants commented on, means any subsequent pain feels more severe. All pain experiences are relative and subjective. A constant level of pain may be easier to overcome than fluctuating levels of pain, as is the case when pain levels were lowered during use of the system. It could also be that the increased concentration required to carry out the novel tasks actually have some temporarily detrimental effect on absolute phantom pain. This is an issue that would need to be closely monitored in future research.

As mentioned above, all participants did make reference to a decrease in experienced phantom limb pain during immersion in the virtual environment. This is a positive result which should be investigated further. SM specifically used the word “distraction” when reporting this reduction, which suggests that at the least the tasks may provide a temporary escape from the phantom pain. It is important to carry out further testing, not only with a larger sample size, but with a control condition in order to assess any placebo affects of pain reduction caused by the novelty of the task. A suitable control condition for this research would be the use of the IVR system without any transposition of movement in the virtual world. For example, physical right leg movements would correspond to virtual right leg movements (Murray et al., 2005; 2006a).

A crucial factor to be addressed in future research would be the intensity of the intervention. Previous work with the mirror-box has used regular intervention sessions of up to twice daily (Ramachandran and Rogers-Ramachandran, 1996; MacLachlan et al., 2004). In the research reported here, participants came for sessions on a weekly basis which may be insufficient to facilitate change. This is understandable given the majority of participants had suffered phantom pain for over eleven years. It may be unrealistic to expect a weekly intervention for less than three months to have any dramatic effect on phantom pain. This is especially the case with this kind of intervention which is not only novel for participants to get used to but also novel in terms of how IVR has been used in rehabilitation in general.

Virtual Agency: Cole and colleagues

In contrast to Murray’s group (and the Dublin Psychoprosthetics Group to be discussed later,) in which a contra-lateral anatomical limb is used to animate a virtual limb in the phenomenological space of a phantom limb, Cole et al (2009) developed a virtual system in which the remaining portion of an amputated upper or lower limb was used to control an in-tact virtual limb representation.[1] The aim of the system is for participants to gain agency for the virtually presented limb which the authors hypothesized would reduce phantom limb pain. The proposed advantages of the system outlined by Cole and colleagues is that bilateral movements are not required and that the movement of the virtual limb is driven from movement on the same side of the participant’s body and the correct side of the brain. In contrast to capturing finger movements of the opposite hand, as with a Data glove in Murray’s (and the Dublin Psychoprosthetics Group’s) system, finger movements are pre-animated.

Empirical Work with the Virtual Agency System

In order to gain exploratory data of the system in use, Cole and colleagues used a sample of participants with unilateral upper-limb (n=7) and lower-limb (n=7) amputations, in which motion captured from their stump was translated into movements of a virtual limb within the VR environment. Measurements of pain in the phantom limb were elicited from patients before and during this exercise. At this time, they attempted to gain agency for the movement they saw and to embody the limb. Afterward, each participant was interviewed about their experiences.

The trials were run in a low-light environment to facilitate participants’ focus on the virtual display. Session times typically lasted 60 - 90 minutes, varying according to patients’ levels of fatigue. Two virtual environments were presented using a standard computer and a motion capture device. Electro-magnetic

[1]This is similar to a system developed by Kuttuva et al. (2003; 2005) who developed a virtual environment that gave persons with upper-limb amputations a virtual hand that could manipulate objects within it. This system used myokinetic activity of the residual limb for the intentional control of virtual hand motions. Users were able to manipulate virtual objects such as balls and pegs in a 3D training environment presented to them on a computer monitor, while their performance at various difficulty levels was scored. These researchers proposed the utility of the system as an assessment tool for rehabilitation engineers, and as a motivator for those with limb loss to exercise and thereby maintain their residual motor ability. However, perhaps because of these researchers’ disciplines in electrical, computer and biomedical engineering, they did not discuss in depth the potential of such work for the treatment of phantom limb pain.

sensors were attached to either the residual arm or the leg of the user so that movements of the stump were translated into movements of the virtual limb. Prior to beginning a goal-directed activity, participants performed a series of physical actions with their stump so that the gesture-based system could be calibrated. Afterward, movements of the stump were interpreted as physical expressions of a modeled gesture and determined probabilistically.

The first environment interpreted motion for a missing arm. Patients were required to grasp an apple resting upon a table. The achievement of this goal was comprised of a number of actions – namely to reach, grasp, retrieve and replace the apple. In the second environment, for participants with a lower limb amputation, the user saw a bass drum as they might view it while sitting on a chair. Here, participants were required to complete four goal-related actions – raising the leg, performing a forward, pressing action of the foot on the pedal, releasing the pedal, and returning to a rest position. The system developed to interpret the movements of physical performance was dynamically recalibrated so that it was responsive to changes in physical performance.

Participants, recruited through consultants in pain and prosthetics, were told that the project was experimental and if there was any effect on their pain it was likely to be short-term. They were also told that although a reduction in phantom limb pain was hoped for, the reverse could occur. The group with lower-limb amputations was comprised of participants between the ages of 27-72 years old, with a mean of 49 years old. The upper-limb group was made up of participants between the ages of 36-82 years old, with a mean of 56 years old. They were taking, or had taken, a variety of analgesics. Some had also tried acupuncture, hypnosis, and Cognitive Behavioral Therapy (CBT) pain management.

Of the seven participants with lower-limb amputations, Cole et al. reported that five gained a sense of agency for the virtual arm and did so usually within half an hour. Along with this sense of agency, participants described distinct perceptions. One man, with severe PLP in some of his fingers and elbow, reported a "buzzing" feeling in his first two fingers as he controlled the virtual arm to make a grasp movement. Another participant felt touch sensation when picking up the apple, so that he experienced sensations not just of movement but of exteroceptive touch also. With the merger of an experienced sense of virtual agency and sensation, pain was reduced. One participant remarked, "Now, when I move the fingers there is still pressure but there is no pain. They are not being ripped off or squashed." Another stated, "When I move and feel the arm, it does not tingle. Pain disappears into the background and merges into the movement sensation." A third participant developed such agency following the trial that her experience of her fingers being held in a painful clawed position changed to one in which they began to open and the associated pain reduced. Moreover, this pain reduction was of a larger magnitude than she had previously experienced with use of a mirror-box.

Of the seven participants with lower-limb amputations, four experienced significant reductions in pain. These experiences ranged from gaining control over the virtual leg to stronger phenomenological changes in the physical location, orientation of and touch by the phantom limb. For example, one participant commented, "I can feel the movement in the missing leg and maybe feel touch too. Once I am on the pedal I relax and feel my foot coming off it. It is second nature as though moving my full leg. The prosthesis is always a prosthesis, this is different. Here I am moving the foot. And at the moment the toes have sensation and though there is slight cramping in the toes, there is no pain" (Cole et al. 2009).

Participants related how they "forgot" about or did not realize that their pain had ebbed away during the task. One said, "Until you mentioned it, I had not realized it was gone. One minute it was there and then, concentrating on the task, I did not realize it was gone." While another said that being in the virtual environment "lightens the pain" and went on to state about the virtual limb, "I know it is not my leg and yet it feels as though it is." Once he stopped moving the pain returned "within a second or two, but equally when I move and feel it is me, the pain reduces." Another participant felt the touch of the drum pedal on his phantom foot.

Augmented Virtual Reality: The Dublin Psychoprosthetics Group

The Dublin Psychoprosthetics Group point out that there are methodological constraints inherent in the use of conventional mirrors, including the task symmetry in bimanual movement of anatomical and reflected limbs, the dependant nature of visual feedback on the movement of an intact limb and the lack of phenomenological correspondence between the intact anatomical limb and the often idiosyncratic topography of phantom limbs, namely, "irregularly shaped" phantoms (O'Neill et al., 2003). Therefore, they sought to develop a system that would enable the control of a virtual phantom by a remaining corresponding anatomical limb. Potentially, this system could be adapted so that it produced a virtual representation tailored to the phenomenological experience of a phantom limb by the person using the system.

The solution they arrived at was an Augmented Reality system for unilateral upper-limb amputees (Desmond et al., 2006; O'Neill et al., 2003). This consisted of a three-dimensional graphic representation of an arm controlled by a wireless data glove (worn on the intact arm) and presented on a flat computer screen. The data glove allows for the measurement and representation of finger flexure and the orientation of the user's hand. As movements are made by the intact hand, the information received from the glove is translated into movements of the virtual facsimile in real time. Movements of the virtual facsimile are therefore controlled by movement of the data glove and appear to the user on a screen in an analogous fashion to the reflected limb in mirror-box work. Alternatively, the system enables the remote control of these virtual movements via a computer. The system includes a facility so that either bimanual symmetrical movements can be made, or the phantom moves in the same direction of the animating anatomical limb.

Empirical Work with the Augmented Mirror Box

As with all VR work on this topic to-date, the Dublin Psychoprosthetics group have conducted exploratory empirical work to enable preliminary evaluation of the changes in phantom limb phenomenology afforded by their system (Desmond et al., 2006). Prior to having participants use the system, the authors carried out semi-structured interviews describing amputation history, prosthesis use, and phantom limb experiences. Three participants were included in the study. The first participant was a 40-year-old man who used a passive prosthesis and who had undergone right-side transhumeral amputation because of osteogenic sarcoma approximately three years before involvement in the study. The second participant was a 25-year-old man whose amputation of the right forequarter was the result of a motor vehicle accident six years previously. He also used a passive cosmetic prosthesis for social occasions only. The third participant was a 49-year-old woman who had an amputation of her right arm distal to the elbow following a motor vehicle accident, approximately 12 years previously. She mainly wore a cosmetic prosthesis but also used a myoelectric prosthesis for particular tasks.

During the experimental phase of the study participants wore a data glove on their intact arm and carried out a series of symmetric and asymmetric arm movements using both their phantom and contralateral arm. These movements required participants to hold their hands flat and simultaneously tap their index fingers, or to attempt movement of all fingers simultaneously, while they held the palm of their hand first towards a mirror and in following trials, toward a flat computer screen. The trials proceeded in an exploratory fashion, with task demands varying for each participant according to both the varying levels of volitional control participants had over their phantoms and their reactions to the visual feedback. The task demands were varied across participants to appropriately consider their individual experiences and reactions. Participants opted to wear their prostheses during the trial.

For two participants, P1 and P3, phantom limb experience was altered and intensified using either visual feedback via a standard mirror or via the augmented mirror. For P1, this effect was more pronounced during use of the standard mirror. When inconsistent feedback was presented, for example, showing the image of the phantom as stationary when the participant was trying to move his phantom fingers, this reduced phantom experience in particular fingers. In contrast, the presentation of inconsistent feedback in the standard mirror condition induced phantom pain. Although the reason for this discrepancy is unclear, the authors note that Participant 1 related how emotional stress could trigger phantom pain. The authors suggested at the end of the testing session, when the standard mirror was reintroduced, the participant might have been tired and frustrated by the task, therefore inducing pain (although he did not believe this to be the case himself.) Viewing the augmented reality phantom image facilitated greater movement of the phantom index finger for Participant 3. Although such movement had previously been impossible, the virtual arm aided independent movement of her third and fourth fingers. Movement of the fingers of their phantom hand could also be remotely generated. In contrast, prior to testing, Participant 2 was unable to produce voluntary movement in his phantom, and use of either the standard mirror or the augmented reality box had no effect on volitional control of his phantom.

In considering the unique contribution of their study, Desmond et al. (2006) highlight their observation that incongruent movement of the phantom limb, visually fed-back via the augmented reality box, may reduce the perception of discomfort and pain. They note that this observation had not previously been possible without augmented reality technology. For Participant 1, attempts to move his phantom while viewing an image of a partially frozen hand, where some but not all of the visually-presented fingers were free to move consistent with movement of the data glove, resulted in alleviation of discomfort in the seemingly frozen fingers. This finding contrasts with a later observation in the same participant that incongruent feedback provided by the conventional mirror induced phantom pain, which the authors suggested warranted additional study.

When Participant 3's virtual facsimile was controlled remotely she felt her phantom fingers move in tandem with the externally controlled phantom image. The authors argue that this finding has potential clinical utility, suggesting that exposure to visual cues may help to free painfully clenched or positioned phantoms. However, they cite as a note of caution a study by Giraux and Sirigu (2003) who observed that passively exposing individuals with brachial plexus avulsion to prerecorded arm movements could also induce painful phantom experiences.

Desmond et al. (2006) highlight that while their exploratory study focused on feedback of noncontingent phantom limb movement, their system allows for a stronger test of the hypothesis that visual feedback of a "virtual arm" increases awareness and/or controllability of a phantom limb and reduces phantom pain. This could be achieved by using limb representations that incorporate postures and structures particular to individuals' phantoms but not readily reproducible using conventional mirrors. However, the ability to present phenomenologically accurate representations of phantom limbs is a potential property of all VR systems to be discussed here. How changes in the virtual representation could be modified over time to best facilitate PLP relief is an interesting issue, but not discussed in depth by the authors.

Conclusion

The three virtual systems discussed in depth here have a number of similarities, but also significant differences, and at present it is not known if any of these is ultimately more efficacious than another. Similarly, the systems all attempt to provide the illusion of a limb which an amputee views and accepts as a powerful representation of their phantom limb, and come to experience increased volitional control and pain relief in this. While Cole's system uses participants' residual limb or stump to control the virtual limb, both Dublin's and Murray's systems transpose movements of the contralateral limb in an analogous manner to that achieved in the mirror-box. While Dublin's group uses a flat screen in place of a mirror, Murray's system is immersive – participants do not see "outside" the environment and willed movements of a physical limb are experienced as carried out by the opposite limb within the virtual environment.

The work arising from these systems is exploratory so far. The different number of participants, inclusion and exclusion criteria, frequency of use of the systems and largely qualitative evaluations of outcomes not only makes comparisons between the systems difficult, but also means that at present there is not enough data to give an unequivocal evaluation on the efficacy of such work. Controlled studies are necessary to explore the number and length of virtual sessions necessary to effect change, how long such change lasts for, which types of amputation and phantom limb phenomenology respond best and which psychological variables predict who will respond best to such therapy. Also, explorations into potential negative responses to virtual therapy are needed.

Clearly there are promising lines of research arising from these interrelated strands of research. The proponents of these systems do not advance VR as a panacea for PLP, but rather as a treatment which could have therapeutic effect for a significant proportion of patients. VR may emerge as a central technology for treating many types of disorders where the power of visual imagery can be harnessed to induce sensations that are ordinarily not possible. If such a system was developed and had proven effect on PLP, the process and cost-effectiveness of implementing such a treatment would be justified. However, further work is needed to determine if such technologies do indeed offer virtual solutions to phantom pain.

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REACTIVITY TO VIRTUAL REALITY IMMERSIONS IN A SUBCLINICAL SAMPLE OF WOMEN CONCERNED WITH THEIR WEIGHT AND SHAPE

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Although virtual reality (VR) is a promising exposure technique for people suffering from an eating disorder, it had not been used with women who show significant but subclinical concerns with their weight and shape. Twenty-seven women took part in three immersions in VR (10 concerned and 17 non-concerned). Measures of anxiety were taken before, during and after the immersions. Weight, shape and food concerns, drive for thinness and body dissatisfactions were measured immediately after the immersions. Compared to the neutral environment, the buffet and pool immersions caused a significantly higher level of anxiety and weight preoccupations among the women who were concerned than among those who weren't. The study conclude VR is effective through the continuum of eating disorders. Not only does it arouse reactions within people suffering from an eating disorder, but also among women concerned by their weight and shape.
Keywords: Virtual Reality, Weight, Shape and Food Concerns, Anxiety

Body image is a multi-dimensional construct that refers to a person's cognitive, affective, behavioral and perceptual dimensions (Farrell, Shafran & Lee, 2006). Any distortion of the body image can be defined as a dysfunction within one of these dimensions. Cash (2002) suggests two basic elements of body image – evaluation and investment. On the one hand, the evaluation element refers to the judgment a person places on their appearance. On the other hand, the investment element refers to their body schema, created in relation to beliefs or assumptions about the importance, meaning, and influence of appearance in one's life (Cash, 2002; Cash, Melnyk & Hrabosky, 2004). The body schema can be considered as the result of comparisons and integration at the cortical level of past sensory experiences with current sensation (Riva, 1998). Taken together, these comparisons and integrations often lead to great concerns regarding weight and shape, especially in women (Hoek & Van Hoeken, 2003). The greater the gap between the real weight and the ideal weight, the higher the likelihood is of developing high levels of body dissatisfaction (Cuadrado, Carbajal & Moneiras, 2000). When young girls perceive their body to be too big and therefore, deviate significantly from the model of fashionable thinness, they become more at-risk to be negatively affected by this model, develop body dissatisfactions, diet or practice unhealthy behaviors towards food (Davison, Markey & Birth, 2003).

For individuals with an eating disorder (ED), the two aspects of body image, evaluation and investment, are affected because these people frequently over-estimate their size and weight. Their body dissatisfaction is also high and constant (Thompson, 1990). Concerns among women suffering from ED are characterised by a predominance of negative thoughts regarding eating, food, fat, weight and shape (Sassaroli, Bertelli, Decoppi, Crosina, Milos & Ruggiero, 2005). Furthermore, among these women, cognitions concerning weight, shape, food, social comparison and others' perceptions are related to negative thoughts and negative emotions such as anxiety (Sassaroli, et al., 2005).

Up to this day, only a few studies have used virtual reality (VR) with ED patients (Perpiñá, Botella, Baños, Marco, Alcañiz & Quero, 1999; Perpiñá, Botella & Baños, 2003; Riva, Bacchetta, Baruffi, Rinaldi & Molinari, 1999; Riva, Bacchetta, Cesa, Conti & Molinari, 2004; Gutierrez-Maldonado, Ferrer-Garcia, Caqueo-Urizar & Letosa-Porta, 2006). Thus, available results stand exclusively on clinical samples. Studies using VR with ED patients have showed that, when added to traditional psychotherapy, in virtuo exposure helps patients to reduce body dissatisfaction, negative thoughts and attitudes towards the body and to improve one's psychopathology in general. Symptoms relating to ED were improved, shown in such variables specifically related to body image, motivation and compliance with treatment (Perpiñá, et al., 1999; Riva, et al., 1999; Riva, et al., 2004).

Although promising, such results do not allow definite conclusions in the effectiveness of the immersions in virtuo. Before concluding so, it is essential to make sure that immersions in virtuo can evoke feelings of anxiety in presence of significant stimuli (Cottraux, 2004). So far, only one group of researchers (Gutierrez-Maldonado, et al., 2006) has addressed this question and again, only people with ED were evaluated. In that study, thirty women suffering from ED were exposed to six virtual environments – a living room representing a neutral environment, a kitchen and a restaurant containing high-calorie food, a kitchen and a restaurant containing low-calorie food and a swimming pool. The results show that VR can simulate problematic situations, experienced on a daily basis,

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that are known to cause emotional reactions in people with ED. Compared to the neutral environment, virtual environments exposing participants to high-caloric food and social comparisons caused the highest levels of anxiety and depression. Those high levels of reactivity are thought to reflect a fear of weight gain as well as an over-estimation of the importance of weight and shape. Moreover, those results clearly support the idea that people with ED tend to have strong emotional reactions when placed in specific exposure situations. However, they do not determine if this reactivity is exclusive to people affected by ED or if it can also be found in other types of women since the intensity of the eating pathology can vary on the ED continuum.

The primary objective of this study is to verify in which ways virtual environments related to body image and food induce anxiety among women concerned by their weight and shape. Since the concerned women are located closer to the women suffering from ED on the ED continuum, it is expected that they will react more strongly than the women without concerns to anxiety-provoking virtual environments tailored for ED women.

The second objective of this study is to assess the short-term impact of immersions in VR on the level of general concerns regarding weight, shape and drive for thinness, as well as body dissatisfactions. Following the immersions in the buffet and swimming pool, greater concern for the drive for thinness and of body dissatisfaction should be observed among the women that are concerned already with these issues than within the ones that aren't.

Materials and methods

Participants

The participants are students and workers of Université du Québec en Outaouais (UQO). The final sample includes 27 women aged 18 and over. The sample has been distributed in two distinctive groups based on the scores obtained on the drive for thinness and body dissatisfaction scales of the Eating Disorders Inventory (EDI) – the concerned group and the non-concerned group. The latter group is comprised of a total of 17 women not concerned about their weight and shape, aged between 19 and 51 years old (mean age is 28.29; SD is 10.58), and with a BMI mean of 23.23 (SD is 2.77). The concerned group includes 10 women concerned by their weight and shape, aged between 21 and 45 years old (mean age is 30.60; SD is 9.47), and with a BMI mean of 26.97 (SD is 4.75).

Equipment and material

An easy-access virtual reality program providing various environments was used – the NeuroVR 1.5 (http://www.neurovr.org). For the purpose of this study, the following environments were used – the office (Office.osg), the swimming pool (Pool.osg) and the restaurant (Restaurant.osg). Participants were immersed in those environments with an HP wx4600 workstation (3 GHz, 3.48 GB or RAM, ASUS GeForce 8800GTX graphics card), an eMagin z 800 head mounted display with build-in 3dof motion tracker and a Gravis Destroyer Tilt Game Pad.

The office was used as a neutral environment. It contains many rooms in which the user can move without the presence of any stimuli related to concerns about weight and shape. This neutral environment allows the participant to get a minimum level of skill in perceiving, moving through and manipulating objects in VR (Riva, 1998). Participants were asked to go in every room of the office to look for flight tickets.

The pool's environment contains a beach and a swimming pool in which seven independent agents (virtual character in SPRITE format) wearing bathing suits can be found. Those agents consist of two normal weight men, four good-looking women with an average BMI and one woman with a BMI over 25. For this environment, participants were asked to virtually "put on their bathing suit, walk toward each agent and carefully look at them."

Finally, the restaurant represents an environment in which participants are facing a buffet presenting high and low-caloric meals. Participants were asked to "move toward the buffet and to take a close look at each meal and then, to formulate a choice of meal." Afterwards, they were asked to "move toward the bar and select a drink" with or without alcohol.

Assessment measures

Eating Attitudes Test-26 (EAT-26)

(Garner & Garfinkel, 1979). The EAT-26 is a standardized and self-reported 26-item scale that measures the level of concerns and the symptoms related to ED.

Eating Disorders Inventory (EDI)

(Garner, Olmsted & Polivy, 1983; Garner & Olmsted, 1984; Criquillion-Doublet, Divac, Dardennes & Guelfi, 1995). The EDI is a 64-item self-report measure divided into eight subscales, including drive for thinness and body dissatisfaction.

Beck Depression Inventory-2 (BDI-II)

(Beck, Steer, & Brown, 1994). The BDI-II is a 21-item self-report instrument that evaluates emotional, cognitive, physical and motivational symptoms associated to major depression.

State-Trait Anxiety Inventory (STAI-Y)

(Gauthier & Bouchard, 1993). The STAI-Y is a 40-item instrument used to measure anxiety-provoking emotions. It includes separate measures of state and trait anxiety. A score over 50 (more or less 10) on each scale discriminates people with anxiety disorder from people without.

One-item rating of anxiety

This measure consists of one question that was asked three times in order to evaluate the anxiety level of the participant while immersed in the virtual environment. The question asked, "On a 0 to 100 scale, what is your level of anxiety right now?"

Presence Questionnaire (PQ)

(Bouchard, 2006). This questionnaire has four questions, assessed in percentages, which allows measuring the level of presence felt in VR. It also includes another question which gives a preliminary measure of simulation sickness.

Procedure

Recruitment of the participants was made using a short description of the study sent by electronic mail to all students at UQO and visits to classrooms with mainly feminine students, such as nursing and psychology. At first, 59 women showed interest in the study and filled out the EAT-26, the EDI, the BDI-II and the STAI. Within these 59 potential participants, 29 returned the questionnaire with a pre-stamped envelope (return rate of 49.2 percent) and then participated to the VR immersions. Two of them were excluded from the study because of simulation sickness.

The EDI subscales, drive for thinness and body dissatisfaction, were used to assign participants to one of the two conditions. A cut off of five was used for drive for thinness and of 10 for body dissatisfaction. People with a score above these cut offs show a level of preoccupation that is higher than what is found in a normative sample of women without ED (Criquillion-Doublet, et al., 1995).

The experimentation consisted of three immersions of approximately three minutes each. The neutral environment was presented first for each participant, followed by the buffet and pool environments in random order. A total of 12 participants, seven non-concerned and five concerned, were exposed to the "swimming pool" as their first challenging environment while the other 15 participants, 10 non-concerned and five concerned, were first immersed in the "buffet." For the assessment measures, the one-item rating of anxiety was used before, during and after each immersion. The EAT-26, the EDI subscales body dissatisfaction and drive for thinness and the PQ were filled out after every immersion. Finally, at the end of the experiment, the weight and height were taken to calculate the participant's BMI. This measure was taken at the end of the experiment in order to avoid inducing anxiety, discomfort and self-consciousness before the immersions. The maximum length of the total experiment was 40 minutes.

Results

Differences between the groups at recruitment

Univariate analysis of variance (one-way ANOVA) were used to confirm the significant differences between the groups in regards to the level of concern related to weight and shape. Means, standard deviations and scores obtained for EAT-26 and EDI's subscales (body dissatisfaction and drive for thinness) are presented in Table 1. As expected, because of the composition of the groups, the results indicate that the participants of the concerned group present scores of BMI, general weight and food concerns, drive for thinness and body dissatisfaction significantly superior to the women of the non-concerned group. The concerned group also reported a higher level of depressive symptoms, situational and state anxiety than the second group (see Table 1).

Table 1

Group differences and partipants' means scores at recruitment

Variables	Non-concerned group/x	Concerned group/x	F	*df*	Partial η^2
BMI			6.72*	1	0.21
EAT-26	4.12 (3.69)	24.50 (12.01)	43.13***	1	0.63
Body dissatisfaction scale (EDI)	2.71 (2.87)	18.10 (6.33)	75.75***	1	0.75
Drive for thinness scale (EDI)	2.06 (2.19)	10.10 (4.61)	38.00***	1	0.60
BDI-II	5.76 (4.31)	14.00 (7.42)	13.46***	1	0.35
State anxiety	32.65 (8.54)	42.40 (9.55)	7.53**	1	0.23
Trait anxiety	32.65 (7.00)	48.90 (10.60)	19.93**	1	0.44

Note. *p < 0.05. **p < 0.01. ***p < 0.001. Standard deviation's scores are in brackets. BMI = Body Mass Index

VR immersions results

Analysis using a 2X3 repeated-measures ANOVA were used to evaluate the groups and virtual environment's influence on the following variables – anxiety, general weight and food concerns, drive for thinness, body dissatisfaction and feeling of presence. Every analysis was followed by a priori contrasts to determine if there were any significant intensity differences for these variables between the neutral (basic level) and the buffet and pool environments. These same contrasts allow establishing whether or not there are any significant differences between the mean levels evoked by both groups. In order to control for Type 1 error, the variables associated with anxiety and weight concerns were respectively grouped in two distinctive families of variables within which a Bonferroni correction was applied.

Anxiety

Means and standard deviations for each variables associated to anxiety, as evaluated by the one-item rating of anxiety, are presented in Table 2. The 2X3 repeated-measures ANOVA scores as well as the group differences are shown in Table 3.

Table 2

One-item rating of anxiety

Variables	Non-concerned group	Concerned group
Anxiety prior to immersions		
Neutral	16.12 (19.20)	26.50 (24.73)
Swimming pool	11.00 (15.66)	13.50 (17.49)
Buffet	11.29 (15.58)	20.00 (27.18)
Anxiety during immersions		
Neutral	15.88 (19.14)	16.00 (23.66)
Swimming pool	14.41 (17.93)	36.00 (29.98)
Buffet	11.47 (14.66)	28.50 (32.24)
Anxiety following immersions		
Neutral	13.18 (16.00)	14.00 (17.92)
Swimming pool	15.29 (18.07)	31.70 (34.16)
Buffet	9.71 (12.56)	21.50 (26.88)

Note. Standard deviations are in brackets.

Table 3

Groups and virtual environments' differences on anxiety

Variables	*Time effect* F value and significant level (partial η^2)			*Interaction effect* F value and significant level (partial η^2)		
	Main effect	Neutral vs. swimming pool environments	Neutral vs. buffet environments	Main effect	Neutral vs. swimming pool environments	Neutral vs. buffet environments
Anxiety prior to immersions	5.54* (.18)	9.32* (.27)	3.25	1.14	N/A	N/A
Anxiety during immersions	5.04* (.17)	8.14* (.25)	1.62	7.48** (.23)	10.93* (.30)	7.08* (.22)
Anxiety following immersions	8.37** (.25)	9.68* (.28)	0.92	4.89* (.16)	5.98	6.79

Note. *p < 0.01. **p < 0.01. N/A; Not applicable when the main effect is not significant.

Anxiety prior to immersions

Results of 2X3 repeated-measures ANOVA 2X3 point out significant differences in the levels of anxiety felt prior to the immersions. A significant difference was shown between the anxiety level evoked prior to immersion in the neutral environment and the "swimming pool" environment. In fact, anxiety level evoked prior to the neutral environment was higher than the level prior to the "swimming pool". However, no significant differences were found between anxiety prior to immersion in the neutral and "buffet" environment. This result is surprising since the order of presentation of the two challenging environments was random. A thorough analysis of the distribution of the concerned and non-concerned women, according to the order in which they were immersed in the first challenging environment, swimming pool vs. buffet, shows that a higher proportion of women in the non-concerned group were first exposed to the "buffet" environment. Yet, since the anxiety level of the women in the non-concerned group prior to exposure to the neutral environment is much lower than that of the concerned women, the greater proportion in the sequence neutral/"buffet" environments shuffles the results.

No significant interactions were found between the virtual environments and the groups regarding the participants' self-reported anxiety level. Therefore, the two groups do not significantly differ from one another concerning anxiety level prior to immersion, regardless of which type of virtual environment was used.

Anxiety during immersions

Results of the 2X3 repeated-measures ANOVA show a significant impact of the virtual environments on the participants' overall anxiety level. Whereas there are no significant differences between the mean levels of anxiety felt during the immersion in the "buffet" environment compared to the neutral environment, the mean level of anxiety evoked in the "swimming pool" environment is significantly higher than the level reported in the neutral environment. Table 2 shows this difference is dependent on the effect observed in the concerned group since a decrease in the mean score of anxiety is obtained with the non-concerned group.

The results also indicate a significant interaction between the virtual environments and the groups, as shown by the level of anxiety reported during the immersions. According to the means observed in Table 2, the concerned participants report a higher level of anxiety than the non-concerned participants in the three environments used. Significant differences in levels of anxiety were obtained between the buffet and neutral environments, as well as between the pool and neutral environments. When the concerned group is immersed in a challenging environment, the participants' anxiety level significantly increases as opposed to the neutral environment. Moreover, the anxiety level of the concerned group increases even more in the "swimming pool" immersion than in the "buffet." In contrast, the non-concerned group presents a higher level of anxiety in the neutral environment, compared to the level evoked in the "swimming pool" and "buffet" environments.

Anxiety following immersions

According to the 2X3 repeated-measures ANOVA results, there is a significant difference between the mean anxiety levels reported after the immersions. Anxiety was reported as higher after the immersion in the "swimming pool" environment than after the immersion in the neutral environment. However, no difference was found between the mean level of anxiety following the "buffet" immersion and the immersion following neutral environment. The low level of anxiety reported by the women of the non-concerned group following the "buffet" environment immersion contributes to this lack of differences.

In addition, a significant interaction is observed between the environments and the groups. Although Table 2 suggests that concerned women report more anxiety following immersions, these differences do not exceed the Boneferroni-corrected significance level.

Variables associated to weight, shape and food concerns

Means and standard deviations score are found in Table 4. The 2X3 repeated-measures ANOVA scores as well as a priori contrasts are in Table 5.

Table 4

Weight, shape and food concerns mean scores

Variables	Non-concerned group	Concerned group
EAT-26 total score		
Neutral	3.71 (2.85)	19.70 (9.42)
Swimming pool	4.65 (4.51)	25.40 (12.27)
Buffet	4.24 (3.99)	23.70 (9.56)
Drive for thinness		
Neutral	1.76 (2.08)	9.80 (5.73)
Swimming pool	1.82 (2.53)	12.10 (5.63)
Buffet	1.88 (2.29)	11.50 (5.15)
Body dissatisfaction		
Neutral	3.00 (2.76)	17.20 (6.32)
Swimming pool	3.65 (3.43)	18.00 (6.98)
Buffet	3.12 (2.80)	18.50 (8.17)

Note. Standard deviations are in brackets.

Table 5

Groups and virtual environments' differences on weight, shape and food concerns

Variables	Time effect F value and significant level (partial η^2)			Interaction effect F value and significant level (partial η^2)		
	Main effect	Neutral vs. swimming pool environments	Neutral vs. buffet environments	Main effect	Neutral vs. swimming pool environments	Neutral vs. buffet environments
EAT-26	16.59** (.40)	29.29** (.54)	17.53** (.41)	8.73** (.26)	15.04** (.38)	10.29* (.29)
Drive for thinness	4.09	N/A	N/A	3.56	N/A	N/A
Body dissatisfaction	1.57	N/A	N/A	.95	N/A	N/A

Note. *p < 0.01. **p < 0.01. N/A; Not applicable when the main effect is not significant.

General concerns

The 2X3 repeated-measures ANOVA show differences between the virtual environments on general concerns related to weight, shape and food, as evaluated by the EAT-26. More precisely, the levels of concern are higher following the "swimming pool" environment and the "buffet" environment than the neutral environment. Results show that the level of concern increases after a challenging environment is introduced and also that such an increase is greater after the immersion in the "swimming pool" environment.

A significant interaction was also found between the environments and the groups. Means observed in Table 4 show that concerned participants reported a higher general concern level than non-concerned participants. This pertained to all the environments. Significant differences were found between groups both for the neutral environment- "swimming pool" environment sequence and for the neutral environment-"buffet" environment sequence. Compared to women in the non-concerned group, concerned women became even more anxious following immersion in challenging environments and this increase was greater when they were immersed in the "swimming pool" rather than in the "buffet."

Drive for thinness and body dissatisfaction. Once the Boneferroni correction was applied, results do not exceed the more stringent statistical significance level on the participants' drive for thinness and body dissatisfaction scores. Also, there is no interaction between virtual environments and groups regarding participants' drive for thinness and the level of body dissatisfaction.

Feeling of presence

The results do not indicate any effects from the "buffet" and "pool" environments on the level of presence ($F2.50 = 3.16$, $p = .51$). In addition, there is no significant interaction between virtual environments and groups ($F2.50 = .25$, $p = .78$).

Relationship between reported anxiety level and severity of eating pathology after immersions

Bivariate correlations were conducted to determine if the reported anxiety level is related to general concerns, the drive for thinness and the body dissatisfaction levels. Following the immersion in the neutral environment, no significant relationship was found between anxiety and the general concerns ($r = .22$, $p = .28$), drive for thinness ($r = .24$, $p = .23$) and body dissatisfaction ($r = .12$, $p = .54$). However, significant relationships were found in the challenging environments. After the immersion in the “swimming pool” environment, strong correlations were found between anxiety and general concern levels ($r = .67$, $p = .001$) and between anxiety and drive for thinness levels ($r = .68$, $p = .001$). Following immersion in the “buffet” environment, anxiety was also strongly correlated to general concerns ($r = .56$, $p = .01$) and to drive for thinness ($r = .50$, $p = .01$). Finally, there is no significant relationship between anxiety after the “pool” or “buffet environments” and the level of body dissatisfaction.

Discussion

The current study targeted short-term responses of women concerned with their weight and shape while immersed in VR. Anxiety, general weight, shape and food concerns, drive for thinness and body dissatisfaction were assessed. The results are particularly interesting considering the fact that the effects of immersion in VR environments that challenge body image still need to be documented and that VR had not yet been used with people whose concerns about weight and shape are important yet subclinical. Groups of participants were formed based on the levels of drive for thinness and body dissatisfaction. Results show that, prior to VR immersions, the groups differed significantly on BMI, weight and food concerns as well as general psychopathology. These results provide additional support to what has been demonstrated in previous studies with regards to the existing link between weight concerns and negative self-image, as well as impaired psychological functioning (Stice & Shaw, 2002).

Differences in anxiety between the neutral environment and the “swimming pool” environment during and following immersions are clearly due to the fact that the group of women concerned with their weight and shape has always reported considerable levels of anxiety. Similarly, the increase in weight, shape and food concerns noticed in the “swimming pool” and the “buffet” environments seems to be mainly attributed to the concerned women group, since these women react more strongly to immersions in challenging context than women without concerns. Moreover, results are not tinged by the fact that they believe more than the non-concerned women in the realism of the virtual environment or that they feel more present in it. The results instead depend on the nature of environments (challenging or not). On a general note, a stronger feeling of presence would probably have produced a more realistic and intense experience in virtual situations and would have possibly increased the emotional response of the participants (Gregg & Tarrier, 2007).

Since concerned women reported more anxiety during the virtual immersion in challenging environments than women in the non-concerned group and since they became more weight, shape and food-preoccupied in reaction to these challenging environments, a conclusion can be drawn that food and social comparison represent discriminating environments and allows placing differing intensities of concerns on a continuum. It also seems that, with concerned women, general weight, shape and food concerns as well as the fear of weight gain, are more likely to act as anxiety-provoking elements.

The current study also shows that the “swimming pool” and “buffet” environments differ in terms of capacity to produce a significant anxious reaction during and following immersions. Thus, the presence of food does not represent as much of a challenge for concerned women than social comparison situations where they have to “expose” their bodies. In the same way, the buffet causes less anxiety for women without concerns than the neutral environment. A possible explanation is that the restaurant represents a situation most people are more frequently exposed to than a public swimming pool environment. Since the restaurant environment is experienced more frequently, it could provoke less anxiety. For the non-concerned women, the restaurant may even represent a normal, anxiety-free, enjoyable and entertaining activity. For concerned women, an avoidance dimension can be added to the habituation aspect in order to explain the results. Situations where a woman must walk in swimwear and therefore expose her body to the eyes and judgment of others are more commonly avoided than those where the person must go to a buffet. Finally, it is possible that having been able to virtually eat the food would have been a much stronger challenge and would have caused more anxiety. It would be interesting to check if the addition of such a procedure would provide a greater anxious response with concerned people and thus a response more similar to what is reported by women suffering from ED.

For women concerned about their weight and shape, the stronger reactions observed in the “swimming pool” environment could be attributed to a greater internalization of fashionable thinness ideals. Having internalized an ideal of thinness similar to women with ED, they become more at risk to be negatively affected by exposure to pictures showing this ideal (Davison, et al., 2003). The “swimming pool” environment includes almost exclusively virtual characters corresponding to the ideal of fashionable thinness and therefore becomes particularly likely to cause a strong anxious response in concerned women. In addition, as concerned women have an average BMI falling in the overweight category (Fairburn, 2008), and as their physical appearance deviates significantly more from the ideal of thinness than women in the non-concerned group (for which the average BMI is considered normal), it seems more likely for them to report a strong feeling of anxiety when exposed to people who meet the thinness standards (Cuadrado, et al., 2000).

Although VR treatment studies with clinical samples demonstrated that body dissatisfaction scores are influenced by the immersions in virtual environments associated with feared stimuli (Riva, et al., 2004), this result could not be replicated with a sample of concerned women. Indeed, the level of body dissatisfaction and the drive for thinness reported by these women was not influenced by VR immersions in a “swimming pool” and a “buffet.” It is possible that the small amount of concerned participants (n = 10) contributes in part to this lack of relationship. It could also be that the drive for thinness and body dissatisfaction refers to a relatively stable self-concept for concerned people as well as for non-concerned people. In etiological ED development models, these factors are usually conceptualized as risk factors rather than as consequences (Aimé & Bégin, 2007). Their etiological positioning makes them less likely to fluctuate easily and more likely to tend towards stability.

In order to maximize perceptible differences between concerned and non-concerned groups of women, it would be advantageous to obtain a higher number of women in each group. Another advantage would be the use of a more immersive head mounted display in order to increase the feeling of presence and reduce the perception of the physical room. Finally, the program that was used, NeuroVR, only allows for few interactions between participants and the virtual environment and a low graphic resolution may have influenced the feeling of presence.

Conclusively, the results of the current study show that VR is effective at creating affective and cognitive reactions among women without ED. Moreover, reactions to VR immersions differ depending on the intensity of each woman’s drive for thinness and body dissatisfaction. Concerned women react more to challenging VR situations than women without concerns, which justifies their positioning closer to ED on the ED continuum. Like women with ED (Gutierrez-Maldonado, et al., 2006), concerned women see their level of anxiety increase after they have been immersed in environments in which they are exposed to food and social comparison. Their anxious response is also clearly attributable to the nature of the in virtuo exposure and not to an apprehension previous to presentation of anxious stimuli. In addition, since a non-clinical sample was studied, the current results increase our understanding of the effects of VR. The results demonstrate that VR not only affects anxiety, but that it also influences cognitions pertaining to diet, weight and shape control. Finally, being exposed to a swimming pool environment with people in bathing suits was shown to be more effective in producing a cognitive and emotional response in the participants. In sum, the current study can be used as anchor for further research and shows VR immersions can provoke an anxious response among a sub-clinical sample. As a result, it may be effective in treatment of patients across the continuum of ED. Further studies using VR could include the whole ED continuum and, therefore, consider the inclusion of non-concerned women, concerned women and ED women.

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SIDE EFFECTS OF IMMERSIONS IN VIRTUAL REALITY FOR PEOPLE SUFFERING FROM ANXIETY DISORDERS

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Side effects caused by immersions in virtual reality (VR) have been documented in experimental studies and with healthy people. With the growing interest of VR applications to assess and treat mental disorders, empirical information on side effects in clinical populations is needed. Three studies were conducted to: (a) describe symptoms and scores on the Simulator Sickness Questionnaire (SSQ) in a sample of 157 adults immersed in VR to treat their phobias, (b) compare exposure treatments involving more or less actions and motions (N = 34); and (c) document the usefulness of assessing symptoms prior to the immersion in VR and following up 26 phobic patients 24 hours post-immersion. Overall, results show that most participants experienced slight side effects, symptoms were strong even before immersion in VR and there are no reasons to be generally concerned with health and safety issues within 24 hours after therapy sessions. Exposure in VR to treat fear of flying was associated with fewer side effects than for other anxiety disorders. The scores on the SSQ were much higher than in studies conducted with non-clinical samples, raising several research questions. Side effects should not be a source of worries but they must be closely monitored and systematically reported in outcome studies.
Keywords: Simulator Sickness, Cybersickness, Adverse Events, Virtual Reality, Phobias

Introduction

In the last decade, the use of virtual reality (VR) has been of great interest to clinicians and researchers because it enables patients to be placed in a standardized and replicable situation in order to elicit emotions, cognitions or behaviors. It is now used in several clinical settings (for illustrations, see Gaggioli, Keshner, Weiss & Riva, 2009; Wiederhold & Riva, 2009).

Although VR offers several advantages, issues concerning the health and safety implications of this technology remain poorly studied in clinical settings. This constitutes a frequent concern raised by research ethics boards and committees. For example, there are warnings against the use of VR within clinical populations such as people suffering from claustrophobia, substance abuse or schizophrenia (Stanney, Kennedy & Kingdon, 2002). Virtual environments have been designed for use with these populations, but testing these applications or implementing them in private practice settings means ethical questions may be raised. There is a lack of data available to address these questions. Worries sometimes associated with VR come from the induction of unwanted side effects such as nausea or eyestrain. Virtual reality-induced side effects, also commonly referred to as cybersickness (McCauley & Sharkey, 1992), may include symptoms such as discomfort, vertigo, nausea, eyestrain, headaches, dizziness, epigastric awareness, cold sweats, hot flashes, increased salivation, burping, drowsiness, vomiting, etc. (Kennedy, Lane, Berbaum & Lilienthal, 1993; Lawson, Graeber, Mead & Muth, 2002). Cobb et al. (1999) and Wilson (1997) conducted a systematic analysis of the symptoms and effects of VR immersions. The technology they used is over a decade old, therefore, some of their results may not apply to the more efficient VR systems. Yet, they found that 20 percent of their participants did not notice any side effects and five percent of their sample experienced side effects severe enough to stop the immersion. Side effects are monitored in an increasing number of studies, including anxiety (Jang et al., 2002), schizophrenia (Fornells-Ambrojo et al., 2008) and substance abuse (Girard, Turcotte, Bouchard & Girard, In press). Unfortunately, in most studies conducted with clinical populations, VR-induced side effects are not systematically reported. Only the number of participants excluded due to strong side effects, also known as adverse events in the pharmacological industry, is mentioned and the scoring procedures are unclear.

VR-induced side effects may be caused by a variety of factors (Harm, 2002; Lawson et al., 2002; Sharples, Cobb, Moody & Wilson, 2008; Viirre & Bush, 2002), including individual susceptibility to motion sickness, update lag of the computer, technologies used for the immersion, mode of interaction, weight and characteristics of the head mounted display, field of view, content of the visual display, or characteristics of the tasks performed by the user, such as significant motion.

Some measures have been published to assess VR-induced side effects. For example, some instruments specifically measure ocular symptoms (Ames, Wolffsohn & McBrien, 2005), others

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provide crude subjective estimates using only one-item self-rating (Hoffman, Garcia-Palacios, Carlin, Furness III & Botella, 2003), or measure potential diagnostic criteria for motion sickness (Miller & Graybiel, 1970). The most frequently used measurement is the final version of the Simulator Sickness Questionnaire (SSQ Kennedy et al. 1993) which measures 16 symptoms – general discomfort, fatigue, headache, eyestrain, difficulty focusing, increased salivation, sweating, nausea, difficulty concentrating, fullness of head, blurred vision, dizzy (eyes open), dizzy (eyes closed), vertigo, stomach awareness and burping. Kennedy et al. (1993) found a three-factor solution composed of nausea (nausea, burping, increased salivation), oculomotor symptoms (eyestrain, difficulty concentrating) and disorientation (dizziness, vertigo). According to Kennedy et al., (1993), the procedure to score the subscales of the SSQ required the addition of all items that load on a factor and, in order to have a standard deviation of 15, multiply that sum by a constant weight. The same procedure is performed for the total score, despite the fact that some items load on two factors, meaning some items are counted twice. The factor structure of the SSQ has been questioned (Bouchard, Robillard & Renaud, 2007) and a two-factor solution may be more appropriate with all items loading only on the nausea or oculomotor subscale.

The phenomenon of simulator sickness is not yet perfectly understood but there is already a large deal of information available on its signs, causes and potential mechanisms (Harm, 2002; Lawson et al., 2002; Sharpless et al., 2008; Welch, 2002). However, most information on simulator sickness comes from non-civilian samples such as Navy pilots (Kennedy, Lane, Lilienthal, Berbaum & Hettinger, 1992), astronauts (Reschke et al., 1994) or healthy civilians (Sharpless et al., 2008). Problematically, these individuals may be in better shape than the average population and is also important to mention the experience in a flight simulator or an experimental study is very different from the use of VR in mental health applications.

The aim of this paper is to report three studies documenting side effects associated with immersions in VR conducted to treat anxiety disorders. Data collected from a large sample of patients immediately after their first therapeutic immersion in VR is described in Study 1 to provide empirical data on the strength and distribution of SSQ scores. Due to the association between physical motion and cybersickness, a comparison was made between patients involved in therapies that require more or less significant motion in the virtual environment (Study 2). Finally, Study 3 was conducted to test the usefulness of administering the SSQ prior to immersion in VR and report symptoms measured at a follow-up 24 hours after the immersion.

Study 1

Method

The goal of this study is to document, using the SSQ, the severity of side effects reported after a therapy session with people suffering from an anxiety disorder. Participants were recruited in the general community following medical referrals and self-referral following publicity in a local daily newspaper. A structured clinical diagnostic interview (First, Spitzer, Gibbon & Williams, 1996) was performed in order to establish the diagnoses of specific phobia of spiders (n = 57), heights (n = 53), flying (n = 25) or enclosed spaces (n = 22) according to the Diagnostic and Statistical Manual of Mental Disorders (APA, 1994/2000). The exclusion criteria imposed on the recruitment were: (a) being aged less than 18 years, (b) not meeting the diagnostic criteria for a specific phobia, (c) suffering from comorbid disorders (for example depression, psychotic disorders, other anxiety disorders, etc.) requiring immediate treatment, (d) taking drugs prescribed for anxiety (for example benzodiazepines, anti-depressants), (e) having previously been immersed in a virtual environment, (f) suffering from migraine headaches and (g) considering oneself very susceptible to motion sickness. The total sample was comprised of 157 participants, with 122 females and 35 males whose age varied between 18 and 68 years old (M = 39.73; sd = 12.57).

Therapists with basic training in cognitive-behavioral therapy and the use of VR carried out the procedures and the treatment. The patients came to the clinic for therapy sessions lasting approximately 60 minutes long. The treatment consisted essentially of exposure to feared stimuli using VR and followed a standardized treatment manual. The protocol required the therapists to devote the pre-treatment session to diagnostic, selection procedures, informed consent and assessment. During the first therapy session, the patient was introduced to the treatment and became familiar with case conceptualisation, understanding the cognitive-behavior model and approach to treatment and the basics of exposure. The patient also tried the VR system for 10 minutes in a neutral virtual environment or a VR environment irrelevant to their phobia. Exposure to VR before initiating therapy was introduced in the protocol to make sure participants were familiar with key concepts, such as VR-induced side effects, before beginning use of VR to face their fears. From the second therapy session onward, the treatment consisted essentially in in virtuo exposure to feared situations (Bouchard, Côté & Richard, 2006). After the therapy session, all participants were required to remain in the clinic's waiting room for 15 minutes before leaving. This time allowed patients to fill out questionnaires and make sure no significant VR side effects were present. It is worth noting that after the 15-minute waiting period, none of the participants in the three studies reported side effects. However, no empirical data was recorded before they left to substantiate that information.

The VR systems used for immersion remained the same within the course of a patient's therapy, but changed during data collection. Although this lack of standardization limits conclusions on hardware factors and content of the virtual environment associated with potential side effects, it has the advantage of increasing the ecological validity of our results. The computers used ranged from a IBM Pentium III (866 Mhz, 128 Meg of RAM with an ATI Radeon 64 Meg graphic card) to a HP wx4600 workstation (3 GHz, 3.48 GB of RAM, with an ASUS GeForce 8800GTX 768 Meg graphics card). Three sets of head mounted displays and trackers were used over the years – a VFX3D (resolution of 640x480, FoV 35º diagonal; IISVR Systems) with build-in 3 dof tracker, an I-Glass (resolution of 640x480, FoV 26º diagonal; I-O Display Systems) coupled with an Intertrax2 tracker (3 degrees of freedom; InterSense) and a z800 (resolution of 800x600, FoV 40º diagonal; eMagin) with build-in 3dof tracker. Forward and backward motions were enabled using a Microsoft joystick or a Gyration wireless mouse. A variety of VR environments were used in order to maximize ecological validity. Some were developed using 3D game engine (Unreal Tournament 2000 ®, Max Payne ®) and other were purchased from Virtually Better (http://www.virtuallybetter.com/). All have been previously described in outcome studies (Bouchard, Côté, Robillard, St-Jacques & Renaud, 2006; Bouchard, St-Jacques, Côté, Robillard & Renaud, 2003; Bouchard, St-Jacques, Robillard, Côté & Renaud, 2003; Rothbaum et al., 1996).

Measures

The Simulator Sickness Questionnaire (SSQ; Kennedy et al., 1993).

The 16 items of the SSQ are scored on a zero, meaning none, to three, or severe, scale. Kennedy et al. (1993) proposed to score the SSQ using the following procedure: (a) for the nausea subscale, sum items 1, 6, 7, 8, 9, 15, 16 and multiply by 9.54; (b) for oculomotor subscale, sum items 1, 2, 3, 4, 5, 9, 11 and multiply by 7.58; (c) for disorientation subscale, sum items 5, 8, 10, 11, 12, 13, 14 and multiply by 13.92; (d) for the total score, sum all items used in a subscale (i.e., items 1, 5, 8, 9 and 11 are counted twice) and multiply by 3.73. Because many researchers and clinicians do not follow this scoring procedure, we also calculated the raw total score of all 16 items, meaning there was no weighting and no items counted more than once. With the proposed revised factor structure, Bouchard et al. (2007) also suggested to simplify the scoring of the SSQ by dropping the weighting procedure for the subscales. Only scores measured after the first in virtuo exposure session are reported in Study 1.

A one-item rating of cybersickness

This rating was also completed by a subset of 66 patients every five minutes during the immersions using a 0 to 100 scale using the prompt "To what extent do you feel cybersickness right now?" A similar procedure has already been used by Hoffman et al., (2003). Much like using Subjective Units of Discomfort during exposure therapy, the one-item rating allows therapists to follow the evolution of side effects during exposure while trying to be the least intrusive as possible. Participants had been educated about the symptoms and potential causes of VR-induced side effects, referred to as cybersickness. At the pre-treatment session, they received a leaflet describing the most important symptoms. Only scores measured during the first in virtuo exposure session have been collected.

Results

The descriptive data provided in Table 1 revealed that SSQ scores are high when participants are involved in an in virtuo exposure therapy session for the first time. When looking at Figure 1, it appeared that more than 80 percent of the participants reported raw scores of 10 or less. Using a subjective cut-off of reporting "slight" symptoms on each of the 16 items, 7.6 percent of our sample reported a raw score above 16. The mean for each of the 16 items ranged between .09 to .80 and the standard deviation ranged between .33 and .89, suggesting that side effects were generally rated as less than "slight" on all items. None of the participants had to stop the immersion due to side effects, even though they had been told they could if needed. An ANOVA comparing the diagnostic groups revealed significant differences among the participants ($F(3,134) = 4.27$, $p < .01$), with those being immersed in VR to treat their claustrophobia reporting a significantly higher score on the SSQ (60.81, sd = 43.47), than all other phobias (arachnophobia = 35.42, sd = 27.25; acrophobia = 33.04, sd = 29.4; aviophobia = 27.81, sd = 28.34).

The one-item self-rating provides additional insight into the severity of the side effects. On the subjective scale ranging from zero to 100, most scores were very low but a few patients reported feeling up to 95 percent cybersick. The change in self-ratings over the course of the therapy session was not significant (repeated ANOVA, $F = .48$, ns).

Table 1

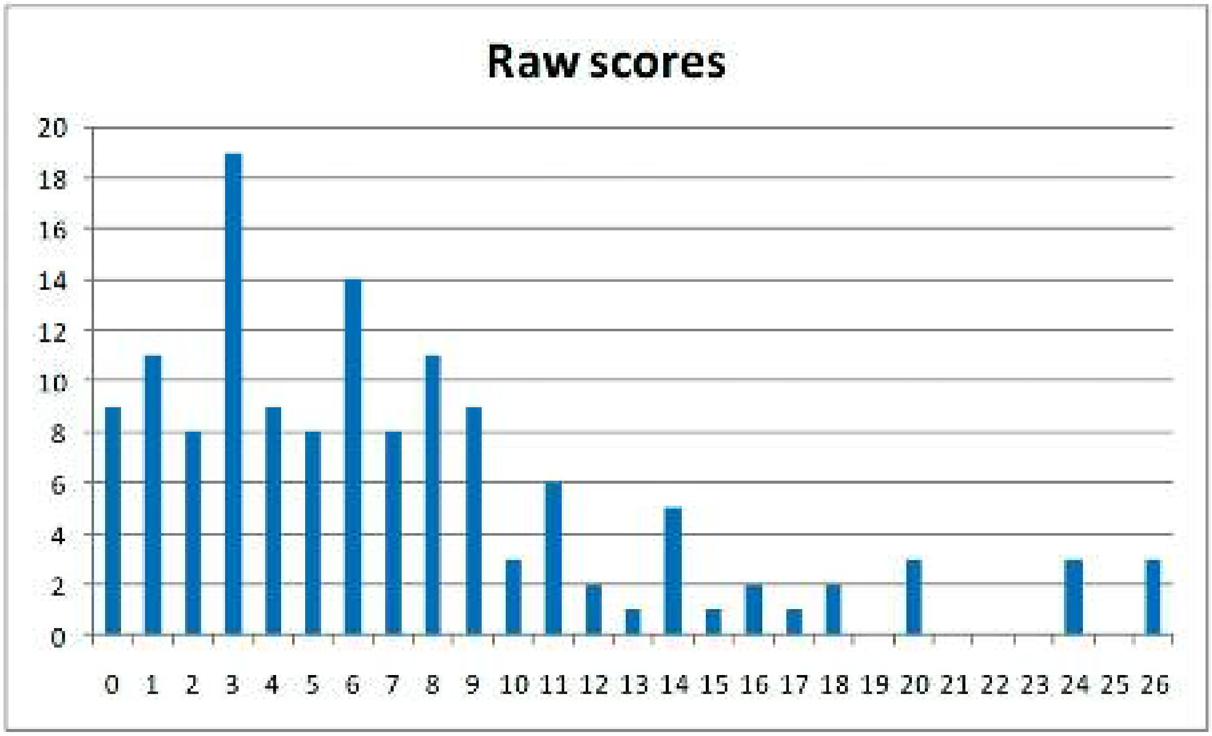
Virtual reality induced side effects in a sample of 157 phobics immersed in VR during their first exposure therapy session

	Mean	SD	Minimum	Maximum
Original SSQ Scoring				
Total score (weighted)	36.27	31.46	0	145.86
Nausea subscale (weighted)	27.47	28.51	0	133.56
Oculomotor subscale (weighted)	30.49	25.6	0	106.12
Disorientation subscale (weighted)	38.83	41.32	0	208.8
Alternative SSQ scoring				
Total score (not weighted)	7.12	6.04	0	26
Nausea subscale (not weighted)	3.51	3.69	0	20
Oculomtor subscale (not weighted)	2.86	2.58	0	11
One-item subjective self-rating (%)				
After 5 minutes	4.09	12.82	0	90
After 10 minutes	4.28	13.84	0	95
After 15 minutes	4.47	12.94	0	80
After 20 minutes	6.23	14.81	0	75
After 25 minutes	6.89	17.39	0	83
After 30 minutes	6.3	14.98	0	65
After 35 minutes	6.65	16.81	0	88
After 40 minutes	7.01	16.03	0	75

Note. SSQ = Simulator Sickness Questionnaire

Figure 1

Distribution of raw (not weighted) SSQ total scores in Study 1 (N = 157)



Study 2

Given differences observed between the diagnostic groups in Study 1, a decision was made to compare side effects experienced by participants in virtuo exposure sessions requiring either more or less physical motion. In order to maximize ecological validity of our results, an open-trial naturalistic approach was favored over a more-controlled experimental design (i.e., instead of using a homogenous sample involved in a standardized experimental manipulation). Clinical observations showed that patients involved in more active in virtuo exposure sessions, such as walking in the virtual environment, report more side effects than those involved in less active sessions, such as acting as passengers in an airplane.

The recruitment and selection procedures performed similarly to Study 1, except for diagnoses and administration of the measures (see below). Based on the diagnostic interview, the sample consists of participants treated with VR for a specific phobia of flying (n = 22), driving (n = 7), enclosed spaces (n = 1), public speaking (n = 1), height (n = 1), or for panic disorder with agoraphobia (n = 1) and post-traumatic stress disorder (n = 1). Of those 34 participants, 27 were women (mean age = 44.30, sd = 12.59) and seven were men (mean age 38.71, sd = 16.07). Since exposure therapy for a phobia of flying requires patients to move significantly less in the virtual environment than exposure for other disorders, participants were assigned to two groups – "more passive" exposure with participants receiving exposure for flying phobia (n = 22) and “more active" exposure with those receiving exposure for other anxiety disorders mentioned above (n =12).

The treatment consists of in virtuo exposure delivered over an average of nine weekly 60-minute sessions. The treatment was delivered by therapists who had received preliminary training in CBT aided by the use of VR. Like Study 1, the treatment protocol focused essentially on in virtuo exposure to feared a situation. For the more passive group, exposure entailed observing surroundings from a passenger seat and while the therapist controlled the events occurring to the patient such as taxi, take off, flying under good or bad conditions and landing. Participants in the more active group were invited to move around in the virtual environment, approach feared stimuli and turn 360 degrees to explore the virtual environment. The hardware used for this study consisted of a Pentium IV PC with a DirectX 3D Accelerator VGA graphics card, an I-Visor DH-4400VPD head mounted display (resolution of 800x600, FoV 31º diagonal; Daeyang Inc.), an Intertrax2 tracker (3 degrees of freedom; InterSense) and a Microsoft joystick.

Participants completed the Simulator Sickness Questionnaire (Kennedy et al., 1993) after every exposure session and results were averaged over the treatment program. The SSQ was scored following Kenendy et al. (1993) procedures.

Results

An ANOVA was performed to compare the SSQ scores over the course of therapy (see Table 2). Results revealed that more active exposure-based treatment in VR led to significantly more side effects, both on the total score and the nausea subscale of the SSQ.

Table 2

Virtual reality-induced side effects in patients involved in more or less active in virtuo exposure session (N = 34)

Simulator Sickness Questionnaire	More active exposure	More passive exposure	ANOVA F (1,32)
Total score	42.08 (33.91)	23.12 (17.79)	4.63*
Nausea subscale	41.34 (36.23)	18.21 (12.80)	7.43**
Oculomotor subscale	30.32 (19.92)	23.77 (18.01)	.952
Disorientation subscale	40.60 (46.53)	15.82 (32.52)	3.32

Note. Mean score, with standard deviation in brackets. * $p < .05$, ** $p < .01$

STUDY 3

Method

The goal of the third study was to follow-up on participants 24 hours after their immersion in VR to explore whether or not they were still experiencing side effects. The study was also used to test the suggestion from Kennedy et al. (1993) to administer the SSQ prior to immersion in order to take into account pre-existing symptoms.

The selection criteria were the same as Study 1, except participants suffered from a phobia of snakes. The sample consisted of 26 adults aged between 27 and 68 years old (Mean = 43.65, sd = 11.58). The participants were mostly female, making up 81.5 percent of the study.

A therapist with preliminary training in CBT using the aid of VR carried out the procedures. Following their recruitment, participants were immersed for 15 minutes in a virtual environment designed to elicit fear in sufferers of snake phobias. The VR immersions were conducted using an IBM computer (Pentium III, 866 Mhz, 128 Meg RAM), an ATI Radeon 64 Meg graphic card, an I-Glass head mounted display (resolution of 640x480, FoV 26º diagonal; I-O Display Systems), an Intertrax2 tracker (3 degrees of freedom; InterSense) and a Microsoft joystick. The virtual environment used a modified map from the 3D game Unreal Tournament®. The participants completed the Simulator Sickness Questionnaire (Kennedy et al., 1993) on three occasions – before the experiment, immediately after the immersion and 24 hours after the immersion. The SSQ was scored according to procedures outlined by Kennedy et al. (1993).

Results

A repeated-measures analysis of variance (ANOVA) was performed on the total score of the SSQ as well as the three subscales proposed by Kennedy et al. (1993). Descriptive statistics and results from the repeated measures contrasts are reported in Table 3. The SSQ scores were already high before beginning the experiment. The repeated measures ANOVA for the total score revealed a significant decrease over time [$F(2,50) = 14.09$, $p < .001$]. The repeated measures contrasts revealed the immersion in virtual reality did not cause a significant increase in symptoms' severity from pre to post-immersion (partial eta squared measure of effect size = .001) and the severity of patients' symptoms was significantly lower on the day following the experiment (partial eta squared measure of effect size = .43).

Similar findings were found for all three subscales of the SSQ: (a) nausea [$F(2,50) = 8.33$, $p < .01$]; (b) oculomotor [$F(2,50) = 11.54$, $p < .001$]; and (c) disorientation [$F(2,50) = 5.95$, $p < .01$]. Pre-experiment scores on the SSQ subscales suggested the presence of symptoms although no immersion had been performed. The immersion in VR did not have any significant impact on the nausea and oculomotor subscales, with non-significant decreases in symptoms associated with extremely small effect sizes (.001 and .02, respectively). For the disorientation subscale, a non-significant increase in symptoms of a medium-effect size (partial eta squared measure of effect size = .08) was found. For all three subscales, a significant reduction in symptoms in the 24 hours following the immersion (see Table 3) was observed. Even though symptoms were much lower on the day post-immersion than before the experiment, there were close to none only on the disorientation subscale.

Table 3

The evolution of virtual reality induced side effects in phobics from pre-immersion to post-immersion and 24 hours later (N = 26)

				Repeated measures contrasts	Repeated measures contrasts
Simulator Sickness Questionnaire	Pre immersion	Post immersion	24 hours follow-up	Pre vs Post F (1,25)	Post vs follow-up F (1,25)
Total score	11.36 (10.44)	11.8 (12.23)	.86 (2.66)	.04	18.9***
Nausea subscale	8.81 (10.77)	8.43 (11.86)	.37 (1.87)	.02	11.25**
Oculomotor subscale	13.12 (13.99)	11.37 (13.09)	1.46 (4.3)	.59	13.63***
Disorientation subscale	5.35 (11.19)	10.71 (17.3)	0.00 (0.0)	2.28	9.96**

Note. Mean score, with standard deviation in brackets. * $p < .05$, ** $p < .01$, *** $p < .001$

Discussion

In this paper, data was presented on the SSQ as a measure of side effects experienced by anxiety disorder sufferers exposed to their fears in virtual reality. Side effects of VR, also referred to as cybersickness, are symptoms not purposefully induced by the treatment. Hence, signs of anxiety and panic experienced by patients during in virtuo exposure should not be considered side effects, as opposed to headache, blurred vision or dizziness. The deliberate focus on clinical applications and populations influenced methodological decisions and led the authors to favor ecological validity over internal validity and standardization. It is hoped that these findings will encourage experimental scientists to conduct more robust investigations, help clinical researchers answer questions raised by research ethics boards and guide clinicians in their application of in virtuo exposure.

The side effects reported by the clinical sample in Study 1 suggest that most participants experienced side effects yet the severity of the symptoms remained generally low. This is consistent with previous reports that minor VR-induced side effects occur in most people (Cobb et al., 1999; Lamson et al., 2002). Yet, some participants scored very high on the SSQ, showing that it is important for therapists to monitor side effects during in virtuo exposure for phobias. It is also important to note that SSQ scores in our sample were much higher than those reported by Kennedy et al. (1993) with their normative sample of Navy and Marine corps involved in flight simulations. Based on 1099 participants, Kennedy et al. (1993) proposed an average total (weighted) score of 9.8 (sd = 15), with scores above 30 fitting in the 90th percentile. Their maximum score was 108.6. Our average total score was 36, meaning the symptoms in our sample occupied, in general, the 90th percentile. In addition, our maximum scores strongly exceeded those in the normative sample provided by Kennedy et al. (1993). The procedure proposed by Kennedy et al. (1993) requires counting some symptoms twice, which may have contributed to a higher total score. For example, a patient reporting only slight general discomfort (item 1) would obtain a total score of 7.48, placing them in the 60th percentile. Looking at raw scores provided a clearer picture and revealed that symptoms were varied and generally mild. High total scores appear to originate from many symptoms receiving a rating of slightly present. It is worth noting that participants in Kennedy et al.'s (1993) normative sample consist only of healthy people since people who were not considered in their usual state of fitness prior to the immersion were excluded. In addition, their participants had already been through simulator training and may not be representative of the middle-aged civilian population generally consulting for anxiety disorders. Yet, based on the profile of SSQ scores amalgamated over 29 studies (Stanney et al., 2002), our results still fit among the 95th percentile. According to Stanney et al. (2002), such high scores should be associated with significant drop-out from immersions, which was not the case in our three studies. Since people suffering from anxiety disorders, including claustrophobia, may be more susceptible to motion sickness (Faugloire, Bonnet, Riley, Bardy & Stoffregen, 2007), higher SSQ scores may be specific to the population studied here. This is partially corroborated by Robillard, Bouchard, Fournier and Renaud's (2003) study comparing reactions of people with phobias and those without phobias being immersed in the same VR environments. Given the small sample size of 13 participants per group, the differences they reported on the total score and the nausea subscale of the SSQ did not reach statistical significance. However, the effect sizes were in the medium range and the differences would have been significant with a sample of 90 participants. The results of the three studies call for a controlled comparative study of anxious and non-anxious people immersed in VR, and probably even a comparison between the different anxiety disorders.

Results of the one-item self-rating scale support the contention that symptoms are low for most, but not all, participants. The intensity of cybersickness was rated by participants as four to seven percent when measured during the immersion, yet a few people rated their symptoms as high as 90 percent. Symptoms also remained stable during the exposure session. Testing is needed to explore whether side effects change over longer and repeated immersions (Kennedy, Stanney & Dunlap, 2000; North, North & Coble, 1996). Another important factor that must be studied more thoroughly is the potential overlap between symptoms induced by exposure and those caused by the immersion in virtual reality. When patients are exposed to feared stimuli, it is expected that they will feel anxious. Exposure causes patients to sweat and may lead to general discomfort, difficulty concentrating, fatigue, blurred vision and other symptoms. These symptoms, and even those of the apprehension that builds up before the exposure session, may be confused with cybersickness. Further research should be conducted on this potential overlap to delineate which symptoms are caused by exposure and which symptoms are side effects of the immersion.

The significant difference between the patients treated for claustrophobia and the other phobias deserves attention. It is known that various factors such as computer lag and moving visual fields contribute to simulator sickness (Lawson et al., 2002). Since the virtual environment used with some phobia sufferers required them to walk and explore the virtual environments significantly more than others, we decided to compare the side effects of in virtuo exposure for patients whose therapy involved a much smaller range of motion than others. The results of Study 2 show that people suffering from flight phobia reported less symptoms than those suffering from other anxiety disorders. Consistent with the hypothesis of activity and range of motion involved during the exposure session, the difference was specific to the nausea subscale. Given the lack of random assignment, measures of actual physical motion and homogeneity in the virtual stimuli, we cannot conclude that our finding is specific to the amount and type (e.g., rotations, forward motion) of movement performed during the therapy. While the medical and psychological communities are waiting for such studies to be conducted, found results support the clinical impressions that more active in virtuo exposure sessions are associated with more cybersickness than what is found when treating people for flying phobia.

Measuring symptoms of VR-induced side effects prior to and long after the immersion led to very interesting observations. First, the high SSQ scores found in Study 1 and 2 may be inflated by the physical and emotional state of the participants before the immersion. The symptoms in Study 3 were already quite strong and the immersion did not cause any significant increase in SSQ scores. Previous studies have already reported the existence of symptoms prior to immersions (Fornells-Ambrojo et al., 2008; Kennedy et al., 1993; Sharples et al., 2008), but not with people undergoing in virtuo exposure. Also, symptoms reported in Study 3 prior to and after the immersion were lower than in Study 1 and 2. Second, the low SSQ scores reported 24 hours after the immersion support the clinical impressions that, if in virtuo exposure caused side effects, they do not last long after the immersion. In addition, the lower scores during the follow-up sessions suggest that symptoms reported prior to the experiment may be more related to situational factors, such as anxious apprehension, than chronic conditions like poor health. Our findings are important for researchers because they highlight the need to systematically administer the SSQ prior to immersion to provide control for the state of the patient. They also suggest that the high SSQ scores reported in Study 1 and 2 should be interpreted with caution as they may be inflated by pre-immersion discomfort, apprehension and health status. Finally, the findings provide reassuring information for clinicians, showing that side effects do not last as long as 24 hours. To offer a more complete picture on the lasting effects of side effects, the assessment of change in symptoms should be conducted at shorter time intervals, such as every 10 minutes during a few hours, and with a more fine-grain analysis of symptoms.

As clinicians are venturing further into the field of VR, side effects should not be a worry but it is important to monitor them regularly. Researchers, however, should be mandated to systematically measure and report side effects in their outcome studies. Symptoms should be measured before each immersion or before beginning treatment and participants dropping out because of side effects must be reported as well. Procedures to score the SSQ should be made explicit in peer-reviewed papers. Based on informal discussions with clinicians, it appears many were not aware of the scoring procedures of the SSQ and used the raw scores from the 16 items to compare patient's results with the Kennedy et al., (1993) normative sample. In addition, results may be biased by sample characteristics specific to anxiety disorders, potential differences among anxiety disorders, and tasks performed during in virtuo exposure.

One of the challenges of studying health and safety issues lies in the complexity of VR-induced side effects. Factors such as hardware and software used for immersion, visual content of the virtual environment, actions performed by the user and population characteristics all influence the side effects that can be experienced by the patient (Cobb et al., 1999; Harm, 2002; Lawson et al., 2002; Sharpless et al., 2008; Stanney et al., 2002; Viirre & Bush, 2002; Welch, 2002). With technology evolving rapidly, hardware and software issues change over time. The pharmacological approach of documenting adverse events and listing side effects specific to each product cannot be applied directly to virtual reality because of the diversity of VR environments and actions performed by patients. Therefore, neither the results of rigorous experimental studies or naturalistic and ecological studies are sufficient on their own to provide a complete picture of cybersickness in clinical populations. Both are needed and systematic examination of VR-induced side effects must be conducted within other clinical populations (e.g., obesity, substance abuse), with different age groups (e.g., children, elderly) and with a variety of actions performed in VR (e.g., assessment, therapy.)

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MOTIVATIONAL DIFFERENCES IN PROBLEM VIDEO GAME PLAY

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Self-determination theory states that motivation plays an important role in initiating, developing and maintaining involvement within an activity. The present study applied this theory to video game playing and surveyed 399 video game players, 82 percent of which were male with a mean age of 20.3 years old, on measures of video game playing involvement, motivation to play video games and problem video game play. Participants were obtained from various video game retail outlets, Internet cafes, and LAN gaming businesses. The results showed that extrinsic motivations to play video games, such as tension release, social approval and external regulation by in-game rewards, and amotivation, or playing without a sense of purpose about the activity, were significant predictors of problem video game playing. The results were discussed in terms of their application to identifying and assisting young people with potentially problematic levels of video game playing.
Keywords: Motivation, Video Game Play, Behavioral Addiction, Self-Determination, Problem Involvement

Introduction

The notion that excessive video game playing may represent a problematic activity in its own right has received increased academic attention (Griffiths, 2008; Griffiths & Davies, 2005; Salguero & Moran, 2002). In the last decade, researchers have identified a subgroup of players, particularly players of online role-playing games like World of Warcraft, who report playing over 50 hours per week (Griffiths, Davies & Chappell, 2003). Numerous other studies have identified high use of video games, although the methods used to classify heavy or excessive use have varied greatly (Charlton & Danforth, 2007; Christakis, Ebel, Rivara & Zimmerman, 2004; Chui, Lee & Huang, 2004; Fisher, 1994; Fleming & Kraut, 2007; Ladouceur & Dube, 1995; Ng & Wiemer-Hastings, 2005; Phillips, Rolls, Rouse & Griffiths, 1995; Salguero & Moran, 2002; Yee, 2006). Nevertheless, it is generally agreed by a number of researchers that such high levels of involvement are likely to have deleterious effects on individuals if they are maintained over time. In addition to having impacts on a person's psychological and physical functioning, shown in lack of sleep and exercise or limited mobility, excessive playing may also compromise work and study commitments and decrease opportunities for other social activities. However, the more controversial element of this area of research is whether or not excessive playing should be treated similarly to recognized behavioral addictions such as pathological or problem gambling (Griffiths, 2008a).

In a number of papers, Griffiths advances the view that video game playing is a form of addictive behaviour because it shows similarities to gambling (Griffiths, 1991a; Griffiths, 2008a; Griffiths, 2008b; Griffiths & Wood, 2000). As with gamblers, video game players find it difficult to resist the urge to participate, find it difficult to cease the behavior, become preoccupied with playing, and, as indicated above, can experience psychological, physiological and social harm if they participate excessively. However, this view has been challenged on a number of grounds by several authors. For example, Jaffe (1990) has argued that the application of the term "addiction" to non-chemical repetitive behaviors may be indiscriminate, which may de-emphasize the importance of identifying specific mechanisms which maintain certain problem behaviors. Similarly, Blaszczynski (2006) has argued that researchers must avoid the trap of accepting self-reported accounts of addiction from computer-users as a basis for the validity of technological addictions, and suggested that the field needs empirical evidence of neuro-adaptive changes in addition to psychological dependency and lack of control before these appetitive behaviors may be accepted as bona-fide addictions. Schaffer, Hall & van de Bilt (2000) and Wood's (2007) reviews of the literature on computer and video game "addiction" have each concluded that there is insufficient evidence to suggest that so-called computer-based "addictions" exist as a singular, primary disorder, and they posit that excessive involvement may instead reflect an underlying psychopathological condition. Warden, Phillips and Ogloff (2004) also warned of the various legal consequences of formally recognizing technological addictions such as Internet addiction, particularly with regard to how these technologies could be subject to various legislative controls, and the greater admissibility of technological addictions as a valid form of psychological evidence in the legal system.

Despite the controversies concerning the term "addiction" when applied to video games, most researchers, including critics, are nonetheless willing to accept that excessive video game playing can have deleterious consequences and is therefore a topic worthy of research. For this reason, it is likely that useful advances in this area might be best served by an approach that examines excessive VG play, not as an identifiable diagnostic category, but as an endpoint of a continuum of playing that has an extensive normal range, but a potential to become problematic or for harm to develop. Accordingly, to understand the phenomena requires the

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identification of predictors, correlates, or risk factors that co-vary with higher levels of involvement and, in particular, those which typically lead to reports of harm. In light of this, the aim of this paper was to examine the extent to which recent developments in motivation and self-determination theory, previously applied to gambling, might reasonably be extended to examine video game play. The strength of this approach is that it does not make the possibly unfounded assumption that excessive video playing is a bona-fide addiction. It also provides a way in which to conceptualize how normative and healthy video game playing might be differentiated from behavior that has a greater likelihood of leading to harm.

Self-determination theory

A theory which has yielded some useful insights into variations in other repetitive and potentially harmful behavior is the self-determination theory. The self-determination theory attempts to explain why some individuals demonstrate highly-committed, autonomous and self-motivated behavior, referred to as high self-determination, whilst others engage in passive, indolent and apathetic behaviors, or low self-determination (Deci & Ryan, 2000). The theory conceptualizes all human behavior as a motivational consequence and suggests that an individual is self-determined when he or she is intrinsically motivated. In contrast, a person lacks self-determination when their behavior is primarily extrinsically motivated. Self-determination has been associated repeatedly with increased psychological functioning in a number of contexts, including education (Vallerand, Blais, Briere & Pelletier, 1989), interpersonal relationships (Blais, Sabourin, Boucher & Vallerand, 1990), work (Blais, Briere, Lachance, Riddle & Vallerand, 1993), sport (Ingledew, Markland & Sheppard, 2003) and leisure (Losier, Bourque & Vallerand, 1993). Recently, the theory has also been used to conceptualize problematic behavior, such as behavioural addictions (Clarke, 2004), and predict how individuals will respond to addiction therapy (Leblond, Ladouceur & Blaszczynski, 2003; Wild, Cunningham & Ryan, 2006).

The self-determination theory is largely concerned with motivational orientation. Motivation involves both internal and external forces that trigger, direct, develop and maintain involvement in an activity (Ryan & Deci, 2000). Three main types of motivation have been proposed (Chantal & Vallerand, 1996). The first type is “intrinsic” motivation, when an individual behaves in response to some internal state, such as a desire to learn, or be pleased or excited, or seek some other kind of inherent satisfaction. The second is “extrinsic” motivation, when an individual is acting primarily in response to external forces, such as rewards of some kind, like money, or by the influence of others, such as peers or persons of higher authority. The third type is “amotivation,” which refers to behavior that is neither intrinsically nor extrinsically motivated, characteristic of a person who has lost their sense of choice and control over their behavior (Chantal & Vallerand, 1996).

In the first-published application of self-determination theory to behavioral “addictions,” Vallerand, Chantal, Vallerand and Vallieres (1995) hypothesized that highly intrinsically motivated gamblers – those who played for positive feelings of efficacy, curiosity, interest and enjoyment – would report greater involvement in gambling than extrinsically motivated gamblers, who played for the rewards of gambling, such as money and social recognition. The results showed that high self-determination, a function of high intrinsic motivation and low extrinsic motivation, was significantly positively correlated with gambling involvement. However, it was not clear from their results whether motivational orientation differed between problem and non-problem gamblers. A follow-up study by Ladouceur, Arsenault, Dube, Freeston and Jacques (1997) surveyed 110 gamblers using measures of gambling involvement, problem gambling and the motivation to gamble. The researchers found that probable pathological gamblers (N = 30) scored significantly higher on the GMS subscales for intrinsic motivation for excitement, extrinsic motivation for introjected regulation and amotivation. Similar findings were also obtained by Clarke (2004), who surveyed 147 New Zealand university students and found that beyond gambling frequency, number of activities and parents’ gambling, motivation explained a substantial proportion of variance in SOGS scores. Also, the strongest predictors of problem gambling included amotivation and the motivations for accomplishment and tension release. Clarke and Clarkeson’s (2007) study of 104 older adult gamblers showed that the strongest motivational predictors of problem gambling were intrinsic motivation to experience stimulation and amotivation.

These results led to the suggestion that problem gambling may be influenced by the dual-process of positive and negative reinforcement (Clarke, 2004). Problem gamblers are positively reinforced by the excitement of wins delivered periodically on variable-ratio reinforcement schedules inherent within games of chance, but also by the way in which gambling relieves feelings of guilt or tension. These motivations to obtain stimulation and to relieve tension override any intentions to reduce or stop gambling. Ladouceur et al. (1997) has suggested that problem gamblers will continue to gamble despite the adverse consequences of doing so because the person does not always perceive the relationship between their gambling behavior and the consequences or “amotivation.”

Given the many similarities between gambling and video game playing, particularly with regard to the structural characteristics of both activities (Fisher, 1994; Griffiths, 1991a; Gupta & Derevensky, 1996; Johansson & Gotestam, 2004;

Ladouceur & Dube, 1995; Wood, Gupta, Derevenksy, & Griffiths, 2004), it is not difficult to apply a gambling model of motivation to problematical levels of video game playing. Problem video game playing may be conceptualized as a maladaptive motivational consequence characterized by low self-determination and thus poorer psychological functioning. Table 1 presents the conceptual definitions of all seven types of motivation as they relate to video game playing. Table 1 shows that it is possible to define each type of motivation in the context of video-gaming, so that findings obtained previously with gamblers can be investigated using a similar methodology.

Table 1

Conceptual definitions of seven types of video game playing motivations

Motivation type	**Definition**
Intrinsic motivation to know	Video game playing for the pursuit of knowledge about the game, including learning, exploring and understanding all of the elements of the game.
Intrinsic motivation to accomplish	Video game playing for the internal need to finish the game or overcome its challenges, as well as improve one's skill at the game.
Intrinsic motivation to experience stimulation	Playing video games for the pleasure and excitement associated with the activity.
External motivation – Introjected	Playing video games for a release of tension or guilt. Paradoxically, it may be that these negative feelings are caused by the excessive amount of time spent playing video games.
External motivation – Identified	Video game playing for internal values such as social recognition.
External motivation – External regulation	Video game playing for the rewards, items, or achievements in the video game.
Amotivation	Playing video games to play to relieve the feeling of boredom but without any purpose, apathetic, mentally disengaged and with little sense of meaning.

Note. Extrinsic motivation involves being part of a positive and negative reinforcement schedule: receiving or avoiding something (i.e., the player is being influenced by a reward system).

The Present Study

The present study employed the self-determination theory to investigate the relationship between motivation and problem video game playing. Previous research suggests that problem gamblers are distinguished by high levels of intrinsic motivation to experience stimulation, extrinsic motivation for identified regulation and amotivation. That is, they are more likely to gamble to fill an emotional need rather than to gamble for a specific purpose, such as to enhance knowledge or skill. Accordingly, this study had two hypotheses. The first was that greater involvement in video game playing would be associated with higher levels of all types of video game playing motivation. The second was that intrinsic motivation to experience stimulation, extrinsic motivation for identified regulation and amotivation would predict additional unique variance in problematic video game playing scores beyond the video game playing variables.

In addition, because males often report higher levels of video game playing and are over-represented in studies of problematic video game play (Griffiths, Davies & Chappell, 2004a, 2004b; Griffiths & Hunt, 1995; McClure & Mears, 1984; Yee, 2006), it was reasoned that any analyses conducted would control for gender differences prior to testing other, more specific hypotheses relating to motivation.

Method

Procedure

Participants were obtained by visiting various video game retail outlets, Internet cafes, and LAN gaming businesses in the city of Adelaide, South Australia. This sampling method was based on previous research that has investigated excessive gambling among patrons of gambling venues (Griffiths, 1991b; Ladouceur & Dube, 1995). This approach was particularly useful for identifying frequent players. Participants were informed of the purpose of the study and told that their responses would be completely confidential. Participants who agreed to take part in the study signed a consent form and were given a paper-and-pencil survey to complete on their own.

Participants

A total of 399 participants completed the survey, including 328 males and 71 females. The mean age of the participants was 20.3 years old (SD = 5.1). The majority of the participants were single (N = 249) and reported having a white, English-speaking background (N = 371). In general, participants were studying towards or had completed their secondary school education (N = 209) or undergraduate degree (N = 114) and were unemployed (N = 112) or working on a casual basis (N = 198). In terms of video game playing variables, the average respondent had approximately 10 years (SD = 5.6) experience playing video games and reported to play three different video games concurrently in the last month. A typical week of video game playing was consisted of 17.8 hours on either a personal computer and/or dedicated games console with an average playing session lasting two hours (SD = 1.4) on a weekday and 2.9 hours (SD = 2.3) on the weekend.

Materials

Video Game Play Survey

This survey measured a person's duration of play (in hours) on different video game systems for each day of the week in a typical week in the last three months. This measure yielded an overall number of hours spent each week playing video games.

Problematic Video Game Playing Test (PVGT)

The PVGT is a modified version of Young's (1998) Internet Addiction Test, a 20-item questionnaire designed to measure problematic aspects of Internet use. Each item on the test was modified to accommodate problematic video game playing. One item, for example, asks "Do you feel preoccupied with video games when not playing?" All questions refer to problems experienced for a period of at least three months. Each item was scored on a five-point Likert scale, ranging from one representing "never" to five representing "always." Thus, total scores ranged from 20 to 100. In the present study, the PVGT demonstrated excellent internal consistency, with a Cronbach's alpha of .93. Validation by King and Delfabbro (2008) showed that the PVGT shows high internal consistency and moderate convergent validity, and the measure corresponds well with the components model of addiction.

Video Game Playing Motivation Scale (VGMS)

The VGMS is an adapted version of the Gambling Motivation Scale (Chantal, Vallerand & Vallieres, 1994), a 28-item measure of a person's motivation to gamble. Each item is scored on a seven-point Likert scale, ranging from "not at all" to "exactly." The VGMS measures seven types of motivation (see Table 1). Higher scores on each motivation subscale indicate greater motivation. Eighteen items were kept identical to the original version because the operant term "game" was applicable to both gambling and gaming activities. However, because video game players play for points and other in-game rewards instead of money, ten extrinsic motivation items were modified. For example, the original item "to make a lot of money" was changed to "to get a really high score."

Results

Gender differences in video game playing

Males and females differed with respect to how long they played video games in a typical sitting. Male participants reported playing for an average duration of 2.3 hours (SD = 1.4) on a typical weekday session and 3.3 hours (SD = 2.3) on a typical weekend session. By comparison, female participants reported playing for an average duration of 1.1 hours (SD = 1.1) on a typical weekday and 1.7 hours (SD = 1.6) on a weekend session. Male participants also reported having played video games for significantly longer in their lifetime than female participants (Males: M = 11.3 years, SD = 5.4, Females: M = 7.9 years, SD = 6.1) and males reported playing significantly more video game titles concurrently than females (Males: M = 4.2, SD = 3.5, Females: M = 2.6, SD = 1.5). Male participants tended to prefer first-person shooters, role-playing games and real-time strategy games, whereas female participants reported to prefer puzzle games, action-adventure and simulation games.

Gender and motivation

Given these broad differences in terms of video game playing patterns and video game preferences, it was reasoned that males and females may also differ in terms of their motivations to play video games and the extent to which they play problematically. Table 2 presents the mean motivation subscale scores and overall problem play (PVGT) score for male and female participants.

Table 2

Gender differences in motivation factors and problem video game playing

	Male (*N* = 328)	**Female (*N* = 71)**	***t*-value**	**Effect size**
Variable	M (SD)	M (SD)	(*df* = 397)	Cohen's *d*
Intrensic motivation (IM)				
To know	17.4 (5.2)	15.3 (5.9)	3.0*	.30
To accomplish	13.8 (4.9)	11.4 (4.9)	3.7*	.36
Experience stimulation	19.4 (4.6)	16.6 (5.8)	4.8*	.45
Extrensic motivation (EM)				
Identified	15.8 (5.0)	12.6 (5.8)	2.9*	.45
Introjected	11.1 (5.3)	9.1 (5.2)	2.8*	.28
External regulation	14.3 (5.9)	13.3 (6.3)	1.2	.12
Amotivation	11.7 (5.9)	10.5 (6.2)	1.6	.15
Problem score	47.1 (15.3)	38.4 (13.9)	4.4	.59

Note. * $p < .01$

Table 3

Correlations between measures of video game playing, motivation and problematic video game play

Measure	1	2	3	4	5	6	7	8	9	10
1. IM - To know										
2. IM - To accomplish	.68									
3. IM - Stimulation	.62	.55								
4. EM - Identified	.52	.53	.58							
5. EM - Introjected	.45	.69	.37	.44						
6. EM - External regulation	.53	.60	.37	.35	.65					
7. Amotivation	.38	.49	.24	.23	.48	.52				
8. Weekday session duration	.32	.27	.25	.38	.30	.19	.17			
9. Weekend session duration	.30	.29	.27	.37	.35	.22	.16	.74		
10. Total weekly hours played	.35	.35	.28	.41	.38	.24	.16	.81	.80	
11. PVGT score	.33	.45	.28	.39	.51	.44	.39	.39	.36	.43

Note. All variables significantly correlated at the .01 level (due, in part, to large N)

A hierarchical multiple-regression analysis was then conducted to identify the strongest motivational predictors of problematic video game play. Because of their strong relationship with the PVGT score, gender and total hours spent playing video games each week were entered on the first step. The two other playing variables, mean weekday and weekend session duration, were not selected due to concerns regarding multi-collinearity due to the strong association (r >.80) with total weekly hours played each week. On the second step, all seven motivation variables were entered. Table 4 presents the results of the regression analysis.

Table 4

Summary of hierarchical regression analysis for variables predicting problematic video game play

Variable	B	SE B	*β*	t
Step 1				
Gender	3.91	1.91	.10	2.04*
Total hours played per week	.467	.06	.38	8.38**
Step 2				
IM - To know	-.18	.18	-.06	-1.00
IM - To accomplish	.14	.22	.05	<1
IM - To experience stimulation	-.08	.18	-.02	<1
EM - Introjected	.36	.16	.13	2.31*
EM - Identified	.56	.18	.19	3.06**
EM - External regulation	.35	.15	.14	2.34*
Amotivation	.43	.13	.16	3.34**

* p < .01, ** p < .001
Note. R2= .19 for Step 1; ΔR2 = .18 for Step 2.

Controlling for gender and total weekly hours spent playing video games, the extrinsic motivation and amotivation factors emerged as the strongest predictors of problematic video game play, explaining as much unique variance in PVGT scores as gender and time spent playing video games each week. The strongest motivation factors were 'EM – identified' and amotivation. None of the intrinsic motivation variables emerged as significant predictors of problematic video game play. The second regression model explained an additional 17 percent of the total variance in PVGT scores, an amount that was almost equivalent to the gender and total weekly use variables. Therefore, the second hypothesis was partially supported.

Discusssion

The present study found that intrinsic motivation to experience stimulation, extrinsic motivation for identified regulation and amotivation were the strongest motivational predictors of problematic video game playing. Controlling for gender and total hours spent video game playing each week, the regression analysis revealed that these factors explained 17 percent of the unique variance in problematic video game playing (PVGT) scores. This finding was highly comparable with studies of problem gamblers (Clarke, 2004; Clarke & Clarkson, 2007; Ladouceur et al., 1997). While gambling research has consistently identified intrinsic motivation (IM) to experience stimulation as a significant predictor of problem gambling (Clarke, 2004; Ladouceur et al., 1997), none of the three IM factors were significant predictors of problem video game playing in this study.

Consistent with previous studies of the demographics of video game playing populations (Griffiths et al., 2004a), the results showed that males reported playing for longer periods on both weekdays and weekends, predominantly playing shooting, role-playing and strategy video games, having a longer life history of playing video games, and having a higher degree of problem video game playing in general. In addition, males reported higher levels of intrinsic motivation for stimulation and accomplishment and external motivation for identified regulation. Therefore, future studies of video game players' motivations should consider the effect of gender to avoid overstating any observed relationship between motivation and video game playing.

While the self-determination theory has been used to explain the general appeal of video game playing (Ryan, Rigby & Przybylski, 2006), the present study also demonstrates the theory's utility in explaining problematic involvement in video games. Problem video game playing and, by extension, video game addiction, appear to be a maladaptive motivational consequence. Problem players report being motivated by extrinsic motivation for introjected regulation, such as playing video games for a release of tension or guilt, identified regulation, such as playing for internal values like wanting to be dynamic and important in the eyes of others, and external regulation, when playing is reinforced by the intermittent reward systems within video games. Problem players are also 'amotivated,' which means that they play with a sense of apathy and mental disengagement as the activity increasingly lacks meaning (Chantal et al., 1994).

Shifting player motivation may underlie the development of problematic video game playing. It is possible that problem players do not initially play video games in order to relieve tension or for some other extrinsic purpose, but play video games because of their intrinsic appeal. Subsequently, as the player's pattern of use becomes increasingly excessive, the motivational orientation shifts to more extrinsic and amotivation factors. However, this model is purely speculative because this study offers only a limited snapshot of the association between motivation and behavioral "addiction." Future research should employ longitudinal research methods in order to determine whether motivation causes or reflects problematic involvement in video games, and assess to what extent other social and psychological variables mediate this relationship.

This research has implications for helping individuals who play video games excessively. Clarke (2004) suggested that motivational orientation may be "re-directed" in order to assist problem gamblers. He claimed that problem gamblers could learn relaxation techniques which could help reduce tension and thus eliminate the need to gamble for this reason (introjected regulation). Further, problem gamblers could seek out alternative sensation-seeking activities, including team-based sports and recreation, which can satisfy internal needs for excitement, accomplishment, and knowledge about an activity, as well as provide opportunities for social approval and other rewards. Similar recommendations may be put forward to help problem video game players. In addition, this research suggests that, from a therapeutical viewpoint, it may be useful for problem video game players to consider what keeps them motivated to play video games. A better awareness of those motivation factors which underpin excessive playing may enable individuals to manage their video game playing habits to ensure more self-determined and intrinsically rewarding experiences.

The present study had a number of strengths, including psychometric tools comparable with gambling research and a large sample drawn from video game outlets, but this study was not without some limitations. First, this research was correlational and therefore cannot make statements on the causal relationship between video game playing motivation and future involvement in problem video game playing. Second, as Charlton (2002) has suggested, video game players sometimes tend to overestimate the amount of time that they spend playing. Third, players may not always be consciously aware of the various motivations which lead them to play and remain involved in a video game. Similarly, some respondents may not be able and willing to provide an objective account of their problem video game playing behaviors. Lastly, whilst respondents were surveyed at a range of locations in different socio-economic areas, it is possible that the sampled population may not represent some types of video game players.

The present study applied the gambling model of motivation to problem video game playing, and provided further support for the theory that motivational orientation may be a key determinant of problematic behavior. For video game players, particularly those players of online role-playing games who are at greater risk of problematic involvement, this information is of significant educational value. Players may benefit by identifying, and subsequently redirecting or reducing, those motivations which contribute to potentially problematic playing styles. Psychologists should encourage problem players to play video games for the positive experiences of enjoyment, learning and having a sense of accomplishment because these experiences produce greater self-determination and increased psychological functioning.

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VIOLENT GAME ACCEPTANCE: THE INFLUENCES OF AGGRESSION TENDENCY, THRILL SEEKING, AND PERCEIVED RISK

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This study examines the relationship between physical aggression, thrill seeking, perceived risk, and behavioral intention of playing violent video games. This study collected data from 619 participants using an online survey, and analyzed the data through structural equation modeling. The results of this study suggest that physical aggression, thrill seeking, and perceived risk affect the behavioral intention of playing violent video games. Physical aggression and thrill seeking are positively related with behavioral intention, while perceived risk is negatively related. Results show that males exhibit higher levels of physical aggression and thrill seeking than females, and lower levels of perceived risk than females. Males also prefer to play violent video games more than females.
Keywords: Violent Video Games; Physical Aggression, Thrill Seeking, Perceived Risk, Behavioral Intention

Introduction

Game consoles and computer games have become increasingly popular in recent years. According to a U.S market survey, game sales in 2007 surpassed 18 billion US dollars, representing an increase of 43 percent from 2006 (NPD Group, 2008). Playing video games is now one of the most popular entertainment activities (Gentile & Anderson, 2003) and during times of leisure many people spend a large amount of time playing video games. A study by Gentile, Lynch, Linder and Walsh (2004), points out that children spend about nine hours per week playing video games.

Studies on the psychological effects of playing computer games provide inconsistent results. Some researchers suggest that playing video games leads to positive results while others argue that there are adverse effects. The findings of some studies suggest that playing violent video games will cause players to adopt aggressive behavior. According to Dill, Gentile, Richter and Dill (2005), many video games containing violent material are extremely popular among adolescents. A previous study indicates that more than 80 percent of video games on the market include violent content (Dietz, 1998; Smith, Lachlan & Tamborini, 2003). According to these researchers, there is a high probability of exposure to violence when playing video games.

Previous research indicates that people who spend a lot of time playing violent video games adopt aggressive behavior. According to Bensley and van Eenwyk's (2001) review, previous empirical studies provide evidence that playing violent video games leads to an increase in aggression and that aggression and violent behavior are connected to people who are repeatedly exposed to violent video games. Other researchers found long-term exposure to violent games can lead to aggressive behavior (Anderson & Bushman, 2001; Anderson, 2004; Gentile et al., 2004; Wei, 2007). In addition, Anderson and Dill (2000) revealed that college students who play non-violent video games exhibit lower levels of aggressive behavior than those who play violent video games.

Anderson and Bushman (2002) proposed the General Aggression Model (GAM) to determine the relationship between violent video games and aggression. The GAM is composed of the cognitive neoassociation theory, social learning theory, script theory, excitation transfer theory and social interaction theory. The GAM integrates these theories to provide a clear framework for researchers to examine the relationship between violent video games and aggression.

The GAM uses two input variables – personality variables, like aggression traits and acceptance levels of aggression, and situational variables, such as the effects of real-life violence or virtual violence. When these two variables interact, they affect an individual's internal state and their external behaviors. According to the GAM, not everyone who plays violent video games is affected the same way due to different personality traits. After playing violent video games, some players become very aggressive while others experience decreased levels of aggression.

Recent studies discuss the relationship between violent video games and aggression. Most of these studies focus on the impact of violent video games on aggressive behavior rather than the reasons why people choose to play violent video games. Sanger, Willson, Davies and Whittaker (1997) pointed out that children enjoy playing violent video games and that their personalities are major factors in the desire to play violent video games. This study shows that people who prefer violent video games may

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have a higher aggressive tendency than people who do not play violent video games. In addition, this study shows that aggressive behavior may be both the determining factor and outcome of playing violent video games.

This study shows that player tendencies toward physical aggression, thrill seeking and perceived risk are relative to their behavioral intentions. This study presents an empirical survey to show the relationships between physical aggression, thrill seeking, perceived risk and behavioral intention.

According to Lemmens, Bushman and Konijn (2006), boys who enjoy playing violent video games exhibit higher aggressiveness traits than those do not. Goldstein (1998) discussed why some people would not rebuff violent material in video and found that violent video games can, for some people, assuage their need for violence. This shows that there may be diversity in violence preferences. Kirsh (2003) followed Goldstein's concept and explained that adolescents who play violent video games are influenced by psychosocial and biological elements. These two elements can encourage adolescents to play violent games, even though they do not show aggressive behavior. Browne and Hamilton-Giachritsis (2005) mentioned that adolescents with aggressive tendencies enjoy playing violent video games. Anderson and Dill (2000) revealed that college students who play violent games generally have aggressive personalities. Furthermore, Carnagey, Anderson and Bushman (2007) found that a positive correlation exists between a physically aggressive personality and a preference for playing violent video games.

Previous studies show correlations between aggressive personalities and violent games. Most of these studies, though, focus on playing violent games as the cause of players' aggressive tendencies. However, the direction of this cause-and-effect relationship can be studied conversely, where aggressive tendencies might motivate playing violent video games. People with an aggressive tendency may have a high intention to play violent games. Therefore, this study hypothesizes that individuals with a tendency toward physical aggression enjoy playing violent video games.

Parrott (2008) suggested that to experience enjoyment and pleasure, thrill seekers would partake in adventurous activities. Aluja-Fabregat and Torrubia-Beltri (1998) indicated that watching violent cartoons satisfy audiences' need for thrill seeking. Ravaja, Saari, Salminen, Laarni, Holopainen and Järvinen (2004) indicated that violent video games usually include attractive multi-media entertaining materials so that players with a high demand for thrill and excitement would tend to play these games. Jansz and Tanis (2007) studied motivational factors in individuals playing shooting games and found that excitement was a major factor. Furthermore, according to Kline (2000), violence in entertainment provides a path for thrill seekers to satisfy their need for excitement.

Video game violence is a common form of entertainment violence that thrill seekers use to satisfy their thrill needs. Thrill seekers may experience excitement and playfulness through entertainment violence. The above inference supports the second hypothesis that individuals who favor thrill seeking enjoy playing violent video games.

Playing violent video games might cause negative effects such as an increase in player aggression (Bartholow & Anderson, 2002), a change in emotions (Olson, Kutner & Warner, 2008), and poor school performance (Gentile & Stone, 2005). According to Featherman and Pavlou (2003), perceived risk refers to engaging in an activity with uncertainty and a risk of potential loss. Players may perceive risk due to the possible negative effects of playing violence games.

Playing violent games might increase a player's aggressiveness, anger and violent tendencies. School performance might also decrease due to extended hours of playing violent video games. People with a high level of perceived risk might worry about the negative effects of playing violent video games. Therefore, this study proposes the third hypothesis that individuals with low levels of perceived risk enjoy playing violent video games.

Anderson and Dill (2000) revealed that males exhibit a strong relationship between playing violent games and aggressive behavior. Also, males are more aggressive than females after playing violent video games. In addition to these hypotheses, this study examines gender differences as a factor that may influence the relationship between aggressive tendencies and playing violent video games.

Methodology

Participants

This study recruited subjects from an online game community. Messages were posted on four discussion groups for three weeks to recruit volunteers. Subjects read and clicked the hyperlink posted on the Web site to join the study. All participants in this study were 17 years old and above.

Measure

This study utilized a five-part questionnaire. First, respondents' demographic data was recorded. The second part used a nine-item physical aggression scale developed by Buss and Perry (1992). The third part used a six-item thrill-seeking scale originally developed by Zuckerman (1984) and adopted by Beadnell, Wilsdon, Wells, Morrison, Gillmore and Hoppe (2007). The fourth part used three items to measure the perceived risk of playing violent games. These three items of perceived risk were revised from a scale created by Featherman and Pavlou (2003). The last part of the questionnaire measured behavioral intention using three items adapted from Hung, Cheng, and Chia (2003). This study also used five-point Likert-type scales to measure physical aggression, thrill seeking, perceived risk, and behavioral intention.

This study used Cronbach's alpha analysis to measure reliability. When calculating the Cronbach's alpha, this study deleted one item, the seventh item of the original scale, from the physical aggression scale to attain a high reliability coefficient. All measured scales revealed acceptable reliability coefficients, ranging from the lowest coefficient of .85 (Physical Aggression) to the highest of .96 (perceived risk).

This study examined the convergent validity by calculating each composite's reliability values. Composite reliability values exceeded .70 and were well within the acceptable range (Fornell & Larcker, 1981).

Procedure

This study constructed a Web site and online questionnaire to collect data. Participants were first asked to fill out the sections related to their demographics and physical aggression. Then, participants watched a demonstration video of a violent video game called "Postal 2." According to the Entertainment Software Rating Board (ESRB), the rating of "Postal 2" is M for mature and is only suitable for people aged 17 and older. Titles in this category contained intense violence, blood and gore, sexual content and strong language. After watching the demonstration video, participants completed the next three sections of the questionnaire related to thrill seeking, perceived risk, and behavioral intention. Each subject's aggressive tendency was measured before they watched the violent video game to determine the relationship between aggressive tendencies and intention to play violent video games.

Before watching the demonstration video, participants were told they could quit the study at any time. The responses were recorded in a database. Ten convenience store gift coupons, each worth about 10 US dollars, were provided in a lottery for respondents who completed the questionnaires.

Data Analysis

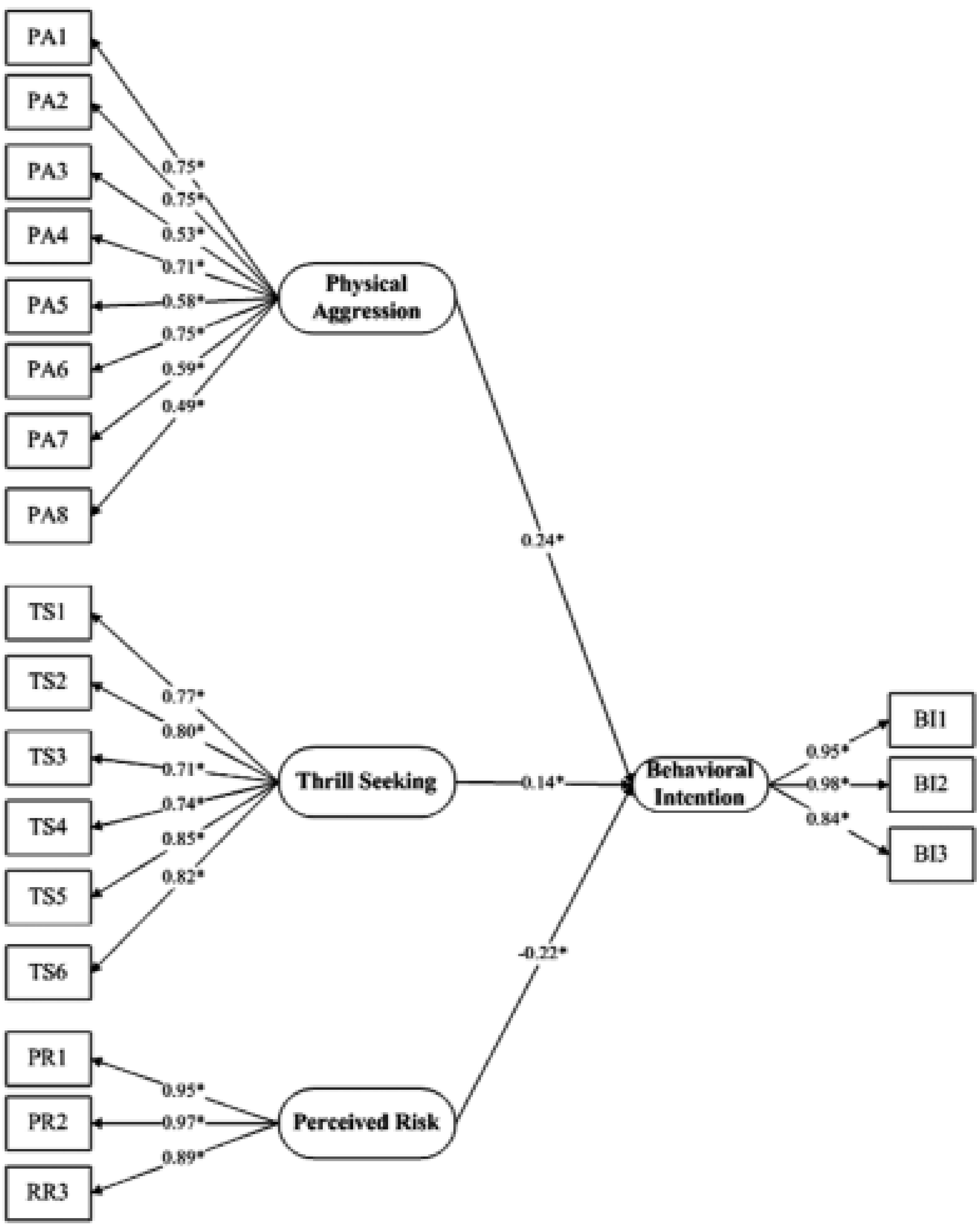
This study collected surveys from 680 respondents, and 61 responses were deleted due to repetitious participation or missing data. The remaining 619, or 91.03 percent, responses were included in data analysis. Of the respondents, 296 (47.82 percent) were males, and 323 (52.18 percent) were females, with an average age of 23.95 years old. The standard deviation was 4.69 years. Of all respondents, 596 (96.28 percent) had experience playing video games, and 23 (3.72 percent), had no experience playing video games. Experienced respondents averaged 6.52 years of playing video games. Of experienced respondents, females reported playing video games for an average of 3.13 hours a day and 2.76 days a week. Males reported an average of playing video games for an average of 3.32 hours a day and 3.5 days a week.

This study adopts Structure Equations Modeling (SEM) to test the relationships between physical aggression, thrill seeking, perceived risk, and behavioral intention. Figure 1 shows the SEM results. To evaluate the model fitness, this study uses the goodness-of-fit index (GFI) and adjusted goodness-of-fit index (AGFI). According to Gefen, Strub and Boundreau (2000) and Jiang, Klein and Carr (2002), the proposed model is acceptable when the goodness-of-fit index (GFI) value is greater than .90 and the adjusted goodness-of-fit index (AGFI) is greater than .80. The GFI of this study is .91, which is above .90. The AGFI is 0.88, which is above .80. These two values were both within the acceptable range.
This study examines three factors affecting the behavioral intention in playing violent video games – physical aggression, thrill seeking, and perceived risk. All the relationship coefficients in Fig. 1 are significant.

There is a positive correlation (.24; $p < .01$) between physical aggression and behavioral intention, and between thrill seeking and behavioral intention (.14; $p < .01$). Perceived risk is negatively related to the behavioral intention of playing violent video games (-.22; $p < .01$). These results support the three proposed hypotheses.

Figure 1

Result of SEM analysis



In addition to testing the hypotheses, this study measures gender differences using the t-test. Table 1 illustrates the means and standard deviations for the variables used in this study. There are statistically significant gender differences in physical aggression, thrill seeking, perceived risk and behavioral intention. The males in this study had a significantly higher tendency toward physical aggression than females (t = 5.99; p < .01). Furthermore, males had a higher level of thrill seeking than females (t = 3.24; p < .01), females had a significantly higher level of perceived risk than males (t = 2.95; p < .01), and males showed a higher level of behavioral intention than females (t = 5.66; p = < .01).

Table 1

Group differences

	All participants (n = 619)	**Female (n = 323)**	**Male (n = 296)**
Physical agression			
M	2.38	2.20	2.59
s.d.	0.76	0.72	0.77
p	t = -6.26*; P < .01		
Thrill seeking			
M	3.19	3.09	3.29
s.d.	0.76	0.75	0.75
p	t = -3.24*; P < .01		
Perceived risk			
M	3.24	3.36	3.11
s.d.	1.03	1.02	1.03
p	t = 2.95*; P < .01		
Behavioral intentions			
M	2.26	2.04	2.50
s.d.	1.03	0.96	1.07
p	= -5.66*; P < .01		

Discussion

This study illustrates why some individuals prefer to play violent video games and shows that physical aggression, thrill seeking and perceived risk affect an individual's behavioral intention for playing violent video games. The relationship of physical aggression, thrill seeking, perceived risk and behavioral intention reveal the following results. First, a positive correlation exists between physical aggression and behavioral intention. Therefore, some individuals that have higher physical aggression levels prefer to play violent video games. Previous research shows that an aggressive personality may result in a greater tendency toward physical aggression, which may lead to a tendency to play violent video games (Carnagey et al., 2007; Peng, Liu & Mou, 2008). This study measured subject's tendency toward aggression before they watched a violent video game. The results of this test reveal that aggressive tendencies motivate a subject's behavioral intention to play violent video games. A violent game player's high level of aggressive tendency may come from their own aggressive personality, although this aggressive tendency may increase after playing violent games.

This study found a positive correlation between thrill seeking and behavioral intention. Thrill seekers gained excitement, delight and satisfaction from playing violent video games. These results support previous research (Ravaja et al., 2004). This study shows that there is a negative correlation between perceived risk and behavioral intention, where individuals who have a higher perceived risk might think that playing violent video games is a risky activity because they may become more aggressive, angry and violent. Therefore, an individual's level of perceived risk may influence behavioral intention for playing violent video games.

This study also considers gender differences. A male's physical aggression is generally higher than a female's, and these results are consistent with previous research (Krahé & Möller, 2004). Males have a higher intention to play violent video games than females and their violent needs are higher than female's. A male's thrill seeking tendencies are also higher than a female's. These results show that males like to seek excitement more than females and consequently, a male's motivation to play violent games is greater than a female's. Lastly, females have a higher risk perception than males which discourages them from playing violent video games.

This study analyzes why individuals prefer to play violent video games and concludes that both physical aggression and thrill seeking are positively related, whereas perceived risk is negatively related to the behavioral intention of playing violent video games. Further research in this field should include indentifying other reasons why individuals prefer playing violent video games.

There are some limitations in this study. First, this study conducted an online survey with online community members. The participants of the online community might similar in age and might not fully represent the opinions of people from other age categories. Further research could investigate a broad range of ages to investigate variables related to age differences in playing violent video games. Further research may indicate that an individual's physical aggression, thrill seeking and perceived risk may change with age. Secondly, further studies should focus on the differences between playing violent video games and watching violent media materials to determine the relationships between playing violent video games and watching violent media. Finally, further research should examine the factors that cause adolescents to play violent video games with the goal of avoiding an increase in aggressive behavior in adolescents after playing violent video games.

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COMFORTING COMMUNICATION IN AN ONLINE EPILEPSY FORUM

Chris Fullwood[1] and Nicola Wootton[1]

There is a tendency to think that face-to-face communication, particularly with respect to emotionally-sensitive issues, is a superior means of offering support compared to computer-mediated communication (CMC). However, there may be situations in which the reduced intimacy of CMC is beneficial to providing support. The current study investigated whether conditions necessary for effective supportive communication as outlined by Burleson and Goldsmith (1998), including anonymity, self-disclosure, discussion of thoughts and feelings and suggestion of change, were present in an online support forum produced by The National Society of Epilepsy. A content analysis was completed on 120 posts and results suggest that all conditions necessary for effective supportive communication were met within the forum. Furthermore, anonymity seems to be a key factor in allowing posters to discuss their thoughts and feelings. It may be the case that the stigma often associated with Epilepsy has a smaller impact with CMC.
Keywords: Online Behavior, Comforting Communication, Forum, Cybertherapy, Epilepsy

Introduction

Computer-mediated communication (CMC) may seem to be a useful and efficient medium but there are a number of potential drawbacks that need to be addressed. For example, the removal of nonverbal cues and a lack of direct physical contact may impinge upon our ability to communicate successfully with others, particularly with regards to the communication of emotional and relational information. Furthermore, online groups are often fleeting or irregular, meaning that when contact is desired it may not always be possible (Caplan & Turner, 2007). This study therefore examines the value of CMC in an online Epilepsy forum.

Although CMC is often associated with a number of shortcomings,for example interactions are more likely to be anonymous, many of these factors may actually provide a more comfortable environment for emotional communication to take place (White & Dorman, 2001), and this would be particularly pertinent when considering online social support groups, such as forums. White and Dorman (2001) offered a number of suggestions for the manner in which forums could facilitate social support, for example by enhancing quality of life, increasing survival time for chronic disease and improving decision-making. They further postulated additional benefits pertaining to online support including continuous accessibility, meaning that support could be enabled at an individual's convenience. A lack of synchronicity should allow one to post more considered and developed responses over time and at one's own speed as immediate responses are not necessarily required in an online forum context. Online support also appears instrumental in allowing sufferers of stigmatized conditions a more welcoming venue to discuss sensitive issues, therefore encouraging self-disclosure (White & Dorman, 2001).

Supportive communication, which appears to be a predominant requirement and outcome of engaging with online medical support groups (Zrebiec & Jacobson 2001), is suggested by Burleson and Goldsmith (1998) to be a sub-category of comforting communication, which helps to alleviate emotional distress. Drawing from Lazarus' cognitive appraisal theory (1991), Burleson and Goldsmith (1998) proposed effective comforting communication enables cognitive reappraisal of an upsetting experience, which may in turn reduce emotional distress. Burleson and Goldsmith (1998) put forward three conditions required for effective comforting – self-disclosure, discussion concerning thoughts and feelings and discussion considering reappraisals. Furthermore, participants are more likely to engage in adaptive reappraisal if they feel secure and safe in the environment in which they are communicating. Caplan and Turner (2007) argue that each of these conditions is adequately represented by CMC.

Many of the unique properties of online communication are actually said to promote effective comforting. For example, anonymous interactions may help participants to overcome the self-presentational dilemma often associated with talking about sensitive issues face-to-face. In Zrebiec and Jacobson's (2001) evaluation of educational and emotional support for sufferers of diabetes and their supporters, they found that 79 percent of respondents rated online participation positively in terms of aiding them to cope more effectively with the symptoms of diabetes. The researchers also argued that patients and their supporters were able to deal more effectively with their problems by building self-management skills and obtaining readily available support, a direct consequence of engaging with the Internet discussion groups.

The results from the diabetes online support is encouraging and suggests that similar positive results may be found for other

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chronic illness support sites. The current study considers the online application of conditions recommended for effective comforting within a forum produced by the National Society of Epilepsy (2001) Web site, providers of support and health information for epilepsy sufferers and their supporters. This study differs from the Zrebiec and Jacobson (2001) study in that it examines a group that not only have a chronic illness but who are also stigmatized. Stigma and epilepsy appear to be concurrent, impacting interpersonal relationships, general health and quality of life (Morrell, 2002). Caplan and Turner (2007) suggest CMC provides some sheltering effects not offered by face-to-face communication. This appears helpful in minimizing perceived risks associated with discussing personal conditions, for example, protection of anonymity. In turn, this is suggested to encourage further self-disclosure, the first condition necessary for supportive communication. Thus, CMC may be particularly helpful for this group. Therefore, it was expected that conditions for effective supportive communication would be evident in the majority of posts. Furthermore, anonymity would encourage users to speak more openly about their thoughts and feelings.

Method

Materials

In order to investigate supportive communication in an online context the National Society of Epilepsy (2001) Web site forum was chosen. The most recent sixty posts from two threads, discussions "for young people" and "for parents," were selected on the February 16, 2008 resulting in one hundred and twenty units of data. A codebook was created incorporating conditions required for effective comforting as suggested by Burleson and Goldsmith (1998), which included anonymity, self-disclosure, thoughts and feelings and suggestion of change. Agreement between two experienced coders was measured using a random selection of 30 posts. Using Cohen's Kappa, significant degrees of consistency were found for all variables – anonymity ($k = .659$, $p = .000$), self-disclosure ($k = .412$, $p = .005$), thoughts and feelings ($k = .841$, $p = .000$) and suggestion of change ($k = .773$, $p = .000$).

Procedure

Each post was checked for anonymity and either assigned to the "anonymous" category, which included pseudo-names or nick-names, the "named" category if real names were used, or were designated as "unable to determine" if authenticity of the name appeared uncertain, for example, when a name was used that was contrary to the perceived sex of the individual. Self-disclosure included any information relating to personal behaviors, personal needs, family details, personal illness or personal medication. The posts were split between either including self-disclosure or not including personal detail. Suggestion of change was coded as "positive change," "negative change," "no change" or "both positive and negative aspects of change." Change was defined behaviorally – for example, physically, like taking medication, emotionally, such as feeling happier, or cognitively, such as thinking more positively. A further variable concerned the inclusion of thoughts and feelings. Each post was examined considering the inclusion or omission of thoughts and feelings. Examples of thoughts and feelings included talking about one's emotional state, or one's opinions relating to sensitive topics.

Results

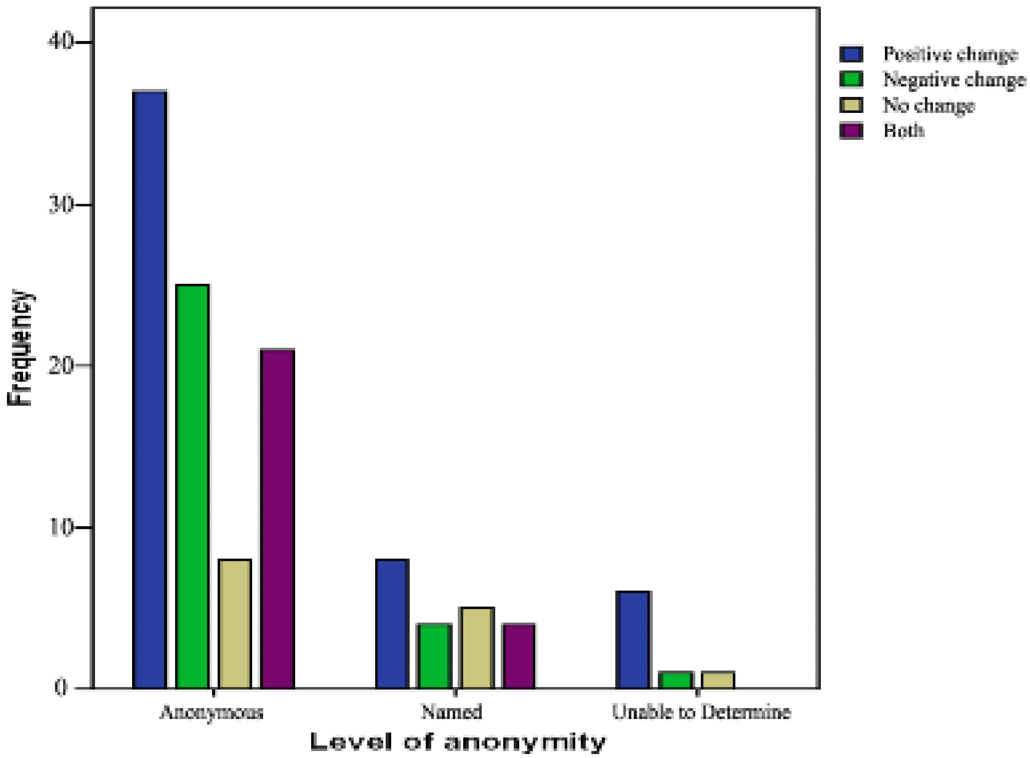
One-way chi-square tests were used to examine if each of the conditions necessary for effective comforting were more likely to be present than not be present in the posts on the National Society of Epilepsy (2001) forum. All tests were one-tailed.

Regarding level of anonymity, there was a significant difference between the categories (χ^2 ($df = 2$) $= 99.65$, $p < 0.001$), suggesting that more posters remained anonymous (91) than named themselves (21).

Regarding the suggestion of change variable, there was a significant difference between the categories (χ^2 ($df = 3$) $= 24.07$, $p < 0.001$), suggesting that more posts contained reference to positive change (51) than negative change (30), no change (14) and both positive and negative change (25). Furthermore (see figure 1 below), of the anonymous group, 41 percent (37) suggested positive change, 27 percent (25) suggested negative change, 9 percent (8) suggested no change and 23 percent (21) suggested both positive and negative change. Whereas, with the named group, 38 percent (8) suggested positive change, 19 percent (4) suggested negative change, 23 percent (5) suggested no change and 19 percent (4) suggested both positive and negative change. This association was found to be non-significant.

Figure 1

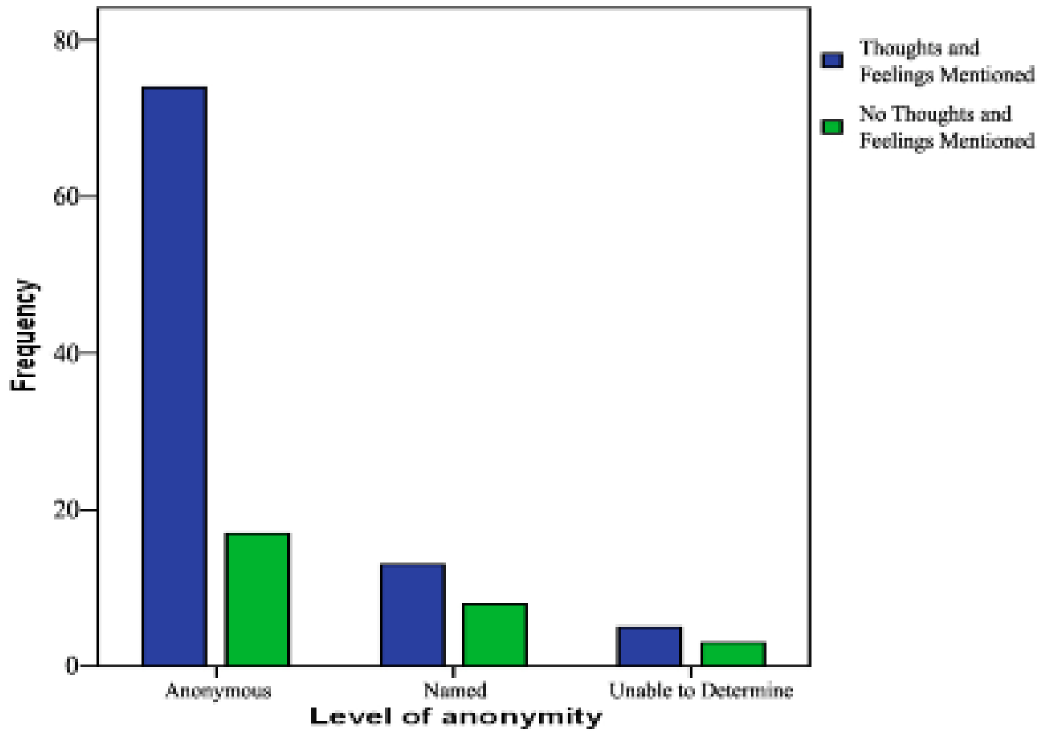
Discussion of thoughts and feelings as a function of the level of anonymity of posters on an Epilepsy forum



Regarding discussion of thoughts and feelings, there was a significant difference between the categories in (χ^2 (df = 1) = 34.13, $p < 0.001$), suggesting that more posts contained reference to thoughts and feelings (92) than did not (28). Furthermore (see figure 2 below), of the anonymous group, 81 percent (74) mentioned thoughts and feelings and 19 percent (17) did not. Whereas, with the named group, 61 percent (13) mentioned thoughts and feelings and 39 percent (8) did not. This association was found to be significant (χ^2 (df = 1) = 3.709, $p < 0.05$), meaning that anonymous individuals were more likely to discuss their thoughts and feelings than named individuals.

Figure 2

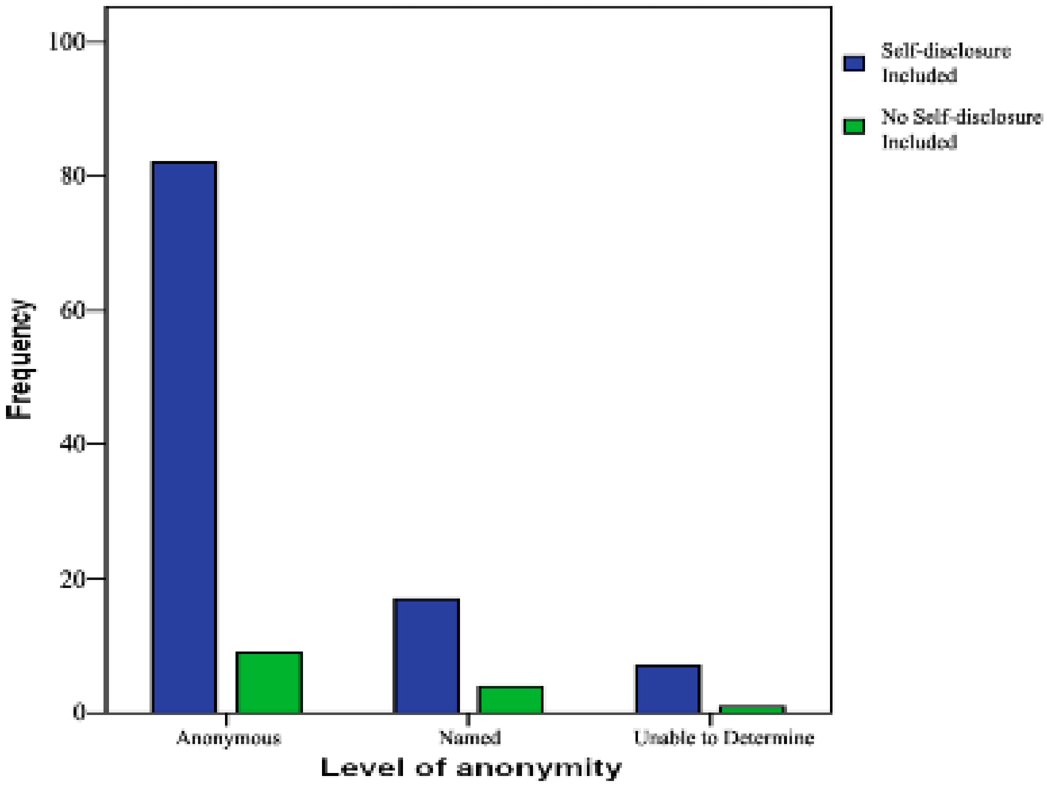
Suggestion of change as a function of the level of anonymity of posters on an Epilepsy forum



Regarding self-disclosure, there was a significant difference between the categories (χ^2 (df = 1) = 70.53, $p < 0.001$), suggesting that more posters self-disclosed (106) than did not self-disclose (14). Furthermore (see figure 3 below), of the anonymous group, 90 percent (82) self-disclosed and 10 percent (9) did not self-disclose whereas, with the named group, 80 percent (17) self-disclosed and 20 percent (4) did not self-disclose. This association was found to be non-significant.

Figure 3

Self disclosure as a function of the level of anonymity of posters on an Epilepsy forum



Discussion

Overall, the results suggest that each of the conditions postulated by Burleson and Goldsmith (1998) necessary for comforting communication appear in the majority of posts. In other words, more posters were anonymous than named, more posts contained reference to thoughts and feelings than did not, a higher number of posts indicated positive change than negative change and more posters self-disclosed than did not. Therefore, this supports Caplan and Turner's (2007) suggestion that these conditions are adequately represented within CMC.

The majority of posters preferred to remain anonymous, which may be one reason for the increasing popularity of online support. Indeed, although no difference was found between the anonymous and named groups with regards to suggestion for change and self-disclosure, a significantly larger proportion of anonymous individuals discussed their thoughts and feelings comparatively to the named individuals. This is consistent with the notion that remaining anonymous allows individuals to overcome the self-presentational dilemma. In other words, remaining anonymous, along with the removal of non-verbal cues, helps to reduce social anxiety, making it easier to discuss one's feelings and thoughts about sensitive issues. The fact that both groups self-disclosed personal information about their conditions equally, however, seems to suggest that the online forum was perceived as a safe environment to discuss personal issues generally. Perhaps the monitored nature of the forum, along with the fact that contributions require users to be registered, meant that contributors felt protected from judgement by others. Given the specialized nature of the forum, it is also highly unlikely that someone would accidentally happen upon private information concerning someone known to them offline.

Although the findings are clearly interesting, this needs to be explored further. Further studies may contrast online support requirements or provision between sufferers and their caregivers. Additionally, the naturalistic nature of the investigation can be considered a strength, particularly as it is unlikely that participants would be as open about their experiences in a more experimental set-up and this should facilitate further investigation where face-to-face research might encounter resistance. As the Internet expands there appears to be little question regarding the increase in healthcare information and personal support now available. Issues requiring further investigation include age-specific needs and expectations surrounding medically mediated support. Additional studies regarding differences across age groups may further enhance knowledge, enabling age-appropriate discussion of important health information or issues. This may result in better understanding and more effective support, which is not only instantaneously available but accurately directed towards the target audience.

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CYBERFOCUS

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Vancouver, BC, Canada
www.uist.org

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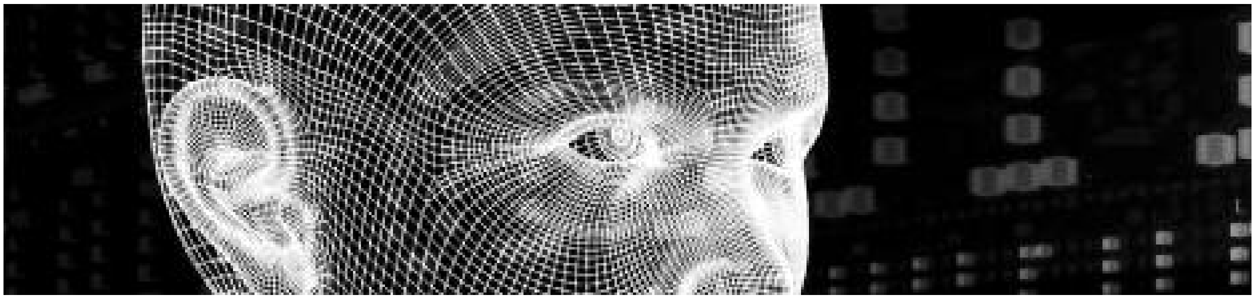

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