



Annual Review of CyberTherapy and Telemedicine

Roots and Future of Using Technologies to
Foster Physical and Mental Wellbeing

Editors:

Brenda K. Wiederhold, Ph.D., MBA, BCB, BCN

Giuseppe Riva, Ph.D., M.S., M.A.

Scott M. Debb, Ph.D., Ed.D., M.A.

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**ANNUAL REVIEW OF CYBERTHERAPY
AND TELEMEDICINE 2019**

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Roots and Future of Using Technologies to
Foster Physical and Mental Wellbeing

Edited by

Brenda K. Wiederhold

Interactive Media Institute, San Diego, CA, USA
Virtual Reality Medical Institute, Brussels, Belgium

Giuseppe Riva

Catholic University of Milano, Milan, Italy
Istituto Auxologico Italiano, Milan, Italy

Scott M. Debb

Norfolk State University, Norfolk, Virginia, USA
Virginia Consortium Program in Clinical Psychology,
Norfolk, Virginia, USA

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Brenda K. Wiederhold, Ph.D., BCB, BCN

Interactive Media Institute
Virtual Reality Medical Center

Giuseppe Riva, Ph.D., M.S., M.A.

Istituto Auxologico Italiano
Università Cattolica del Sacro Cuore

Scott M. Debb, Ed.D., M.A.

Norfolk State University
Virginia Consortium Program in Clinical Psychology

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Norfolk State University
Virginia Consortium Program in Clinical Psychology

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Interactive Media Institute
6540 Lusk Boulevard, Suite C115
San Diego, CA 92121 USA
Telephone: +1 858 642 0267
E-mail: cybertherapy@vrphobia.com
Web site: <http://www.interactivemediainstitute.com>
Journal Web site: <http://www.arctt.info>

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About the Journal

ARCTT is a peer-reviewed all-purpose journal covering a wide variety of topics of interest to the mental health, neuroscience, and rehabilitation communities. The mission of ARCTT is to provide systematic, periodic examinations of scholarly advances in the field of CyberTherapy and Telemedicine through original investigations in the Telemedicine and CyberTherapy areas, novel experimental clinical studies, and critical authoritative reviews. It is directed to healthcare providers and researchers who are interested in the applications of advanced media for improving the delivery and efficacy of mental healthcare and rehabilitative services.

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Our publication pays careful attention to the protection of a patient's anonymity in case reports and elsewhere.

Identifying information such as names, initials and hospital numbers must be avoided. Also, authors should disguise identifying information when discussing patients' characteristics and personal history.

Preface

ARCTT is a peer-reviewed all-purpose journal covering a wide variety of topics of interest to the mental health, neuroscience, and rehabilitation communities. This mission of ARCTT is to provide systematic, periodic examinations of scholarly advances in the field of Cybertherapy and Telemedicine through original investigations in the telemedicine and cybertherapy areas, novel experimental clinical studies, and critical authoritative reviews.

Healthcare delivery systems have been evolving to rely more heavily on technology. There has been a shift in care diagnosis and treatment which has decreased the importance of traditional methods of care delivery. Technology has not only helped to extend our lifespan, but it has improved the quality of life for all citizens.

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

1. **Editorial:** This introductory text expresses the position of the Editors – Brenda K. Wiederhold Giuseppe Riva Scott M. Debb - about the focus of this year's issue;
2. **Critical Reviews:** These chapters summarize and evaluate emerging cybertherapy topics, including technology, enhanced rehabilitation, Interreality, and Intersubjectivity;
3. **Evaluation Studies:** These chapters are generally undertaken to solve some specific practical problems and yield decisions about the value of cybertherapy interventions;
4. **Original Research:** These chapters research studies addressing new cybertherapy methods or approaches;
5. **Clinical Observations:** These chapters include case studies or research protocols with long-term potential.
6. **Work in Progress:** These chapters include papers describing a future research work.
7. **Brief Communications:** These chapters include brief papers reporting preliminary data on-going research work and/or new developments.

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

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

We are grateful to Silvia Serino and Ian T. Miller for their work in collecting and coordinating chapters for this volume.

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

Brenda K. Wiederhold
Giuseppe Riva
Scott M. Debb

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SECTION I

EDITORIAL

This introductory text expresses the position of the Editors – Brenda K. Wiederhold, Giuseppe Riva, Scott M. Debb - the focus of this year's issue.

*Brenda K. Wiederhold, Giuseppe Riva,
Scott M. Debb*

Virtual Reality meets Artificial Intelligence: The Emergence of Advanced Digital Therapeutics and Digital Biomarkers

Giuseppe RIVA^{1 a,b}, Brenda K. WIEDERHOLD^c, Daniele DI LERNIA^a,
Alice CHIRICO^a, Eleonora Francesca Maria RIVA^d,
Fabrizia MANTOVANI^e, Pietro CIPRESSO^{a,b}, Andrea GAGGIOLI^{a,b}

^a*Department of Psychology, Università Cattolica del Sacro Cuore, Milan, Italy*

^b*Applied Technology for Neuro-Psychology Lab. Istituto Auxologico Italiano, Milan, Italy*

^c*Interactive Media Institute, San Diego, CA, USA*

^d*Department of Cultural Heritage and Environment, Università degli Studi di Milano,
Milano, Italy*

^e*Department of Human Sciences for Education, Università degli Studi di Milano-
Bicocca, Milan, Italy*

Abstract. In the past 25 years, researchers have discovered that Virtual Reality (VR) is an effective tool for mental health treatment and assessment in anxiety disorders, eating and weight disorders, and pain management with long-term effects that generalize to the real world. Moreover, VR is also an effective assessment tool with practical applications that range from social and cognitive deficits to addiction. Nevertheless, despite progress, evidence-based psychological treatments still need improvement. In this paper we suggest that the integration of VR with another emerging technology – Artificial Intelligence (AI) – will provide clinicians with two new powerful tools for improving evidence-based psychological treatments: advanced digital therapeutics and digital biomarkers. The term “Digital Therapeutics” indicates the use of digital/online health technologies to treat a medical or psychological condition. Following this definition, any VR clinical application can be defined as a form of digital therapeutics. However, the integration between VR and AI allows a critical feature for any digital therapeutic: personalization. On one side, VR allows the collection of “Digital Biomarkers” - physiological, and behavioral data that are collected by means of digital technologies and used as an indicator of biologic processes or biological responses to therapeutic interventions – that are directly connected to the brain functioning and can be altered to correct the specific dysfunctions of the predictive coding mechanisms in the individual’s brain. On the other side AI, by applying machine learning techniques to the individual’s digital biomarkers, allows the optimization of the individual treatment strategy facilitating the transition to a personalized, effective and engaging medicine.

Keywords. Virtual Reality, behavioral health, neuroscience, digital therapeutics, digital biomarkers, embodied medicine

1. Introduction

In the past 25 years, researchers have discovered that Virtual Reality (VR) is an effective tool for mental health treatment and assessment. As suggested by two recent meta-

¹ Corresponding author: Giuseppe.riva@unicatt.it

reviews [1, 2], VR is a successful treatment in anxiety disorders, eating and weight disorders, and pain management with long-term effects that generalize to the real world. Moreover, VR is also an effective assessment tool with practical applications that range from social and cognitive deficits to addiction. Nevertheless, despite progress, as clearly underlined by Homes and colleagues [3]: “evidence-based psychological treatments need improvement.” (p. 288). In particular, the integration of VR with another emerging technology – Artificial Intelligence (AI) – will provide clinicians with two new powerful tools for improving evidence-based psychological treatments [4, 5]: advanced digital therapeutics and digital biomarkers.

2. Virtual Reality meets Artificial Intelligence

According to Wikipedia, “Digital Therapeutics” are “a health discipline and treatment option that utilizes digital and often online health technologies to treat a medical or psychological condition.” Following this definition, any VR clinical application can be defined as a form of digital therapeutics. However, as underlined by different researchers, a key feature of these tools is “personalization” [6, 7]: the individual treatment strategy is optimized through the use of technology. For example, by applying machine learning techniques to the patient's data.

Machine learning is an emerging AI approach that uses statistical approximation to learn from a data set and make predictions without being programmed with explicit rules [8]. More, differently from expert systems that use rules-based algorithms, machine learning improves and learns with experience via exposure to large and new data sets. Finally, the machine learning approach is data independent: the same tools used for medical imaging interpretation can also be used to assess human personality, allowing for rapid expansion in different fields. The power of machine learning fits well with one of the key characteristics of VR: the total control over everything enacted (implicit and explicit behaviors) and experienced (emotions and cognitive states) by its user. In other words, VR brings different and effective digital biomarkers to AI that facilitate an advanced prediction and personalization of the therapeutic approach.

The term “biomarker” indicates a physiologic, pathologic, or anatomic characteristic objectively measured and used as an indicator of biologic processes - normal or pathologic - or biological responses to therapeutic interventions [9]. Following this definition, “digital biomarkers” are a set of objective, quantifiable, physiological, and behavioral data that are collected and measured by means of digital technologies used to explain, influence and/or predict health-related outcomes [10]. The use of VR allows the direct collection and storage of many digital biomarkers, both related to the behavior – explicit (i.e., movements, speech and language, etc.) and implicit (i.e., facial expressions, eye-movements, saccades, etc.) – in the virtual environment and to the different characteristics of the physiological states associated to it (i.e., heart rate, EEG data, etc.). Additionally, the collection of these digital biomarkers is mostly transparent for the user, since many sensors are directly embedded in the VR tools and the input/output devices.

3. Brain-like Digital Biomarkers

The power of VR is not only related to the quantity of digital biomarkers it allows to collect, but also to their quality. Different major discoveries in the field of neuroscience

suggest that our brain produces and updates an embodied simulation of the body in the world: the “body matrix” [11, 12]. This simulation is actively used by different cognitive processes to represent and predict actions, concepts, and emotions [13-15].

VR works in a similar way: through the integration of data from trackers and contents of a simulated 3D world, a VR system builds a model (simulation) of the body and the space around it. If we compare this process with the one used by the brain, the VR system - like the brain - uses the simulation to predict the sensory consequences of the individual's movements [12]. This prediction is then used to provide, using the VR hardware, the expected sensory input: the same scene the user would see in the real world after the tracked movements. Obviously, to be realistic, the VR model tries to mimic the

brain model as much as possible: the more the VR model is similar to the brain model, the more the individual feels present in the VR world [12, 16].

As noted by Riva and colleagues [12], if presence in the body is the outcome of different embodied simulations, and VR is a simulation technology, then assessing the experience of the body and the cognitive processes directly connected to it by designing targeted virtual environments is a possibility.

A series of recent studies support this vision. Serino and colleagues [17] and Realdon and colleagues [18] recently compared the efficacy of a simple immersive non-interactive VR experience - the Picture Interpretation Test (PIT) 360° - with standard conventional paper and pencil tests of executive functions in two different clinical samples: Parkinson's disease and Multiple Sclerosis patients. In both samples, while standard neuropsychological tests failed to differentiate between clinical and non-clinical groups, the PIT 360° was successful in detecting executive dysfunctions. More, all participants described the PIT 360° as an engaging tool and reported positive reactions to their experience. In another study, Pedroli and colleagues [19] used VR to investigate executive functions in individuals with obsessive-compulsive disorder. Using either two VR scores or three neuropsychological tests was possible to discriminate between patients and controls.

4. Digital Therapeutics 2.0

The direct link between VR and brain functioning also makes VR an “embodied technology” able to update/modify the embodiment experience of its users [2]. Specifically, this feature suggests the use of VR as an advanced digital therapeutic tool able to correct the dysfunctions of the predictive coding mechanisms (embodied medicine [20, 21]).

Different authors [20] recently suggested that an altered functioning of the predictive and simulative mechanisms of the brain might be the causes of different neurological and psychiatric conditions. In this view, it should be possible to counteract these deficits through the modulation and/or integration/replacement of the different components of the Body Matrix [12, 22-24]. Specifically, VR can be used to generate new cross-modal associations between bodily stimuli that have not been experienced as systematically related before [25]. Moreover, the cross-modal association has to produce a *significant prediction error* (high surprise), reducing the level of estimation uncertainty, to update the predictive internal models of the body matrix through the generation of new priors [20]. Using this approach, technology can be used:

1. *to facilitate the integration of external and inner body signals* [26-28] and,
2. *to induce a controlled mismatch between the predicted/dysfunctional content and the actual sensory input* [29].

The emerging fields of interoceptive technologies [26, 30, 31], sonoception – the use of sound and vibration to modify inner body signals [20, 28] – and body illusion techniques [32], support the feasibility of this approach.

In conclusion, even if digital biomarkers and digital therapeutics can be obtained using different technologies, the integration between VR and AI may offer more advanced solutions. On one side, VR allows the collection of digital biomarkers that are directly connected to the brain functioning and can be altered to correct the dysfunctions of the predictive coding mechanisms in our brain. On the other side AI, by applying machine

learning techniques to a patient's digital biomarkers, can optimize the individual treatment strategy facilitating the transition to a personalized, effective and engaging medicine.

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SECTION II

CRITICAL REVIEWS

In general, there are two reasons why cybertherapy is used: either because there is no alternative, or because it is in some sense better than traditional medicine.

In this sense telehealth has been used very successfully for optimizing health services delivery to people who are isolated due to social and physical boundaries and limitations.

Nevertheless, the benefits of cybertherapy, due to the variety of its applications and their uneven development, are not self-evident.

However, the emergence of cybertherapy is supporting the cost-effectiveness of certain applications, such as assessment, rehabilitation and therapy in clinical psychology and neuroscience.

Wiederhold & Riva, 2004

Cognitive Effects of Transcranial Direct Current Stimulation and Virtual Environments

Justin ASBEE^a Thomas PARSONS^{a,1}

^a *Computational Neuropsychology and Simulation Lab, University of North Texas*

Abstract. Transcranial direct current stimulation (tDCS) involves the introduction of a small amount of current to the participant's brain to influence brain activity in the stimulated areas. Research using tDCS has involved a wide range of cognitive and affective domains. A limitation to the generalization of these findings to everyday cognitive processes is that these studies often involve simple stimuli that may not reflect the more dynamic cognitive and affective processes found in activities of daily living. To address this issue, a growing number of studies have begun using virtual environments (VE) that include dynamic simulations of everyday activities. Lacking is a quantitative meta-analysis that enhances understanding of the cognitive manipulations resulting from tDCS protocols that include VEs. Searches of electronic databases yielded 756 studies. Thirteen studies (618 subjects) met inclusion criteria. Preliminary results reveal that tDCS produced a statistically significant Hedge's g of 0.45. The effect for tDCS was statistically significant for both immersive virtual stimuli, $g = 0.25$, and screen captures from VEs, $g = 0.79$. Analyses of results relative to cognitive domains revealed that tDCS had the greatest influence on risk assessment, $g = 0.67$. Small effect sizes were observed for attention and executive functioning, $g = 0.21$ and hippocampal dependent tasks, $g = 0.17$. In summary, while tDCS combined with VEs produced medium effects on cognition, the effects were relative to cognitive domain. A potentially promising use of tDCS with VEs may be that of training.

Keywords. Transcranial direct current stimulation, Virtual Reality, Meta-analysis, Cognition

1. Introduction

Non-invasive brain stimulation, such as transcranial direct current stimulation (tDCS), modulates brain activity without direct contact with the brain [1]. The application of tDCS consists of introducing a small amount of current (between 0.5 and 2.0 mA) at the scalp to influence neural activity [2]. Although the first peer-reviewed study of tDCS with humans occurred less than two decades ago [3], numerous publications have emerged [4]. An important aspect of tDCS is that it introduces current to the brain with only minimal and well-tolerated side effects, (e.g. tingling or mild itchiness). Moreover, it has a relatively low cost and low level of difficulty in its administration [5].

The effects of tDCS are dependent on factors including amount of current, polarity, and size of electrodes [6]. Stimulation from tDCS influences the neural excitability near the location of the electrodes [4]. While the current from tDCS does not directly cause neurons to fire, it does influence the likelihood of firing [7]. Researchers generally find that anodal tDCS causes an increase in neural excitability, while cathodal stimulation tends to decrease neural excitability [4].

Researchers have examined the effects of tDCS on motor learning in relation to rehabilitation [8-13]. Additional uses of tDCS include manipulation of cognitive and perceptual processes in non-clinical populations. Potential explored applications include manipulations of cognitive and affective domains [14-18]. Several applications revolve around enhancement of learning, memory, and training [19-21]. Tremblay and colleagues (2014) conducted a narrative review of tDCS studies that discussed the impact

¹ Corresponding Author, Thomas.Parsons@unt.edu.

of tDCS on cognitive constructs such as working memory, verbal problem solving, and emotion processing.

Unfortunately, manipulation of cognition has often been used in conjunction with simple stimuli that may not be generalizable to everyday cognitive processes. Examples include words being presented with pictures [22] and the n-Back task [23]. The focus of many of these tasks is experimental control [24]. An issue associated with the use of static stimuli is they can often be poor representations of real-life events or environments [24]. Gibson has argued that perception and behavior are the result of being part of and interacting with one's environment [25]. The behaviors observed in the laboratory are highly dependent on the stimuli presented. If the stimuli do not reflect real-world activities, then the results may not generalize beyond controlled laboratory settings.

There is growing interest in the human neurosciences in the use of more dynamic stimulus presentations that simulate everyday activities [24, 26-28]. Virtual reality (VR) simulation and virtual environment (VE) paradigms include the experimental control of laboratory measures with interactive simulations of everyday activities [24, 29; 30]. There are an increasing number of published studies of the impacts of tDCS on cognition while interacting with VEs [15, 18].

VEs and VR systems consist of three main components: input devices, output devices, and the simulated environment, which all work together to either enhance or decrease how real or believable the simulation feels [24, 29]. Input devices allow the user to interact with the VE, such as mouse, keyboard, or motion detectors. Output devices give information to the user about the environment, these consist of head mounted displays (HMD), speakers, smell generators, etc. Finally, the simulated environment itself is composed of virtual objects which have various properties and behaviors which determine how the user may interact with them, such as picking up objects, limiting movement of the user in the virtual environment, and other forms of manipulation [24]. VR systems transmit visual and auditory information with the greatest fidelity, even approaching levels of exactness of real-life stimuli, with mirroring real stimuli often being the end goal [29].

To elicit emotional reactions from users of VEs, "the feeling of being there", are required [15, 31]. One way that may increase presence for VE users is through increasing the immersiveness of the VE such as the graphical fidelity, interactivity, and use of various sensory output [32]. Clemente and colleagues [33], had participants look for objects while exploring a VE. In their study a higher degree of immersion lead to greater feelings of sense of presence, when comparing having participants view photos, watch videos of navigating through the VE, and allowing participants to freely navigate the VE on their own.

The current quantitative review (following PRISMA guidelines) was conducted to address issues found in the current literature. Specifically, the current meta-analysis did the following: 1) examined the overall effect of tDCS on cognition when using stimuli from VEs; 2) compared the effects of tDCS on dynamic versus static stimuli; and 3) assessed the impact of tDCS relative to cognitive domains measured. These goals were accomplished by consolidating data from currently available literature into both an overall analysis of cognition (i.e., all cognitive domains combined); and by partitioning the collected data into separate cognitive domains.

2. Methods

2.1. Study selection

Studies were selected based upon their use of tDCS in conjunction with virtual stimuli to influence cognitive outcomes. Selected studies used non-clinical (e.g., no clinical diagnosis) participants. An article search was conducted using a combination of key words including "tDCS OR transcranial direct current stimulation", "virtual reality OR VR", and "virtual environment OR VE". Databases included PsycInfo, Psychology and Behavioral Sciences Collection, PubMed, and, PubMed Central. Additionally, Google Scholar was used to search for articles that cited articles found from the other databases. Only studies written in English were included. Databases were last searched June 2018.

2.2. Study eligibility criteria

For the current analysis, only studies that met the following six criteria were included in the study: 1) reported quantitative data including interval or ratio data; 2) used a cognitive measure; 3) included at least one experimental group and a control (sham) group; 4) peer-reviewed and published study; 5) included enough data to calculate an effect size; and 6) used stimuli from a virtual environment.

2.3. Data analysis

The current study used a random-effects meta-analytic model. Researchers used means and standard deviations to calculate Hedge's g values for each study. For studies that did not report means and standard deviations, researchers used F -values to calculate Hedge's g values. The statistical analyses were performed using Review manager 5.3.5 (RevMan; 2014). First, a preliminary analysis was performed that used all available data to examine overall effects of tDCS on cognition. Secondary analyses were performed after partitioning data by cognitive domains and stimulus type. This included a comparison of virtual environment stimuli to psychological tests. Next, we conducted analyses based on cognitive domains such as attention and executive functioning, risk assessment, and processes associated with hippocampal functioning.

Publication bias was assessed via visual inspection of funnel plots [34]. Eleven of the research papers reported all data. Three studies selectively reported measures that reached statistical significance, only briefly mentioned other measures, and did not report quantitative data.

3. Results

The overall effect of tDCS on cognition when using stimuli from VEs produced a medium effect, Hedge's g of 0.45, 95% CI [0.30, 0.60], $z = 5.95$, $p < .001$. In the overall analysis, 68% of variability was due to differences in the ways in which studies were conducted, $\tau^2 = 0.21$, $\chi^2 (56) = 176.82$, $p < .001$; $I^2 = 68\%$.

The effect size for tDCS on cognition using dynamic stimuli produced a small effect, which was statistically significant, $g = 0.25$, 95% CI [0.09, 0.41], $z = 3.09$, $p < .01$. There was a significant amount of heterogeneity for these studies as well, $\tau^2 = 0.14$, $\chi^2 (36) = 90.82$, $p < .001$; $I^2 = 60\%$.

Additionally, a large statistically significant effect was observed for tDCS on cognition using static stimulus pictures from VEs, $g = 0.79$, 95% CI [0.58, 1.01], $z = 7.31$, $p < .001$. A statistically significant amount of heterogeneity in studies was present for studies using static stimuli, $\tau^2 = .12$, $\chi^2 (19) = 37.73$, $p < 0.01$; $I^2 = 50\%$.

Due to the large amount of heterogeneity in the studies a discriminant analysis was used to determine a rule of classification (cognitive domain of interest or different domain) using Fisher's linear discriminant function. A stepwise technique was used to select from a list of possible cognitive tasks that were chosen a priori as potentially contributing to the discrimination. Domains included attention and executive functioning, risk, and hippocampal dependent tasks. Attention and executive functioning ($g = 0.21$, 95% CI [-0.05, 0.46], $z = 1.56$, $p = .12$), risk assessment ($g = 0.67$, 95% CI [0.41, 0.92], $z = 5.19$, $p < .001$), and hippocampal dependent tasks ($g = 0.17$, 95% CI [-0.08, 0.43], $z = 1.36$, $p = .17$).

4. Discussion

This meta-analysis set out to consolidate findings from studies combining tDCS and VEs to influence cognition. Findings revealed moderate effects for overall cognitive processing. Stimulus type, screen capture or immersive VE, appeared to moderate the effect of tDCS on cognitive outcomes, with static stimuli producing larger effects. When examining the studies based on cognitive domains, a medium to large effect size was

observed in risk assessment. However, small effect sizes were found for studies assessing attention and executive functioning or hippocampal dependent tasks.

These results indicate that overall less immersive stimuli tended to have a greater influence on cognition than more immersive stimuli. It is possible that limited extent to which the dynamic stimuli were utilized, were not very immersive, and did not engender a sense of presence. Several researchers indicated that immersion and presence are important factors for user reactions to VEs [31, 32]

The effect size of tDCS on cognitive measures when used in conjunction with VEs could be due to several factors. While meta-analyses can increase statistical power to detect effects that are nonzero within the population, there are still a limited number of studies which use both tDCS and VEs. For the current study 13 research articles were used. These articles examined a broad range of cognitive domains, from learning surgical skills to threat detection [20, 40].

The current meta-analysis revealed that the impact of tDCS on cognition may be quite complex and more research is needed to examine potential moderators and mediators of the effects of tDCS on cognition when using VEs. As demonstrated by the additional analyses performed, tDCS leads to a range of effect sizes from a large effect for risk assessment, $g = 0.67$, to small effects for hippocampal dependent tasks, $g = 0.17$.

Studies evaluating attention and executive function relied mainly on common psychological assessments such as Balloon Analog for Risk Taking, Iowa Gambling Task, and continuous performance tasks. Executive functioning involves the ability to actively engage in a task and modify behaviors for optimal outcomes [39]. The effect of tDCS was relatively small and the effect did not reach statistical significance.

Data for risk assessment came from the largest subset of studies and included a variety of tests mainly focused on visual identification of threat. The confidence interval for the effect size was relatively small, likely due to the number of measures used. The results may be due to the fact that many of these studies came from a similar group of researchers who used measures that may have led to a larger effect size when compared to other domains. Results revealed that tDCS had a small effect on cognitive processes associated with hippocampal functioning such as learning, memory, and spatial navigation [37-39]. It is important to note that while meta-analyses may improve the accuracy of effect size estimates through the shrinking of confidence intervals associated with effect size estimates [37], the current review only included 13 studies. Studies in the current review also used a wide variety of experimental procedures. One of the most relevant differences among studies was the use of online versus offline stimulation. While online stimulation occurs during the task being measured, offline stimulation occurs either before or after the task [41].

In summary, the addition of tDCS to VEs can produce medium effect sizes on cognition. The produced effects appear to be dependent on the cognitive domain assessed. Given that tDCS had a larger impact on risk assessment, one of the most fruitful uses of tDCS and VEs may be for visual identification tasks. However, additional studies with larger sample sizes are needed.

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Cyberbehavior: A Bibliometric Analysis

Manuel J. SERAFIN^a, Gustavo R. GARCIA-VARGAS^b,
María del Pilar GARCÍA-CHIVITA^c, Mario I. CAICEDO^d and Juan C. CORRERA^{e,1}
^a*Departamento de Ciencias Básicas, Vicerrectorado "Luis Caballero Mejías",
Universidad Nacional Experimental Politécnica "Antonio José de Sucre", Venezuela*
^b*Departamento de Psicología, Universidad de Ibagué, Ibagué, Colombia*
^c*Centro de Estudios Aeronáuticos, Aeronáutica Civil, Bogotá, Colombia*
^d*Departamento de Física, Universidad Simón Bolívar, Caracas, Venezuela*
^e*Facultad de Psicología, Fundación Universitaria Konrad Lorenz, Bogotá, Colombia*

Abstract. Cyberbehavior, as the object of study of cyberpsychology, refers to the set of human behaviors that require an electronic device with Internet access to interact with other persons in both synchronous and asynchronous ways. Although the first studies of cyberbehavior took place with the popularization of the so-called "Social Web", few works focus on reviewing this literature. This paper aims to provide a bibliometric review of the scientific publication on cyberbehavior by analyzing all the documents published by four of the most representative international journals on the topic. The results show that in spite of the growth of the scientific community, the research has focused on the use of Facebook and other social media, while relevant subject matters for psychologists (e.g., motivation, personality, Internet addiction, cyberbullying or self-expression) remain little explored.

Keywords. Bibliometric; Cyberpsychology; Scientific collaboration.

1. Introduction

Scientific and technological advances have always been crucial factors in producing important changes in the whole history of the human race [1]. The magnitude of these changes and the rate at which they occur are increasing, and they have become part of us to the point of making life impossible, as we understand it in the absence of technology [2]. Since the worldwide popularization of the Internet, we can differentiate two manifestations of human behavior. The first one, known as real behavior, occurs in "natural" environments such as the office, the classroom, and the home in the usual sense. The second one, known as cyberbehavior, takes place in virtual environments that require the use of electronic devices to access the web to interact with other people or objects, in both synchronous (with continuous interactions without interruptions) and an asynchronous way (with intermittent communications, depending on the individual's availability to interact) [3]. Based on this definition, what do we know, then, about cyberbehavior? Cyberbehavior is the object of study of a discipline called cyberpsychology [4]. Roughly speaking, cyberpsychology focuses on studying the effects of the Internet and cyberspace on the individual and groups [5]. According to Harley, Morgan and Frith [2] cyberpsychology refers to the "study of how new communication technologies influence, and are influenced by, human behaviors and subjectivities" (p. vii). As these definitions rely on different perspectives with applications to various topics, a bibliometric analysis [6] proves to be the adequate method for identifying relevant information on the discipline as a whole.

The interest in cyberbehavior was already noted several decades ago by notable science fiction writers such as Robert A. Heinlein, Isaac Asimov or Arthur C. Clark, and

¹ Corresponding author: juanc.correan@konradlorenz.edu.co

nowadays its relevance is evident not only in the production of popular films and television series (e.g., “Black Mirror” or “The Social Network”), but in the creation of specialized scientific journals such as “Cyberpsychology, Behavior and Social Networking”, “Cyberpsychology and Behavior”, “Computers in Human Behavior” and “Human Computer Interaction”.

Cyberbehavior began to be known back in 2000 when Tim O’Reilly [7] popularized the term “Web 2.0” or “Social Web” [8], which refers to those websites that allow its users to interact and collaborate, being generators of content within a virtual community. Some examples of Web 2.0 are web communities, services, and Web applications, social networking, and video hosting services, wikis and blogs, mashups and folksonomies. Cyberbehavior is conspicuous, as it is present when talking about subjects such as cyberbullying [9], perceived privacy on Snapchat [3], Facebook security for teenagers [10], the paradox of happiness in social networks [11], the propagation of false news in social networks [12], the publication on Twitter of conspiracy theories about viruses or diseases [13], the consumption of pornography on the Internet [14], the laundering of money with bitcoins by criminal organizations [15] or the use of services to order food over the Internet [16].

The diversity of topics associated with cyberbehavior and their implications for other areas of knowledge makes their interest naturally multidisciplinary. Until 2009, conceptions of cyberbehavior from psychological perspectives were in an early phase [5]. Up to the best of our knowledge, there exist two types of reviews focusing on topics related to cyberbehavior. The first one, known as “CyberEurope”, targets the research of cyberpsychology in Europe between 2006 and 2016 [17,27-46]. “CyberSightings” is a second type of review that covers scientific breakthroughs, latest devices, conferences, book reviews, and general announcements of interest to researchers and clinicians [29 33- 14]. Apart from these efforts, we are not aware of bibliometric reviews of cyberbehavior at a worldwide scale. Because of its multidisciplinary relevance, we believe that the conceptions of cyberbehavior will reach maturity when psychological approaches integrate with proposals from physics, computing, economics, linguistics, communication, and marketing, due to the methodological contributions that these disciplines might offer about getting access to the data of the cyberbehavior and how to analyze them. As a discussion of the further contribution of other disciplines is beyond the scope of this paper, that could be the aim of another work.

A couple of cases will illustrate why other disciplines can provide valuable methodological contributions [34]. For example, a clear contribution from computer sciences refers to the use of web scraping as a technique that allows researchers to obtain public data from the Internet [35]. The employment of web scraping, for example, is useful to understand the influence of Twitter on electoral processes [36] or evaluating the impact of traffic conditions on key performance indicators of online food delivery platforms [16]. The intersection between network science [37] and economic sciences provides another clear contribution to analyzing the financial transactions carried out in cryptocurrencies and understanding why the blockchain system can be inefficient when it comes to registering quickly and accurately the economic exchanges between buyers and sellers [38].

The ideas mentioned above should make clear why cyberbehavior is relevant nowadays. Cyberbehavior analysis proves to be in the center of all internet-based interactions among human beings and information and communication technologies. Although it is not possible to exhaustively enumerate all the interdisciplinary links that exist to study cyberbehavior, we can, however, analyze a representative sample of these studies. This work aims to provide a bibliometric review of the articles published in four international journals with the highest impact factor within the scientific community specialized in the area. Supplementary materials accompany the approach presented in this work (e.g., raw data, and computational scripts developed in R). These materials (see sub-section 2.3) allow other readers to verify and reproduce the results we show after the following section. In section 3, we describe the most relevant findings of the scientific publication on cyberbehavior. The work ends with a discussion in section 4, focusing on the future of research on this subject.

2. Methodology

2.1. Research design

This work follows the specifications of a bibliometric study [39]. Bibliometric studies, according to Aria & Cuccurullo [6], are particularly useful to complement the literature review of a topic, by structuring and quantifying bibliographic information with the purpose of identifying the elements that make up the scientific study of a subject matter; for example, the most outstanding and influential authors and institutions in the scientific community, the most frequent keywords, the changes in the thematic limits of the disciplines and the identification of temporary research trends, among other aspects.

2.2. Data Collection Procedure

On November 15, 2018, the SCOPUS database was used to retrieve the bibliographic information of all the documents published by four of the most representative international journals on cyberbehavior: “Cyberpsychology, Behavior and Social Networking” (ISSN: 21522723), “Cyberpsychology and Behavior” (ISSN: 10949313), “Computers in Human Behavior” (ISSN: 07475632) and “Human-Computer Interaction” (ISSN: 07370024). The selection of these journals was based on their focus on topics related to human-computer interaction and applied psychology. To consult the bibliographic information in SCOPUS, the “International Standard Serial Number” or ISSN of each journal was employed as search criteria, with the following query string (ISSN (21522723) OR ISSN (10949313) OR ISSN (07475632) OR ISSN (07370024)). Year-by-year original records were downloaded in BibTeX format and were processed in the R environment [40] with the help of the bibliometrix package [6]. A total of 6,934 records published between 1985 and 2018 were downloaded. Since cyberbehavior began to occur thanks to the worldwide popularization of Web 2.0 [28], the analysis focused on the period between 2000 and 2018 ($n = 6,761$). The interested reader can access both the data of this work and its procedure for reproducing the following results by visiting this web address (<https://github.com/jcorrean/Cyberpsychology-A-Bibliometric-Analysis>).

2.3. Data Analysis

We used descriptive statistics and data visualization techniques in R [41]. We calculated the average annual growth rate of the publications with the algorithm “Annual growthrate” implemented in the “bibliometrix” package of Aria & Cuccurullo [6]. Furthermore, we used network analysis and visualization techniques [42] to analyze the evolution of the network that depicts the collaboration between authors with the new graphical user interface called “biblioshiny” launched from bibliometrix version 2.0.2. This type of analysis allows to visually understanding the growth of a particular scientific community. In addition, we identified the most dominant topics with the algorithm “KeywordGrowth” of the bibliometrix package. We employed standard text mining techniques to identify thematic clusters inside each journal. We discarded the bibliographic records that corresponded to the notes of CyberEurope and Cybersighting to get a resulting corpus consisting of 6678 unique article titles without common-use jargon and English stop words like articles, prepositions or adverbs whose frequency of appearance makes them less informative from a semantic point of view. We used the words of each title to generate a term-document matrix as the raw input that allowed us to build a dissimilarity matrix that we later employed to estimate pairwise-distances between articles and extract the words that belong to each cluster from each journal.

3. Results

Figure 1A shows the top-ten of most productive countries in the publication of scientific articles on cyberbehavior. The United States of America, Taiwan, South Korea, the United Kingdom, and Germany occupied the first five positions in this list, while the Netherlands, Italy, Canada, Spain, and China complemented this top-ten. Figure 1B

shows that the publication of articles between 2000 and 2018 presents two distinct periods, according to their volume of production. The first period, between 2000 and 2009, was characterized by a publication that did not exceed 150 articles per year. As of 2010, the publication of articles changed dramatically, increasing its volume by almost two orders of magnitude.

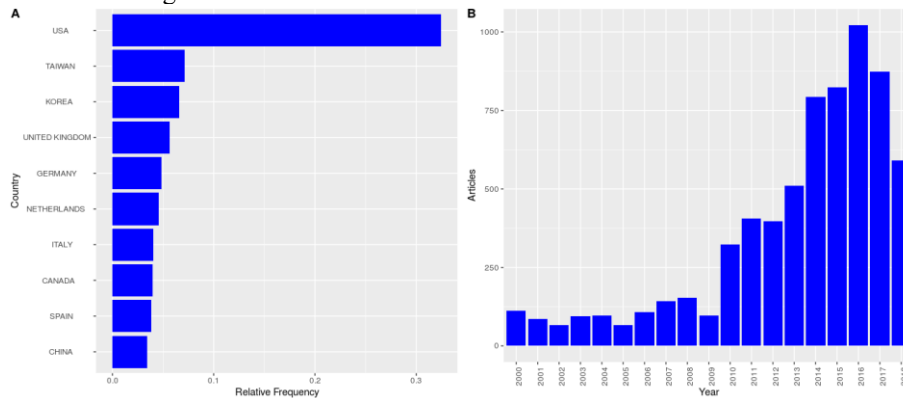


Figure 1: (A) Top-ten of most productive countries. (B) Publication volume between 2000-2018

The interannual average growth for the whole series was 9.68%. On average, any paper published in the journals that we queried is usually cited 23.79 times. In 2000, the size of the scientific community was composed of 227 researchers, distributed across 125 institutions in 17 countries, and by the end of 2018, its size reached a total of 13,059 researchers, spread across 3,893 institutions in 82 countries. Figure 2 depicts the evolution of scientific collaboration in the last 19 years where countries with the darkest blue proved to be the most active ones in publishing, and curved pink lines reflect the collaboration between countries.

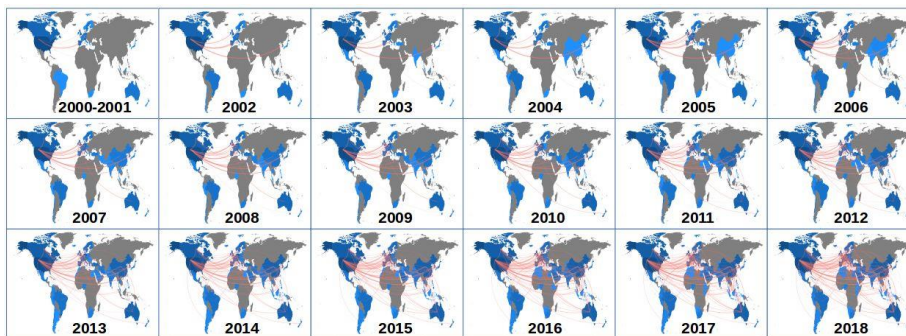


Figure 2: Evolution of the scientific collaboration network between 2000 and 2018.

The average number of authors per document was 1.93, while the average number of documents per author was 0.518. The index of collaboration among authors was 2.18 with 89.70% of articles signed by two or more authors. Figure 3 shows the network of the most productive authors in the publication of topics on cyberbehavior (those that occupy the 99th percentile in number of publications within the whole series).

In this network, authors are red nodes or points whose size represents the number of papers they have published between 2000 and 2018. The leaders of the most productive authors are editors in chief or regular editors of notes and reviews of the cyberbehavior community. The connection between authors is visualized by a straight line that connects two or more researchers if they are authors or co-authors of the same work. The transitivity coefficient of the authors' network was 0.527. This number represents the expected value of the probability that two authors will write a new work if they both share a co-author within this same network. The network that involves the 13,059 authors has a diameter of 31 nodes. This diameter represents the number of articles that a reader should read to grasp the panorama of topics that constitute the study of cyberbehavior by the journals consulted.

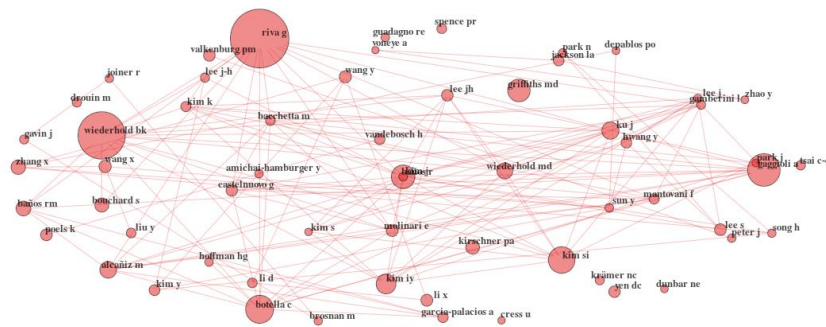


Figure 3: Most productive authors' collaboration network.

The dominant subject matters in cyberbehavior were those terms with the highest frequency of appearance within the authors-assigned keywords of each article. Figure 4 summarizes the growth in the number of publications that contain the 20 most dominant authors-assigned keywords between 2010 and 2018.

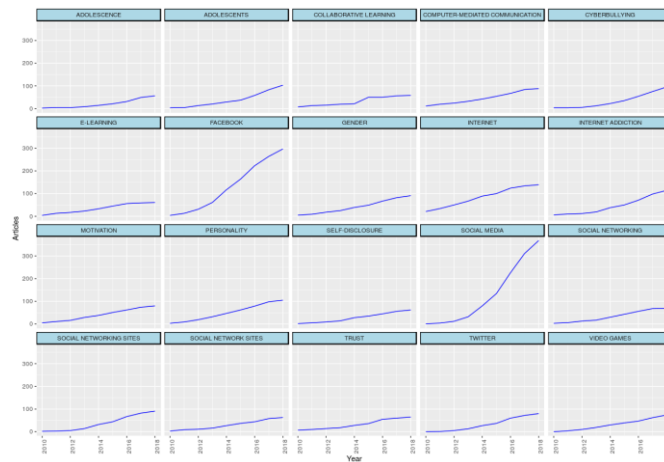


Figure 4: Top-20 rank of the most dominant authors-assigned keywords in the sample of published papers

In the last nine years, two terms occupied the first two positions in the top-20 rank of most common authors-assigned keywords of published papers. These terms, “social networks” and “Facebook”, highlight from all others by showing a steeper slope in Figure 4. Interestingly, some of the concepts with greater relevance for psychologists such as “motivation”, “personality”, “self-expression”, “Internet addiction”, “gender”, “adolescence”, “cyberbullying” and “confidence” were not as visible (less pronounced slope) as “social networks” and “Facebook”. It is also evident that the publication on cyberbehavior also shows some works on entertainment (i.e., videogames) and computer-mediated communication and learning (e.g., E-learning, collaborative learning). Although these less dominant yet visible keywords are more of the interest of software engineers and educators, respectively, they were not as prominent as the first two keywords of this rank. Moreover, keywords that reveal possible interdisciplinary links to tackle different aspects of cyberbehavior (e.g., telemedicine, cybersecurity, web scraping, application-program-interface, data science, network science, bitcoin, blockchain, virtual reality, cybersex) are missing from this rank.

Figure 5 depicts the thematic clusters that emerged from text mining the titles of the sampled articles. The largest cluster (n = 2845) emerged from the papers published in Computers in Human Behavior with the following words in their titles: “virtual”, “impact”, “networks”, “communication”, “interaction”, “new”, “digital”, “product”, “reality”, and “web”. The second largest cluster (n = 692) emerged from the papers

published in *Cyberpsychology, Behavior and Social Networking* with the following words in their titles: “impact”, “behavior”, “perceived”, “life”, “digital”, “training”, “effects”, “cyberbullying”, “sexual”, “theory”. The third cluster (n = 425) emerged from *Cyberpsychology and Behavior* with these words in their titles: “social”, “communication”, “web”, “cyberspace”, “effects”, “effect”, “women”, “theory”, “chat”, “characteristics”. The fourth (n = 387) and fifth (n = 338) clusters belonged to *Computers in Human Behavior* with these terms: “learning”, “collaborative”, “environments”, “group”, “multimedia”, “cognitive”, “reading”, “effect”, “system”, “solving”, “Internet”, “adolescents”, “cyberbullying”, “addiction”, “gender”, “gaming”, “use”, “problematic”, and “scale”.

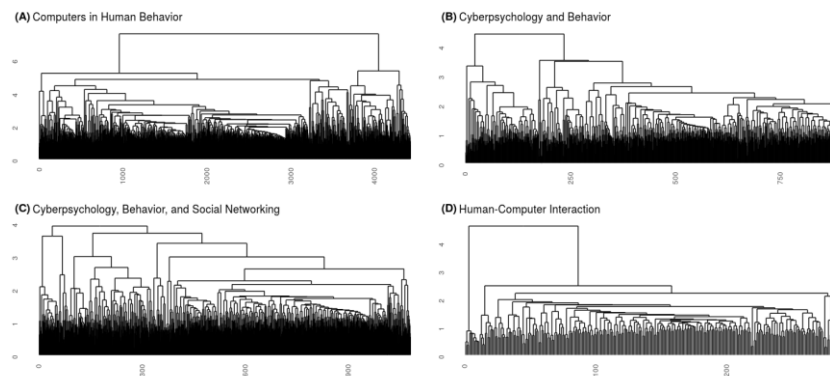


Figure 5: Thematic clusters from the titles of the articles published (A) *Computers in Human Behavior*, (B) *Cyberpsychology and Behavior*, (C) *Cyberpsychology, Behavior, and Social Networking*, (D) *Human-Computer Interaction*.

Some of the most cited papers that belonged to these clusters were those that analyzed why people use social networks [43], reviewed the research on cyberbullying [44], analyzed the intersection of users’ personality and social media use [45], examined Facebook Groups users’ gratifications [46, 47], described the motivations for play in online games [48], summarized virtual reality applications in the field of motor rehabilitation [49], synthesized the factors that facilitates remote work among working teams [50], or analyzed the use of Internet for cognitive therapies [51], online payment [52], generate trust on mobile commerce [53] and reviewed the role of social media in higher education [54].

4. Discussion

A bibliometric analysis of the scientific publication on cyberbehavior was the aim of this paper. We analyzed the bibliographic information of the articles published in four of the most influential journals in the area: *Cyberpsychology, Behavior and Social Networking*, *Cyberpsychology and Behavior*, *Computers in Human Behavior*, and *Human-Computer Interaction*. These analyses lead us to claim the following couple of contributions to the discipline.

While in previous studies explicit definitions of cyberbehavior are provided from the point of view of evolutionary psychology [5] or from subjective experiences that include the way in which people engage with Internet-based technologies [2], we showed another approach to cyberbehavior. In particular, we have illustrated the advantages of computational bibliometric reviews following the principles of comprehensive science mapping analysis [6]. The implementation of this kind of analysis, under the R environment [40], helps other researchers reproduce our results and verify the evidence we have provided [55]. The possibility of using computational bibliometric reviews as a means to generate new literature reviews or complement existing ones is a fruitful way to understand the behavior of scientific communities, as well as the dominant topics in the research agendas of scientific groups. The adoption of our approach might be beneficial for PhD candidates and other early-career researchers [56]. Arguably, the most

salient feature of this bibliometric approach was its focus on extracting quantitative information out of massive bibliometric records obtained from SCOPUS. This approach, then, overcomes the limitation of traditional literature reviews as it helps researchers in saving time when they look for relevant information inside technical literature.

A second contribution of our work relates to our results. In spite of the growth of the scientific community, we have shown that the research has focused on the use of Facebook and other social media., while relevant subject matters for psychologists (e.g., motivation, personality, Internet addiction, cyberbullying or self-expression) are far from deeply explored. Arguably, the attention that Facebook has generated on the scientific community might be associated with its role as a profitable business model that poses significant ethical concerns regarding users' privacy [57]. However, as cyberbehavior research also relates to other topics such as telemedicine, virtual reality, cybersex, E-commerce, and distance education, we foresee that future research on these topics will catch the attention of researchers coming from disciplines distinct from psychology. Finally, it is worth mentioning that research on these topics would expand the research toolbox of psychologists, as other sorts of data collection techniques will be available for analytical purposes (e.g., click stream analysis, content preferences, web analytics, APIs, face recognition, biometrics, etc.).

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Online Suicide Games: A Form of Digital Self-harm or A Myth?

Maria BADA^{a,1} and Richard CLAYTON ^a

^a*Computer Laboratory, University of Cambridge, Cambridge, UK Affiliation*

Abstract. Online ‘suicide games’ are claimed to involve a series of challenges, ending in suicide. A whole succession of these such as the Blue Whale Challenge, Momo, the Fire Fairy and Doki Doki have appeared in recent years. The ‘challenge culture’ is a deeply rooted online phenomenon, whether the challenge is dangerous or not, while social media particularly motivates youngsters to take part because of their desire for attention. Although there is no evidence that the suicide games are ‘real’, authorities around the world have reacted by releasing warnings and creating information campaigns to warn youngsters and parents. We interviewed teachers, child protection experts and NGOs, conducted a systematic review of historical news reports from 2015-2019 and searched police and other authority websites to identify relevant warning releases. We then synthesized the existing knowledge on the suicide games phenomenon. A key finding of our work is that media, social media and warning releases by authorities are mainly just serving to spread the challenge culture and exaggerate fears regarding online risk.

Keywords. Suicide, self-harm, online games, prevention

1. Introduction

Much attention is currently given to the threat apparently posed by online suicide games, such as the Blue Whale Challenge, Momo, the Fire Fairy, Doki Doki, and others. They are said to involve posting about progress through a series of challenges, which include self-harm behavior, ending in suicide. Authorities regularly draw attention to these games by issuing warnings about them. The ‘challenge culture’ is a deeply rooted online phenomenon. There are many other less obviously dangerous challenges besides suicide games, such as the salt and ice challenge, the cinnamon challenge and more recently, skin embroidery. Regardless of whether a challenge is dangerous or not, youngsters are especially motivated to take part, presumably because of a desire for attention. They are constantly faced with a barrage of cultural norms and values, what their peers think and do, media coverage and social policies, each of which inform their thinking, values and beliefs [1].

Mainstream media links the Blue Whale Challenge to at least 130 teen deaths in Russia and attempts at suicide in Spain and Ukraine [2]. However, despite these claims there is no evidence for large numbers of deaths linked to suicide games. Snopes investigated Blue Whale in 2017 and deemed the story ‘unproven’ [3]. In 2019 the BBC posted a detailed history of Blue Whale showing there was no record of such a game prior to a single Russian media article of dubious accuracy [4]. The UK Safer Internet Centre (<https://saferinternet.co.uk>) calls the claims around Momo ‘fake news’, while YouTube has (despite this being central to media accounts) found no evidence of videos showing or promoting Momo on its platform. Researchers who studied five Italian case histories allegedly linked to Blue Whale found that the patients, although self-harming, were not participating in a suicide game [5].

¹ Author: maria.bada@cl.cam.ac.uk

Nevertheless, authorities around the world continue to react to inaccurate media reports by releasing warnings and creating information campaigns to warn youngsters and parents about the risks related to these online suicide games.

This paper examines the online phenomenon of the 'challenge culture' and its association with self-harm, focusing on: 1) identifying the social media spread of the challenge culture; 2) understanding the behavior of young people taking interest in the Blue Whale challenge and other games; and 3) exploring the practices of authorities in providing warnings and awareness programs.

2. Literature Review

2.1. Self-harm

Previous research shows that the Internet is spreading self-harm behavior among vulnerable teenagers who are characterized by epidemiological, psychological, psychiatric, social, and cultural risk factors [6]. However, there is little research on the reasons or the motivation of young people for revealing self-harm online.

Boyd [7] speculated on three possibilities: self-harmers might be uttering a cry for help, they might want to appear 'cool', or they may be trying to trigger compliments. If digital self-harmers are 'crying for help', this indicates that mental health problems or disorders might be present. Self-harm is the strongest predictor of suicide among young people and adolescents who self-harm report that it is difficult to talk about their suicidal feelings and that they do not really feel 'listened to' when they do communicate on this topic [5]. Research has shown that self-harm and depression are linked to an increased risk of suicide and so, online manifestation of self-harm behaviors may precede suicide attempts [8]. Self-harm may be a demonstration of felt pain and distress while those who participate in offline self-harm are more likely to be involved in digital self-harm [9].

Studies suggest that the Internet may exacerbate existing risks, illustrated by examples of individuals who commit to killing themselves in online suicide for a and then feel they cannot back down [10]. Phippen [11] stresses that both content and behavior have a contribution to causing upset online for young people. Young people use online technology for communication, they do not merely consume content with these platforms.

2.2. Technopanic

The term 'technopanic', often used by experts in child online safety, highlights the exaggeration of sometimes real, other times non-existent, risks in the digital world. Technopanic is not new, it has accompanied all new technology - from electricity, to radio and television. But digital technopanic has a special characteristic which amplifies it - the submerging of the new generation in new technologies and the unpreparedness of parents for 'digital parenting' [12]. Overcoming fear may be perceived as adventurous and psychologically rewarding. It is natural that daring against an unexposed fear gives a feeling of pleasure and satiation, especially upon success. Adventure games exploit this fear psychology [13]. So exaggerating youth risk-taking and spreading both the hype and fear only increases the risk to young people who are relying on perception rather than facts. It directly impacts their behavior, in this case in a negative direction [14].

2.3. Media Literacy

Understanding what media content really means, what its source is and why a certain message has been constructed, is crucial for quality understanding and recognition of media mediated messages and their meaning. Adequate answers to all these questions can only be acquired by media literacy [15]. However, in most countries, media education is still a secondary activity that teachers or media educators approach without proper training or material. It has been added to the curriculum in many countries but much more is needed in practice.

A key concern when discussing suicide games is the risk of ‘suicide contagion’ [16], which could turn stories into a tragic self-fulfilling prophecy for a small number of vulnerable youths. The American Foundation for Suicide Prevention has published guidelines for journalists that include avoiding, “*big or sensationalistic headlines, or prominent placement of suicide reports, and not describing recent suicides as an ‘epidemic’, ‘skyrocketing’, or other strong terms*” [17].

2.4. Policy Implications

As a response to incidents of youth suicide and the linkage of these incidents to online suicide games, policy decisions have been made in the UK and other countries. In the UK social media firms are now being forced to disclose data that could reveal their role in fueling self-harm and suicides [18]. The UK Government have now published a White Paper [19] on online harms which sets out the government's plans for a package of measures to keep UK users safe online.

There have been also national level policy decisions such as taking down websites. In India, this has led to a court decree for shutting down websites to stop the spread of the Blue Whale challenge [20]. The Indian government has also asked companies like Google, Facebook, WhatsApp, Instagram, Microsoft and Yahoo to remove all links related to Blue Whale Challenge [20]. Additionally, in 2017 Russia passed a law [21] introducing criminal responsibility for creating pro-suicide groups on social media and for inducing minors to commit suicide.

3. Research Methods and Results

We took several approaches to this research, so as to triangulate data from different sources. Triangulation refers to using multiple data sources in qualitative research to develop a comprehensive understanding of phenomena [22]. Triangulation has also been viewed as a qualitative research strategy to test validity through the convergence of information from different sources. Below we present the results from a) interviews; b) news reports and media; and c) warning releases.

3.1. Interviews with Teachers, Child Protection Experts & NGOs

We conducted five interviews with teachers, child protection experts and NGOs using open-ended questions. The questions used referred to: a) the challenge culture; b) youth and self-harm; c) psychological disorders associated with self-harm; d) the role of parents and schools; e) the links to authorities; f) awareness programs or training provided to teachers and parents and g) ICT-risk related policies at schools.

We found a lack of understanding that online suicide games are ‘fake news’ and a general misperception of how to react to related incidents. A teacher informed us that “*Recently, two teachers from two different classes heard children talk about Momo, they were planning to call over the weekend* (Participant 1).” The school then decided to release a warning email to parents.

Additionally, interviewees informed us that “*according to school policy children under 13 years old, are not allowed to use social media, and if they do it needs to be reported* (Participant 1).” According to interviewees, “*children think that it is cool to discuss about these games, they would play a game because their friends do and then they would talk about it at school. It is cool, it is trendy* (Participant 2).”

Regarding the ‘challenge culture’, an interviewee mentioned that “*children do enjoy the YouTube videos and anything that has to do with challenge and then there is also peer pressure* (Participant 3).” It was also mentioned that “*Facebook and Google have tried to control the circulation of videos with the title challenge, Momo etc. but people would find a way around it and still circulate videos* (Participant 3).” An interviewee from an NGO noted that “*media started to repeat the story about the Blue Whale Challenge back in 2015. At that point the helpline was receiving 35 calls every day, people were worried, and the story spread quickly. Schools also shared warnings with parents. Then parents shared with Facebook. However, these were no real case evidence* (Participant 4).” An expert from an NGO further noted, “*There is no*

suicide game, no risk. The real risk is lack of communication and the generation divide. If we talk to a specific challenge or game, then it promotes the game. We need to talk in general (Participant 5)."

3.2. Media reports review

We searched for news reports in the period 2015-2019 using the keywords: 'Online AND Suicide AND Game', 'Self-harm', 'Blue Whale Challenge', 'Momo Challenge', 'Blue Whale Suicide Game', 'Doki Doki'. We then used Buzzsumo to count articles, Twitter shares and Facebook mentions in the last two years.

As Table 1 shows, the original news stories have been amplified many times through social media with news about Momo spreading further than the Blue Whale challenge. In February 2019, Momo was once again picked up by UK media and social media, leading to a rapid increase of search interest from the public [23].

These findings indicate that seeing articles or news reports of online suicide games is becoming more common. The main issue here is whether media reporting on the online suicide games is becoming the norm. As mentioned above, there is a general misperception and a general lack of media literacy around this topic.

Table 1. References (blogs, tweets etc.) to relevant media articles 2017-2019

| Media source 'Blue Whale' | References | Media source 'Momo' | References |
|---------------------------|------------|------------------------|------------|
| The Sun | 8.479 | BBC | 718.500 |
| BBC | 7.700 | The Atlantic | 157.300 |
| Daily Mail | 3.400 | Forbes | 107.900 |
| | | The Guardian | 84.700 |
| | | New York Times | 31.000 |
| | | Wired | 23.700 |
| | | National Online Safety | 20.000 |
| | | The Telegraph | 1.500 |

3.3. Police and School Warning Releases

We searched UK Police and related websites for warnings about online suicide games. We found some use of the web to post warnings to alert parents, but that warnings often appeared on social media, such as Twitter or Facebook.

A Devon and Cornwall Police PCSO posted on Twitter "*Who ever created this horrible game is sick! Parents: Please be aware of this 'game' talk to your children about it if concerned*" [2] (Quote 1) and Cambridgeshire Police warned parents about "*a sinister social media suicide game*" (Quote 2) but both said there were no reports of anyone in their counties taking part in the game [24].

Schools have also been asked to inform parents. Schools in Essex, Cambridgeshire, Hertfordshire, Cornwall and elsewhere have sent letters to parents explaining the risks involved in the challenges. A central justification appears to be that "*the school has a duty of care for young people*" [25, 26].

4. Discussion

News reports and articles about online suicide games are extremely common, but there is a lack of media literacy around this topic which means that these reports are often taken at face value, whereas the overwhelming evidence is that they are 'fake news'. This is compounded by a lack of knowledge about how best to report suicide incidents so as to avoid any possibility of 'contagion'.

We found that police officers in Britain, France and Belgium have been posting warnings about suicide games using media such as Twitter and Facebook. However, Bulgaria's Centre for Safe Internet reported in 2016 that stories about suicide games were essentially online rumors and no basis in fact could be found. The Centre made the link to a more general inability of children and their parents to distinguish fake news from real content on the Internet [27].

Better media literacy is needed, but training and awareness-raising programs need to be frequent and tailored to the needs and interests of each group and communicated in a way and language they can easily relate with [28]. Different approaches are available to support young people, such as a games, videos or exercise-based educational material [29]. Our research leads us to the following policy recommendations:

- **Awareness and education** to ensure that young people can handle risks online and offline [28]. Training of teachers is needed as well as study materials. Online media education must take its place in the curriculum [30], but considerable attention also needs to be devoted to helping and empowering parents, so that they can guide their children to personally determine if an activity is risky or not;
- **Guidelines for media and social media reporting of suicides** are needed at national and international levels [17] to ensure that media and social media report suicides responsibly. These guidelines must evolve in line with improved strategies for suicide prevention and the development of community response plans;
- **Improve social media and media understanding of suicide.** Media must avoid re-running details of each death in every report, avoid speculation about the 'trigger' for a suicide and should use the story to inform readers about the causes of suicide, its warning signs, trends in rates and recent treatment advances [31];
- **Collaborative efforts to prevent 'fake news' about suicides.** Google, Facebook and Twitter have already floated a range of ideas to combat the spread of fake news more generally, including compiling lists of fake news sites, flagging certain stories as having been disputed as fake, using plug-ins and apps to detect fake news, and even taking down known fake news providers [32];
- **Quality control of warning releases by authorities.** Authorities must follow general guidelines for news about suicides, warning but not stimulating extra interest. However, they must go further to ensure that they are not just another source of fake news. They must collaborate with other authorities and with NGOs to ensure that their warnings relate to real events - and then, when appropriate, work with cybercrime units to deal with criminal behavior.

We do not dispute that suicide amongst young people is of justifiable concern, but we can find no evidence of suicide games leading to mass suicide in the way that the hype suggests. Media and social media are copying stories about suicide games and feeding on each other with little evidence that their tales are true. The exaggerated fears around online risk and official warnings merely promote the challenge culture and drives youngsters to seek out these challenges.

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SECTION III

EVALUATION STUDIES

To date, some cybertherapy applications have improved the quality of health care, and later they will probably lead to substantial cost savings.

However, cybertherapy is not simply a technology but a complex technological and relational process.

In this sense, clinicians and health care providers that want to successfully exploit cybertherapy need a significant attention to clinical issues, technology, ergonomics, human factors and organizational changes in the structure of the relevant health service.

Wiederhold & Riva, 2004

Propensity to make social connections and structural social capital of SNS users

Yadviga SINYAVSKAYA^{1, a} and Alexander PORSHNEV^a

^a*National Research University Higher School of Economics, Laboratory for Internet Studies, Saint-Petersburg, Russia*

Abstract. The present study aims to investigate the relationship between structural social capital of social networking site (SNS) users and their propensity to make social connections. We focus on Vkontakte SNS as the most popular one in Russia and obtain both network data on ego-networks characteristics and self-reported data on the motivation to make connections from 363 respondents. The results support the idea that the growth of personal networks is driven by the own motivation of users along with the effect of preferential attachment is observed. In addition, users with different level of motivation to connect with others turned out to demonstrate different patterns of online friending behavior: less motivated users form more tight and dense ego-networks in comparison with highly socially-oriented users. In contrast, highly motivated users possess more loose and centralized networks, which may reflect the tendency of ego-network having a star-structure.

Keywords: Social capital, Propensity to make connections, ego-networks, Social network analysis, Social Networking Site (SNS)

1. Introduction

The advent of Social networking sites (SNSs) has brought about a revolution in the daily communication process. The extant body of studies has evidenced how users' engagement with SNSs leads to several advantages in terms of social capital [1].

The stream of research on online social capital may be categorized based on the conceptualization of social capital it proposes. The present study relies on the structural understanding of social capital, which takes individuals' social network structure as an approximation of the social capital suggesting that social benefits derive from the composition of social ties in the personal networks [2]. Using Putnam's distinction on bonding and bridging social capital [3], the previous studies showed that different characteristics of individuals' personal online social networks are associated with both types of social capital. Brooks et al. conceptualized bridging social capital based on the number of clusters (social groups) within an individual's online network and bonding social capital as the density of social ties within the network [4]. In addition to this, the topology of a personal online social network is associated with higher socioeconomic status and more diverse economic resources [4]. In addition, the extent of the already-gained amount of social resources of a person also matters for the online social capital growth: users with a higher number of social connections ("online friends") in SNS have a stronger ability to make new ones [5]. However, it remains unclear, how the propensity of a user to initiate and maintain social ties is related to the individual structural social capital. In this research, we aim to bridge the gap in understanding the mechanism of accruing online social ties in SNS: whether the online social capital is a result of users' own intentional activity to build the social landscape rather than a byproduct of the already gained amount of social resources. In particular, we examine the relationship between the propensity to make social connections and the structure of personal social networks (so-called "ego-networks") on SNSs. In the online context, the ego-network is a reflection of existing social ties between a user ("ego") and its online friends. First, we analyze how the growth of users' online social networks in SNS is related to their motivation to establish social connections. Second, we investigate how users differ in the structural characteristic of ego-networks depending on their level of motivation to establish social ties.

To the best of our knowledge, no research to date has explored the dynamic and structure of personal social networks in the proposed context.

¹ Corresponding Author, Book Department, IOS Press, Nieuwe Hemweg 6B, 1013 BG Amsterdam, The Netherlands; E-mail: bookproduction@iospress.nl.

2. Data and method

The study focuses on SNS users from a typical Russian city (Vologda), which are registered on the most popular and largest Russian-speaking SNS - Vkontakte.ru (VK). It provides functionality similar to Facebook: users may create a personal account, form a network of online friends, or exchange messages in private and public. In addition to this, users may use the personal pages in VK as a channel for broadcasting different information, e.g. offer different services, selling goods etc.

The data from 363 respondents in correspondence with the demographic distribution of Vologda city were collected during the online survey (Fall 2017). The online application¹ which contained the questionnaire was integrated into Vkontakte as a standard public available application. The preview page provides information about the research project, the consent form and the terms of using the app. During the online survey, the self-reported data on the motivation the make social connections, the usage of Vkontakte and demographics were obtained. In addition, the application downloaded automatically the online data about the VK friends after getting users' agreement to share with this information. In order to assess the shift in the number of online friends 1 year apart, the two waves of downloading data on users' online friends were performed (Fall 2017-2018).

2.1. Measures

Motivation to make social connections

The scale of propensity to make connections with others (PCO scale) introduced by Totterdell et al. was used to measure the motivation of individuals to establish social ties [6]. Previously the scale was tested in the organizational context: it was shown that propensity to make connections is related to such positive social capital outcomes as social support received, work attainment and well-being [6] as well as job satisfaction [7]. In the context of the research, only two dimensions were of interest: the intention to have social connections (e.g., "I like being able to connect people") and the self-reported evaluation of its current amount (e.g., "I often put people in touch with the right person when they need something"). According to the research of Totterdell these two dimensions can form one scale. Cronbach's alpha of the adapted scale exceeded the 0.7 threshold (Cronbach's $\alpha=0.8$, $M=1.8$, $SD=0.96$), which is suggested as the appropriate value for exploratory research [8].

Structural online social capital

First, we assessed the *shift in the size of personal networks*. It was calculated as a delta in the number of user's online friends between two time periods (1 year apart).

Second, the information on users' online friendship ties was used for building the ego-networks (mapping the social ties within users personal network) and calculating *different metrics* like density, number of isolates, mean distance, transitivity, modularity and several types of network centralization (by degree, by closeness and by eigenvector) [9].

Demographics and control variables

Participants were asked a series of questions about the demographics: age, sex, and education. 56% of respondents were female, with an average age of 32.5 (min=14, max=83, median=31, $SD=12.97$). About one-third of participants reported "unfinished high-education" level of education (30.7%), 9.9% of respondents were university graduates. We also controlled for the professional usage of VK by asking respondents to evaluate the extent that they used their account for selling goods and services, developing online communities for commercial goals or promoting themselves (Likert-type scale). In addition, we measured the intensity of VK use by asking respondents: 1) "During the last few weeks how much time a day did you spend on average surfing Vkontakte?" (time of online session) and 2) "How quickly do you get to know that your friend wrote you a message in Vkontakte?" (frequency of usage).

¹ DigiFriends app: https://vk.com/app6067290_-53622302

3. Procedure and results

First, to test our main hypothesis that motivation to make connection contributes to the growth of the individual's social network, we ran a series of nested Ordinary Least Squares (OLS) regressions. In addition, we consider the actual number of friends in order to control for effects of preexisting online ties on the growth of users' ego-networks. As our goal was to predict the *growth* of the personal network, the users with negative shifting in the network size (i.e. users who have excluded some friends from the network during the observed period) were removed from the sample. The final sample consisted of data on ego-networks from 274 respondents who have demonstrated the positive or zero shift in the number of online friends. Second, we explore how people with various levels of motivation may differ in the ego-network structure. We divided our sample into two groups by the mean value of propensity to make social connections. In result, we received the group with a high level (N=185) and the group with a low level of propensity to make connections with others (N=168). Only three ego-network parameter variables were successfully transformed into normally distributed ones by means of log-transformation: density, the number of isolates, and transitivity. Thus, the non-paired non-parametric Wilcoxon signed-rank test was used for assessing the difference in means values of different network parameters between two groups.

Descriptive statistics

Descriptive analysis showed that respondents are highly engaged in Vkontakte: two-thirds of them spend at least an hour or more per day in Vkontakte. 20% of respondents pointed out that they have an instant notification on their devices about new messages received.

3.1 Predicting the social network growth

In the regression model (Model 1) predicting the shift in the size of personal networks, the control variables accounted for 6% of the variance, with professional usage of SNS ($\beta = 0.18$, $p < .001$) and time of the online session ($\beta = -0.15$, $p = .016$). It means that professional users tend to expand their personal networks more heavily than regular ones. The length of an online session associates negatively with the increase in online friends. Other demographic variables: sex, education level, and occupation type remained non-significant (as well as the frequency of SNS use) and were excluded from the model.

On the next step, the variable on the propensity to make connections was added to the model (Model 2), which increased the model fit (Adj. $R^2 = .151$). Motivation to make connections significantly predicts the shift in the number of friends ($\beta = 0.46$, $p < .001$), supporting the idea on the role of motivation in the formation of social ties. Additionally, it reduces the effect of professional usage of SNS and time of the online session.

Finally, the actual number of friends (log-transformed value) was included in the model in order to control to what extent the shift in the network size is explained by the current number of friends ("preferential attachment effect") (Model 3). Addition of a logged number of friends in the model ($\beta = 0.53$, $p < .001$) increased the quality of the model (Adj. $R^2 = .344$) while propensity to make connections was still significant ($\beta = 0.06$). Thus, we observe that people who already possess great number of friends are more prone to expand their social circle. At the same time, the growth of the personal network is explained by the own motivation of an individual to make social connections as well. The essential results are presented in Table 1.

Table 1. OLS Regression predicting friendship shift in the personal networks of SNS users

| | Model 1 | | | Model 2 | | | Model 3 | | |
|--|-------------|------------------|----------|-------------|------------------|----------|-------------|------------------|----------|
| | <i>B</i> | <i>std. Beta</i> | <i>p</i> | <i>B</i> | <i>std. Beta</i> | <i>p</i> | <i>B</i> | <i>std. Beta</i> | <i>p</i> |
| (Intercept) | 2.80 | | <.001 | 1.89 | | <.001 | -0.41 | | .358 |
| Professional use | 0.18 | 0.55 | <.001 | 0.09 | 0.27 | .088 | 0.07 | 0.21 | .154 |
| Time of online session | -0.15 | -0.45 | .016 | -0.11 | -0.32 | .069 | -0.06 | -0.18 | .267 |
| Propensity to make connections | | | | 0.46 | 0.87 | <.001 | 0.28 | 0.54 | <.001 |
| Log. friends | | | | | | | 0.54 | 1.12 | <.001 |
| Observations | 274 | | | 274 | | | 274 | | |
| R ² / adj. R ² | .114 / .059 | | | .204 / .151 | | | .347 / .301 | | |
| Only significant variables are presented at the table. | | | | | | | | | |

3.2 Motivation to establish social ties and ego-networks structure

It was explored how users with various level of propensity to make connections differ in the ego-network structure. The comparison of the means values showed that there is a significant difference between groups in some network parameters.

The users with high level of motivation to connect with others possess significantly less dense networks ($Z=-3.6$, $p<0.001$) with greater number of isolates in there ($Z=4.4$, $p<0.001$). The ego-networks of highly motivated users are more centralized (by degree ($Z=3.3$, p -value = $p<0.001$), by eigenvector ($Z=3.49$, p -value = $p<0.001$) and by closeness ($Z=2.49$, $p<0.001$)) relatively to users with low level of motivation to establish social ties. In addition, the former have significantly more friends ($Z=5.4$, $p<0.001$) with greater value of mean distance between them ($Z= 3.6$, $p<0.001$). The difference between groups in transitivity values was non-significant ($Z=-1.07$, p -value = 0.283). The results of the comparison are presented in Table 2.

Table 2. The results of Wilcoxon signed-rank test, the comparison of users with high and low level of propensity to make connections

| Group | Number of friends | Density | Isolates | Mean distance | Transitivity | Centrality (degree) | Centrality (closeness) | Centrality (eigenvector) |
|-------|-------------------|---------|----------|---------------|--------------|---------------------|------------------------|--------------------------|
| Low | 112 | 0.074 | 10.5 | 1.926 | 0.284 | 0.934 | 0.969 | 0.848 |
| High | 200 | 0.056 | 17.0 | 1.944 | 0.246 | 0.949 | 0.976 | 0.878 |

4. Discussion

The aim of the study was to investigate the role of motivation to connect with others in the online social capital formation of SNS users.

First, the results support the idea that the growth of the ego-network in the SNS is affected not only by the current number of social connections in SNS but also by users' own motivation to have more social ties. Thus, the number of online contacts in a social network is a reflection of general users' ambitions in social terms. It allows considering social networking sites and users' digital traces as a valuable source of data which in fact relate to the identity of SNS users. Second, users with various levels of "social" motivation turned out to differ in ego-network structure. Users less inclined to social activity form more dense and tight ego-networks in comparison with socially oriented people. In contrast, highly motivated users possess more loose and centralized networks, which may reflect the tendency of ego-network having a star-structure.

These results may indicate different patterns of managing the online social environment. According to certain indicators like geodesic distance and centralization of networks, it could be concluded that less motivated users reproduce small-world type networks (i.e., highly connected networks). At the same time, the networks of the highly motivated users consist of “heterogeneous” contacts with connection being mediated by the ego, as evidenced by the greater values of networks’ centralizations, the average geodesic distance and the number of isolates.

These findings could be expressed in terms of “strong” and “weak” ties. The denser networks of less-motivated users could be treated as “strong” oriented ties, while loose networks of highly motivated ones as weak oriented ties. Thus, if the ego-network structure is associated with the users' intentional social activity, we can suppose that different people tend to pursue the various types of online social capital. Highly motivated develop bridging social capital which is associated with the weak ties while low-motivated ones are oriented to the bonding social capital which is associated with the strong ties.

The limitation of this study is that we obtained only publicly available data on online friends, parts of which were unreachable due to privacy restrictions applied by a user. In addition, since we analyzed data from one of the most popular SNS in Russia, the ability of ego-networks gained from only one particular SNS to reflect the entire social circle of individuals may be limited. Finally, our study is not free from the typical sampling issues inherent for online studies: first, we are unable to reach individuals who do not have Internet access; second, studying the online population may address by default only those who already have a high motivation to connect with others. Finally, the construct of motivation to connect with others was assessed by means of the self-reported method.

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#Eating disorders and Instagram: What emotions do you express?

Clelia MALIGHETTI^{a,1}, Alice CHIRICO^a, Simona SCIARA^{a,b} and Giuseppe RIVA^{a,c}

^a *Department of Psychology, Università Cattolica del Sacro Cuore, Milan, Italy*

^b *UniSR-Social.Lab, Faculty of Psychology, Vita-Salute San Raffaele University of Milan*

^c *Applied Technology for Neuro-Psychology Lab, Istituto Auxologico Italiano, Milan, Italy*

Abstract. Instagram is an image-based social media platform for mobile devices that promotes a new form of communication and self-expression based on images and photos. Although this image-based communication has become a wide form of online self-presentation, it is still less investigated if compared to social media text content analysis of written posts. Crucially, most Instagram images that circulate on a daily base show thin, muscular, and unrealistic body ideal, creating a breeding ground for disordered eating. Far less investigated is the emotional profile of pictures with hashtags related to eating disorders. The aim of the study was to examine the emotional expression of hashtags related to eating disorders of images posted by users on Instagram. Two hundred and fifty Instagram photos of females were considered. The hashtags were selected accordingly to a web-ranking on the most popular hashtags for eating disorders on Instagram: #anorexia, #thininspiration, #eatingdisorder, #fitinspiration and #body. The emotions expressed in each photo were measured using the Emotion API from Microsoft Azure Cognitive Service. The results showed that happiness intensity was significantly higher in images with #eatingdisorder and #fitinspiration compared to #body, and higher levels of neutral emotion were found in images tagged with #body and #thininspiration. This exploratory study was one of the few studies focusing on discrete emotional expression of eating disorder photos using artificial intelligence technology.

Keywords. Instagram; Eating Disorder; Emotions; Hashtags

1. Introduction

Instagram is an image-based social media platform for mobile devices that offers the possibility to upload, edit, share pictures and very short videos with other users. This increasingly used social media platform promotes a new form of communication and self-expression based on images and photos. Most Instagram images that circulate on a daily basis show thin, muscular, and unrealistic body ideal. Exposure to these thin ideals can result in decreased body satisfaction [1-4] that has been associated with unhealthy weight control behaviors and binge eating [5], eating disorder (ED) symptomatology [6, 7], depressive symptoms and low self-esteem [8]. In accordance with these findings, recent studies have shown that social media generally, and Instagram specifically, represent a breeding ground for the development of EDs [9, 10]. There is a large amount of literature [11,12] showing the relevance of body appearance on social media communities and the alarming implications that social media exposure has on body acceptance [13,14]. Furthermore, to contribute to the virality and the exposure of images, Instagram provides hashtags, tags or words prepended with ‘#’ used to indicate the content of the picture or the tone of the message. To date, there are many hashtags related to body satisfaction and eating disorders posted on Instagram.

¹ Corresponding author: Clelia.malighetti@unicatt.it

Most of this content is classified as “thinspiration” or “thinspo” [15].

These hashtags have fueled the proliferation of the idealized body therefore increasing media exposure to viewers [16]. ‘Inspirational’ imagery is often shared on social media with the aim of inspiring to achieve a certain, often unachievable, body type. This inspiration refers to content posted on social media that inspires a user to be thin, and this is typically achieved through the presentation of images that contain thin bodies, as well as tips for lose weight or manage the hunger [17]. Traditionally, thininspiration has been associated with the pro ED community that considered eating disorder as a lifestyle choice instead of an illness condition [18]. More recently, thininspiration content has moved away from this association with the ED community and has been shared by everyday Instagram users. However, thinspiration or inspirational messages promoting thinness, has received criticism for its detrimental effects on body image [19] and has been accused to be a contributor towards the onset of eating disorders.

Several researchers have analyzed thinspiration content on social networks showing that these posts feature images of extremely thin or underweight women, often in sexually suggestive poses focused on the pelvis and abdomen, and the bony features of those parts, emphasizing appearance and attractiveness, rather than health, as motivation for engaging in fitness behaviors [20]. In this regard recent studies revealed that ‘Fitspiration’, a popular hashtag coined by the fitness community as a healthy alternative to thin inspiration, actually increased negative mood, body dissatisfaction and decreased self-esteem [21, 22] describing images that contained only thin and toned body type and objectifying elements. Whilst fitspiration presents itself as a healthy alternative it may, however, contain some negative elements typically found within thinspiration content. To date, psychological researches on social networks have focused mainly on the effect of exposure to content. Very few studies have investigated the emotional profile of pictures with hashtags related to EDs: researchers have focused less on the study of the emotional expression of images or photos on Instagram and the few existing studies relied on a positive/negative model of emotions.

In light of the proliferation of “inspirational” hashtags related to eating disorders and the lack of research regards the emotional implications, the present study aims to explore the emotional expression of hashtags related to EDs of self-produced images posted by users. Instagram provides a new opportunity to investigate the role of authoring figurative content and its emotional salience as it allows users to be simultaneously content-creators and consumers. Furthermore, this investigation focused on discrete emotions expressed by posted images to overlap the bipolar approach (positive vs negative) toward emotions on Instagram.

Despite the preliminary nature of this study, we assumed that, according to previous studies on the effect of the exposure to images showing certain body type [23,24] the images described by hashtags related to eating disorders will be significantly associated with negative emotions, while #body will be associated with neutral emotions.

2. Material and Methods

A total of 250 Instagram photos of female were considered. The sample size was calculated by using the G power software (version 3.1). An effect size of $f = 0.25$ was fixed, and with a power effect of 0.89, we obtained a sample size of 245 photos. However, since this is largely an exploratory study, we chose to be conservative and included 250 pictures in our final sample. The hashtags included in the study were: #eating disorder, #anorexia, #fitspiration, #thininspiration and #body. The hashtags #eatingdisorder and #anorexia, were selected as the most widespread hashtags for eating disorders active online [25]. The problematic emphasis on thinness and physical attraction on social media as the motivation and reward for exercise suggests that the female body ideal has shifted to emphasize both extreme thinness and fitness. This consideration led us to the investigation of #fitspiration and #thininspiration. Finally, #body was selected as the most widespread hashtag related to body. Inclusion criteria for emotion recognition consisted in clean photos that showed female faces. Exclusion

criteria included photos that showed males faces, multiple faces and not clear images. To obtain a random sample of photos, each hashtag was entered on Instagram's public timeline, which displays a subset of Instagram media that was most recent at that moment. Fifty photos were randomly downloaded for each hashtag in order to select those that fulfilled the criteria. The emotions expressed in each photo were measured using Emotion API from Microsoft Azure Cognitive Service (Fig.1). Introduced in November 2015, this technology, relying on machine learning algorithms, can recognize eight emotions: anger, contempt, disgust, fear, happiness, neutral, sadness, and surprise. These emotions are understood to be cross-culturally and universally communicated with facial expressions. Developers allowed free use of the API of the service, which made it widespread. It is an artificial intelligence service that detects faces on a given photo and assigns a score to the emotional categories for each detected face so that the sum of the eight scores will be 1 [26].



Figure 1. An example of emotion detection with API.

3. Results

Eight between subject one-way analysis of variance (ANOVA) were computed in SPSS 25.0 (IBM, Corp, NY) with alike number of emotional categories (i.e., Neutral; Happiness; Surprise; Fear; Disgust; Anger; Contempt; Sadness) as measures and hashtags (#eatingdisorder; #fitinspiration; #body; #thininspiration; #eatingdisorder) as independent variables, to determine whether there are any statistically significant differences between hashtags on emotional expression. The results did not show any statistical significance across the hashtags. However, to deepen our understanding of the phenomenon, we did a post hoc analysis. We ran the Levene test for equality of variances. When the variances were not equal, we considered the Tamhane test, which did not show any significant results. When the variances were equal, we considered LSD across the different conditions for every discrete emotion (Table 1): the results showed that happiness was significantly higher in images with #eatingdisorder compared to #body ($p= 0.034$), and in images with #fitinspiration compared to #body ($p= 0.038$). Neutral emotion was significantly higher in images with #thininspiration ($p= 0.049$) and #body ($p= 0.036$) both compared to #eatingdisorder.

Table 1. Descriptive Statistics of all the hashtags considered.

| Measures | #body | #thininspiration | #fitinspiration | #eatingdisorder | #anorexia |
|-----------|------------------|------------------|------------------|------------------|------------------|
| | Mean (SD) | Mean (SD) | Mean (SD) | Mean (SD) | Mean (SD) |
| Neutral | 0.560 (0.432) | 0.548 (0.476) | 0.395 (0.458) | 0.370 (0.441) | 0.466 (0.456) |
| Happiness | 0.399 (0.45) | 0.427 (0.485) | 0.598 (0.470) | 0.600 (0.461) | 0.483 (0.482) |
| Surprise | 0.218 (0.39) | 0.002 (0.55) | 0.004 (0.21) | 0.003 (0.024) | 0.013 (0.056) |
| Fear | 0.000 (0.001) | 0.000 (0.00) | 0.000 (0.001) | 0.000 (0.002) | 0.000 (0.000) |
| Disgust | 0.000 (0.000) | 0.000 (0.000) | 0.000 (0.000) | 0.000 (0.000) | 0.000 (0.000) |
| Anger | 0.000 (0.000) | 0.000 (0.000) | 0.000 (0.000) | 0.000 (0.000) | 0.000 (0.000) |
| Contempt | 0.003 (0.007) | 0.014 (0.081) | 0.019 (0.091) | 0.015 (0.079) | 0.005 (0.027) |
| Sadness | 0.011 (0.343) | 0.002 (0.008) | 0.005 (0.013) | 0.003 (0.017) | 0.130 (0.593) |

4. Discussion

The aim of the present study was to explore the emotional expression of hashtags related to EDs of self-produced images posted by users on Instagram. Our results suggested that images posted by users with hashtags related to EDs express different discrete emotions. Contrary to our hypothesis, people that posted images with #eatingdisorder and #fitinspiration conveyed greater happiness emotions compared to the images posted with the #body. Inspirational imagery is often shared on Instagram with the aim of inspiring users to achieve a certain body type [17]. #Fitspiration has been coined by the fitness community as an allegedly healthy alternative to thininspiration hashtag. Happiness expressed by images posted with #fitinspiration and #eatingdisorder compared to images with #body might be read as the expression of the achievement of a certain body goal/ideal. Women who internalize the thinness-as-beauty ideal may engage in extreme and often pathological behaviors in order to achieve and maintain a slim figure [27]. Furthermore, fitinspiration has been largely used to encourage healthy bodies [17] and has been generally considered as a positively valanced content. The faces present in the images described with #fitinspiration and #eatingdisorder might be happy precisely for reaching the thin and fit body type to which we are constantly subjected and persuaded to reach.

In line with our second hypothesis, we found higher neutrality in #body. Furthermore, our results showed higher neutrality in #thininspiration. These results might be interpreted as a form of emotional flatness. Thininspiration refers to content posted on Instagram that inspires a user to be thin, and this is typically achieved through the presentation of images that contain thin bodies [20]. Nowadays, thin inspiration images are one of the most prominent photos posted on Instagram designed to motivate people to exercise, or to be skinnier. The neutrality found might be interpreted as lack of

expressions [28] or a type-approval [29] that match with some of the core symptoms of EDs [30,31,32], such as alexithymia [33]: users' tendency to present themselves mainly with neutral images could be consistent with the mitigation of emotional expression found in EDs [34,35,36].

In summary, the present study showed that people that posted images described with #eatingdisorder and #fitinspiration expressed themselves mainly through happiness, which might be explained as a form of satisfaction for the achievement of a desired body. The images posted with #thin expressed mainly neutrality, suggesting that the faces in those images prefer to transcend from emotional expression, freeing themselves from an emotional connotation. Most people that posted images with #body tended to express neutrality. Compared to all other EDs hashtags, #body seems to express less defined emotions. Further studies are necessary to deepen the valence of neutral emotions related to #body. Finally, interestingly, #anorexia did not show any significant differences in terms of emotional expression, compared to all other hashtags for all type of emotions, which would require further investigations. The limitations of the study concern mainly a more granular analysis of emotions as well as to include a higher number of photos. To our knowledge, this is one of the few existing studies that investigated the expression of discrete emotions on Instagram related to eating disorders. In conclusion, the emotional salience of the images posted should be further investigate so that effective interventions and preventative measures could be informed, developed, and implemented.

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Effectively Integrating Cybersecurity into the Teaching of Sociology and Criminal Justice with Experiential Pedagogy

Carlene BUCHANAN TURNER^{a,1} and Claude TURNER^b

^a*Sociology Department, Norfolk State University, Norfolk, VA, USA 23456.*

^b*Computer Science Department, Norfolk State University.*

Abstract. Socio-cybersecurity is a new discipline that infuses cybersecurity into sociology and computer science within the academy. This article presents the outcomes from the curriculum development efforts for infusing cybersecurity into the sociology curriculum at Norfolk State University through experiential learning pedagogy. The goals of the socio-cybersecurity project are to develop, implement and assess twenty-four laboratory and lecture modules which will integrate cybersecurity into sociology and criminal justice courses. For this paper, we will present the development and implementation efforts for the ‘Creating Strong Passwords: A Simple National Security Tool’ module into a 200-level Social Problems course. The infusion project is grounded in the social construction learning paradigm. This theoretical perspective falls under the experiential pedagogy school of thought. A two-pronged methodology was used to assess the outcome of the infusion of the modules into the targeted courses. First there was the data analysis based on in-class surveys and treatment in a quasi-experiment, and secondly the assessment of the students’ in-class, hands-on exercises based on the modules. Paired t-test analysis was used to compare the indicator means before and after module infusion and content analysis was performed on the students’ assignments. The paired t-test results demonstrated that the infusion of the module into the Social Problems class impacted students learning outcomes for four out of ten concepts. The content analysis of the students’ work also indicates an increased awareness of cybersecurity. The utilization of the social construction of learning theory reinforced the value of experiential learning in teaching cybersecurity to sociology students.

Keywords. Cybersecurity

1. Introduction

This paper examines the impact that the use of experiential pedagogy in socio-cybersecurity has on undergraduate students’ learning outcomes. More specifically, the paper presents results from the efforts to integrate cybersecurity into the social science undergraduate curriculum. The goals of this socio-cybersecurity project are to develop, implement and assess a set of laboratory and lecture modules which will integrate cybersecurity into sociology and criminal justice courses. The innovative subject area that is subsequently added to the curriculum is Socio-cybersecurity. Socio-cybersecurity is defined as the socio-cultural aspects of cybersecurity [1]. For this paper, we will present the development and implementation efforts for a module entitled ‘Creating Strong Passwords: A Simple National Security Tool’ into a 200-level Social Problems course.

The infusion project is grounded in the social construction of learning. The impetus to apply experiential pedagogy (also known as hands-on or active learning) in this project

¹ Corresponding Author, Carlene Buchanan Turner; Sociology Department, Norfolk State University, 700 Park Ave, Norfolk, VA, USA 23456.; E-mail: cmturmer@nsu.edu.

was primarily deduced from these two paradigms. Students in undergraduate degree programs who would not traditionally be taught cybersecurity, can be exposed to the pervasiveness of cybersecurity concerns, as well as about its applicability to their discipline. The research question that guides this pedagogical analysis therefore asks if there is increased cybersecurity awareness in a cohort of Social Problems students after the integration of the Password Module in their curriculum. The methodological

techniques used to evaluate the learning outcomes were a quasi-experimental application with pre/post-test surveys before and after the modules and a content analysis of students' answers to laboratory questions. A triangulation of different methods allowed for a confident conclusion about the outcome of the modules.

2. Background

2.1 Theoretical Framework

The theoretical framework for this project is predicated on the belief that experiential learning is a pivotal part of how human beings acquire knowledge [2]. Each of the modules created in the project is required to have a hands-on or laboratory component that can be used to reinforce the concepts being taught. The aim is to allow the students to be engaged in practicing the concepts through active learning. A new thrust to integrate this type of pedagogy in sociology is realized in this project. Korgen and Atkinson point out in their new textbook (2018) that active learning will allow "students to do sociology through real-world activities designed to increase learning, retention, and engagement with course material" [3].

The students targeted by this project will learn by doing, as this theory recognizes that experience is the root of, and stimulus for, learning [4]. Additionally, Vygotsky's social constructivism theory of learning reinforces the value of the students' experience and their social context in the learning process [5]. The theory is relevant to this project as cybersecurity theory and praxis can be seen as part of the new 'knowledge society.' Teaching cybersecurity to non-computer science students may require universities to reconfigure the 'foci of learning' to include an interdisciplinary focus. This includes experiential learning that brings together instructors from computer sciences and sociology, who have adopted their own construction of reality to effectively teach their students using experiential pedagogy. In the present situation, the culture is how classes are taught in sociology and computer science, and the structure would be the university's resources. The students will therefore socially construct what it means to operate in a cyber-safe environment through actual and simulated experiences from the laboratory modules that will be developed.

2.2 Literature Review

The existing literature supports the use of modules to integrate new concepts into a school's or college's existing curriculum [6]. Additionally, the use of modules as instructional resources seems to occur more seamlessly in the physical and computational sciences, more so than in the social sciences [7]. The discourse in the literature supports the practice of instructors broadening the teaching of science by enriching the syllabus with interdisciplinary modules [6]. Gardener (1973) implemented a module infusion program where she and her colleagues introduced scientific concepts to non-science majors. The results from the project demonstrated that such efforts allow for the appeal to a large general audience of students who need a citizen's (or working) complement of science, but at the same time it is best if the modules are topical, more investigative, student-centered, enjoyable, flexible, and more integrated than full-science courses. This background is especially useful in guiding the implementation of the current project.

The proposed cybersecurity infusion across the curriculum model is based on the development and design of *security injections*. The best practice is that these should be self-contained modules focused on specific, well-established principles [8] [9]. As stand-alone modules, security injections can be inserted seamlessly into existing courses with

planned frameworks and targeted preparation. Additionally, these new modules will expose students to the relatively new practice of cybersecurity beyond computer science and information technology departments.

3. Methodology

A two-pronged methodology was used to assess the outcome of the infusion of the Password Module into the Social Problems course. First there was data analysis based on in-class surveys collected through a quasi-experiment framework, and secondly the evaluation of the students' assignments based on the modules. The two-fold methodology assessed students' outcomes resulting from the cybersecurity infusion into the Sociology course. Social Problems is a required course for all Sociology majors at Norfolk State University. The Social Problems course focuses on current social issues, such as poverty, race and ethnic relations, unemployment, crime, national security issues, war and terrorism, drug use, the elderly population, and environmental problems. There is also an examination of various explanations, consequences, and suggested solutions for each problem.

The Password module was taught for the third time in a section of the Social Problems course, and the infusion deliberately followed the chapter on National Security Issues in the Social Problems curriculum. The title of the module is 'Creating Strong Passwords Using Rational Choice Theory: A Simple National Security Tool.' The module was co-taught by a Computer Science professor and a Sociology professor.

3.1 *The Pre- and Post-Test Surveys*

The primary methodological tool that was used for the evaluation of the module infusion process was a quasi-experiment based on the population of NSU students who were enrolled in the targeted course. The objective questionnaire captured students' opinions on the concepts being taught. Identical questions appeared on both the pre and post-test instruments. The Password questionnaire had fourteen items, with four demographic questions and ten password content questions. Two content questions explicitly measured students' perception of the impact of the module.

Table 1. demonstrates the characteristics of the students, and the responses to the password items (which will be addressed in the Results section). While 17 students participated in the pre-test, there were three fewer participants in the post-test. This resulted in only 13 paired observations across the pre and post-tests conditions. The data demonstrate that approximately 62% of the class were female; just about half were juniors; and approximately two-thirds were Sociology majors.

3.2 *Content Analysis of student's Assignments*

Another methodological technique utilized for the Password Module was a review of students' assignments. The students were divided into group of four in order to create PassPhrases with the laboratory guidelines. They then wrote up their group's reflections and shared them with the entire class.

3.3 *Limitations*

Two noted limitations of this quasi-experiment curriculum development project are: (1) Some students may have previously been exposed to other socio-cybersecurity modules in other sociology and criminal justice classes. This may have impacted their before module awareness of cybersecurity concepts including best practices in password creation and management. (2) Additionally, because some students did not attend both classes when the pre- and post-test were deployed, respondents who were absent from of any of the sessions were dropped from the T-test analysis because of the paired sample assumption.

4. Results

4.1 Descriptive Statistics

In examining the descriptive statistics for the password content questions, Table 1. demonstrates that the infusion of the module into the Social Problems class impacted student learning. There was a 20% increase in the number of students who believed that passwords should be at least eight characters. There was a 20% increase in the proportion of the students who said that passwords should be memorable. There was about a 20% increase in students who said that passwords should have special characteristics. In the post-test condition, more students indicated that passwords should be changed three months, rather than every six months. There was also a 20% increase in the proportion of students agree that national security agencies had strong password protocols. There was a 30% increase in the opinion that weak passwords can compromise national security. In the post-test condition more students said their passphrases were now secure or very secure, compare to secure somewhat secure in the pre-test. There was a 11% increase in the option that the USA's cybersecurity has been attacked a lot.

Table 1. Comparative Descriptive Statistics for Password Variables- Social Problems Class, Spring 2019

| Before/After Module Infusion | | | | | |
|------------------------------|-------------------|------------------------------|----------------|-------------------------------|--|
| | | Pre-Test Condition (N=17) | | Post-Test Condition (N=13) | |
| Gender | Female | 64.7% | Female | 65% | |
| Classification | Junior | 47.1% | Junior | 53.8% | |
| Major | Sociology | 82.4% | Sociology | 76.9% | |
| Concentration | Crim Just | 78.6% | Crim Just | 72.7% | |
| PassWordLeng | At Least 8 Charac | 82.4 | At Least 8 | 100% | |
| Memorable | Strongly Agree | 88.2% | Strongly Agree | 100% | |
| SpicalCharac | Sometimes | 52.9 | Always | 69.2% | |
| TimetoChange | Every 6 Months | 41.2 | Every 3 | 76.9% | |
| NatSecurityRu | I'm Sure They Do | 82.4 | I'm Sure They | 76.9% | |
| WeakPasswor | Yes | 70.6 | Yes | 100% | |
| USAAttackdL | Yes | 88.2 | Yes | 76.9% | |
| Your Psswr | Secure | 41.2 | Secure/Very | 30.8% | |
| Completed | No | 82.4 | Yes | 92.3% | |
| Lab Helpful | Very Much | 17.6% | Very Much | 92.3% | |

There were two questions that measured the effectiveness of the experiential labs. In the pre-test 82.4% of the students said they have never completed a password module compared to 100% saying they completed the lab in the post-test condition. The main item measuring the impact of the of the experiential pedagogy questioned whether the lab was helpful, and there was a 75% increase in the proportion of the students who said, 'very much.'

4.2 The Pre and Post-Test Surveys

The students were taught eight critical concepts in the Password Module, and they were asked two items about the impact of the teaching style. These questions were captured in Likert-scaled questions on the survey which asked students to select: (1) How long a password should be; (2) Should a password always be memorable; (3) Should we use special characteristics in passwords; (4) How often should we change a critical password; (5) Do you believe national security agencies should have strong password protocols; (6) Do you believe weak employee passwords can compromise national security; (7) Unsecure passwords have caused attacks on the USA; (8) If they think their passwords are safe; (9) Have you ever completed a password lab; and (10) Was the lab helpful? The two hypotheses that drove the analysis are:

H1: There is no difference in the means of the password indicators across the pre- and post-test responses. (Based on indicators 1-8).

H2: There is no difference in the means of the perception of the helpfulness of the password lab across the pre- and post-test responses. (Based on indicators 9 and 10).

In addressing the first hypothesis, the paired T-test analysis covered eight individual password items and two pedagogy items as indicated by Table 2. Two significant means between pairs resulted from the Password Module analysis. First, there was a significant difference in the scores for whether it's important to use special characteristics in passwords before the module was taught (M=2.62, SD=.870) and after the module was taught (M=3.46, SD=.877); $t(12)=-3.09, p=0.009$.

Table 2. T-Test Results for Password Indicators in Social Problems Class, Spring 2019

| Outcome | Pretest | | Post-Test | | 95% CI for Mean Diff | t | Sig 2-Tailed df |
|----------------|---------|------|-----------|------|----------------------|-------|-----------------|
| | M | SD | M | SD | | | |
| PassWordLeng | 2.77 | .439 | 3.00 | .000 | -.496, .034 | -1.90 | 12 .082 |
| Memorable | 1.08 | .277 | 1.00 | .000 | -.091, .245 | 1.00 | 12 .337 |
| SpcialCharac | 2.62 | .870 | 3.46 | .877 | -1.44, -.250 | -3.09 | 12 .009* |
| TimetoChange | 2.31 | 1.11 | 1.38 | .870 | -.205, 1.64 | 2.80 | 12 .016* |
| NatSecurityRul | 1.31 | .630 | 1.46 | .967 | -.750, .442 | -.562 | 12 .584 |
| WeakPassword | 1.54 | .877 | 1.15 | .555 | -.079, .848 | 1.81 | 12 .096 |
| USAAttackdLot | 1.15 | .555 | 1.38 | .768 | -.593, .131 | -1.39 | 12 .190 |
| Your Psswr | 2.77 | 1.17 | 2.38 | 1.39 | -1.41, .910 | 1.59 | 12 .137 |
| Completed Lab | 1.77 | .439 | 1.08 | .277 | .402, .983 | 5.20 | 12 .000* |
| Lab Helpful | 3.31 | 1.65 | 1.08 | .277 | 1.18, 3.28 | 4.62 | 12 .001* |

Another significant mean difference was realized for how often students think passwords should be changed. The before module condition resulted in (M=2.31, SD=1.11) and after the module was taught (M=1.38, SD=.870); $t(12)=2.80, p=0.016$.

The second hypothesis conforms with the pedagogy items. There was a significant mean difference between students who have completed a password lab before. The question was asked because some students were previously exposed to other socio-cybersecurity labs previously, the question was used to capture that experience. For this item, the before module condition resulted in (M=1.77, SD=.439) and after the module was taught (M=1.08, SD=.277); $t(12)=5.20, p=0.000$.

Finally, there was a significant mean difference for how helpful the modules were. The before module condition resulted in (M=3.31, SD=1.65) and after the module was taught (M=1.08, SD=.277); $t(12)=4.62, p=0.001$. The other six indicators did not result in any other significant results.

4.3 Analysis of Students' Assignments

Directly after the Password module was taught, the students – divided into groups – were instructed to create their own passwords based on self-selected passphrases. All four groups successfully created passwords that conformed to the password rules that were taught in the lab. These were: choose a memorable phrase; pull the first letter of main words; include numbers; special characteristics; upper-case letters; and they should not simply be dictionary words. Table 3. presents the innovative passwords the student groups created.

Table 3. Students' Passwords Created from The Module's Lab- Social Problem Spring 2019

| Password | Phrase-Based Mnemonics |
|------------------|---|
| OMDhafeio!2 | Old McDonald Had a Farm |
| #hMWWAWCCIAWCCW6 | How much wood would a wood chuck chuck if a wood chuck could chuck wood |
| T0i1B2S! | The Itsy Bity Spider |
| 1KH2TMSL% | I know how to <u>tie</u> my shoe laces |

5. Discussion and Conclusion

The infusion of the Password Module provided evidence for the continued integration of cybersecurity modules into Sociology courses [1]. For the Password Module, the increased awareness of the students was seen across the two evaluation tools presented. First, the paired t-test indicated that there was a significant mean difference in students' opinion on use of special characteristics, and the importance of password in keeping the USA from being attacked. More importantly, there was a statistically significant mean

difference in the perception of the laboratory exercise as helpful across the pre- and post-test conditions. This was based on the indicator where the students were asked to rate the helpfulness of the modules.

Secondly, the students' use of popular phrases to create their pass phrases was not only fun, but it demonstrated the power of experiential learning [10]. The laboratory exercise reinforced the theoretical underpinning of the project. The results of the in-class exercise were based on student-groups creating their own passphrases and the content analysis outcomes are presented in Section 4.3. Students were more engaged with the course material and constructed their own social understanding of the material when they were exposed to experiential pedagogy.

An exceptional finding in the comparative descriptive statistics is the post-test position that passwords should be changed every three months, compared to the modal answer of very six months in the pre-test. It was exceptional because the accepted norm previously was for a change of password after six months. The mean difference seems to be a direct result of these Social Problems students being introduced to the new password management and creation rules from the National Institute of Standards, particularly recommendation change in passwords after three months [11].

In conclusion, the learning outcomes were enhanced not just by the module's lecture, but also the hands-on laboratory exercise. Moving forward with this socio- cybersecurity infusion project, the principal investigators plan to pursue a research project which aims to investigate the role of experiential learning for social science students in STEM courses (or modules) and this research will be grounded in Vygotsky's social constructivism of learning [5].

6. Acknowledgment

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SECTION IV

ORIGINAL RESEARCH

Health care is one of the areas that could be most dramatically reshaped by these new technologies.

Distributed communication media could become a significant enabler of consumer health initiatives. In fact they provide an increasingly accessible communications channel for a growing segment of the population.

Moreover, in comparison to traditional communication technologies, shared media offer greater interactivity and better tailoring of information to individual needs.

Wiederhold & Riva, 2004

Towards an Advancement of Multisensory Integration Deficits in Anorexia Nervosa: Exploring Temporal Discrimination Processing of Visuo-Auditory Stimuli

Alice CHIRICO^{1,a}, Clelia MALIGHETTI^a, Silvia SERINO^b, Pietro CIPRESSO^{a,c},
Elisa PEDROLI^c, Cosimo TUENA^c, Manuel MURATORE^c, and Giuseppe RIVA^{a,c}

^a*Department of Psychology, Università Cattolica del Sacro Cuore, Milan, Italy*

^b*MySpace Lab, Department of Clinical Neurosciences University Hospital Lausanne
(CHUV)*

^c*Applied Technology for Neuro-Psychology Lab, Istituto Auxologico Italiano, Milan,
Italy*

Abstract. Anorexia nervosa (AN) is a severe eating disorder affecting mostly young females and involving significant weight loss, a high fear of gaining weight and a distorted body image. Anorectic patients incur overestimations of their own body, thus suggesting that a distorted experience of body may play a crucial role in this disease. Specifically, a recent model (Riva et al., 2014) posits that a distorted body image could be due to difficulties in integrating the perception of signals from different parts of the body. Many studies evidenced that patients affected by Eating Disorders (EDs) have impairments at the visual, interoceptive, proprioceptive, and tactile level. However, it is still unexplored whether anorectic patients struggle to integrate auditory-visual signals together. In this study, we tested whether temporal discrimination processing of visuo-auditory stimuli is impaired in patients with AN using the Sound-Induced Flash Illusion (SIFI). The more we experience this illusion, the more impaired is our temporal discrimination processing. We hypothesized that ANs showed less correct responses at the task compared to healthy participants. We exposed healthy women and ANs selected from the Centro Pilota Regionale per i disturbi del comportamento alimentare (Regional Pilot Center for Eating behavioral disorders) (SR CDCA) Spedali Civili of Brescia (Spedali Civili of Brescia), to this illusion to assess the degree of impairment of visuo-auditory integration and we compared their performances in terms of accuracy. Result showed that ANs gave less correct responses than controls especially for longer Stimulus-onset asynchronies (SOAs). This study can have crucial implications for designing new treatments of EDs since it elucidates processes underlying multisensory integration impairments, which can be specific for this population

Keywords: eating disorders; anorexia nervosa; multisensory integration; visuo-auditory integration; temporal discrimination processing.

¹ Corresponding author: alice.chirco@unicatt.it

1. Introduction

Anorexia nervosa (AN) is a severe eating disorder affecting mostly young females and involving significant weight loss, a high fear of gaining weight and a distorted body image. Specifically, anorexia is a composited disorder affecting cognitive, affective and, perceptive components of patients' body image [1]. The perceptual dimension concerns how patients estimate their own body in terms of their size, shape and weight compared to their real dimensions. Patients with AN tend to show a distorted body representation at the level of the *body percept* (i.e., mental representation of our body), the *body schema* (i.e., postural and somatic information) and on the tactile dimension [2]. Specifically, it has been suggested that the main issue concerning participants with AN's distorted body representation does not only depend on a distorted stored image of their own body, but especially on their inability to update this long-term (LT) representation on the base of new incoming information [3-6]. This could be due to a deficit in integrating multiple sensory inputs, especially if the discrepancy between what patients expect and what they perceive is huge. With this regard, it has been argued that the way we represent our body emerges as a result of a predictive integration of sensory information from different channels [7], which pertains to higher-cognitive levels as well as to lower sensory levels [8]. When this integration fails, one consequence concerns being stuck into rigid LT memories of the body. In turn, this is related to a deficit in integrating multisensory signals from different parts of the body [9]. Many studies evidenced that patients affected by dysfunctional eating behaviors have impairments in cross-modal integration of visual, interoceptive, proprioceptive, and tactile stimuli [10]. This multisensory deficit can affect not only the body but also the way patients perceive stimuli in the environment, such as food [11]. For instance, it has been demonstrated that there is a mutual contribution of both taste and sound of food [12], as well as taste and food visual appearance [13] in providing a unified perception of flavor. There is little evidence of this cross-modal integration for obese patients, who showed deficits in integrating audio-tactile [14] and audio-visual stimuli [11], and far less is known about how multisensory integration of audio and visual stimuli occurs in patients with AN. Crucially, there is no evidence on how anorectic patients integrate temporal synchronized sounds and images.

Although some audio-visual stimuli do not occur precisely at the same time, people tend to perceive them as a unified percept. This effect depends on the multisensory temporal binding window (TBW) [15], which is composed of several stimulus-onset asynchronies (SOAs) (temporal discrepancy between the onset of the visual and of the auditory stimuli) affecting the probability of integration of multisensory input [15]. However, whether patients with AN struggle to integrate auditory-visual signals together is still an open issue. This would be a crucial aspect, for instance, in food intake when patients are overwhelmed by information from different senses, such as the sight of a chip along with the sound of crunching it. This study tested whether temporal discrimination processing of visuo-auditory stimuli is impaired in ANs patients compared to healthy controls using the Sound-Induced Flash Illusion (SIFI) [16]. Auditory and visual stimuli were presented at different SOAs and patients were involved in a temporal discrimination task, thus expressing whether the stimuli were presented at the same time or successively. We assumed that anorectic patients would be more susceptible to the illusion than healthy controls. Finally, we hypothesized a smaller number of correct responses by participants with AN at the task compared to healthy participants.

2. Material & Methods

2.1 Sample and measures

The study sample was comprised of 18 women (9 controls and 9 AN). In order to assess body image in patients and controls, the Eating Disorder Inventory – 3 (EDI-3) [17] was administered. Controls were evaluated also with the Mini- International

Neuropsychiatric Interview (M.I.N.I) [18] for anorexia and bulimia nervosa symptoms to guarantee the absence of these signs in the control group. Their height and weight (only for control group) were taken using a meter wall and weight scale (patients with AN' height and weight were provided by the Hospital). Each participant's ability to discriminate temporally visuo-auditory stimuli was assessed using the SIFI task. This task provides behavioral measures (Reaction Times and Accuracy) of the ability to integrate visual and acoustic stimuli in the same percept. Descriptive statistics for both groups are presented below.

Table 1. Mean and standard deviation of demographics and clinical data.

| | Patients with AN (N = 9) | Controls (N = 9) | U | p-value |
|-----------|--------------------------|------------------|------|---------|
| Age | 30 (10.46) | 24.56 (1.67) | 49 | .476 |
| Education | 13.22 (0.67) | 16.67 (1) | 0 | < .001 |
| BMI | 15.59 (1.96) | 22.69 (2.14) | 0 | < .001 |
| DT | 12.89 (10.61) | 7.56 (6.60) | 52 | .329 |
| B | 3 (4) | 3.89 (3.10) | 31.5 | .448 |
| BD | 22 (10.21) | 18.11 (8.37) | 50 | .426 |
| EDRC | 37.89 (22.33) | 29.56 (13.91) | 46.5 | .626 |
| GPMC | 112 (49.97) | 52.56 (24.95) | 74 | < .01 |

BMI = Body Mass Index; DT = Drive for Thinness; B = Bulimia; BD = Body Dissatisfaction; EDRC = Eating Disorder Risk Composite; GPMC = General Psychological Maladjustment Composite; U = Mann-Whitney statistic.

Note. DT, B, BD, EDRC, GPMC are all dimensions of EDI-III.

2.2 Data analysis and procedure

Participants signed the consent form and were seated 40cm from the screen. They filled out the EDI-3 and the M.I.N.I. Afterwards, a training task for the SIFI task was administered. Participants had to place their fingers on the 1 and 2 numbers of the keyboard to indicate how many flashes they saw in the trial. To move to the next trial, they pressed the space bar. Next, the experimental trials started (94 trials: (i) unimodal visual; (ii) unimodal auditory; (iii) bimodal without illusion, and (iv) SIFI with illusion. We used Presentation® software (Version 17.0, Neurobehavioral Systems, Inc., Berkeley, CA) to preset the stimuli, which was run on an Alienware AW13R3-7420SLV-PUS 13.3" Gaming Laptop (7th Generation Intel Core i7, 16GB RAM, 5SSD, Silver) VR Ready with NVIDIA GTX 1060 laptop. The task consisted of eight unimodal auditory stimuli (10ms beep) presented in a randomized order during the task at different Stimulus Onset Asynchronies (SOAs). Each trial consisted of pairs of stimuli presented every 70ms-110ms-150ms-230ms. Each SOA was presented randomly two times. 24 unimodal visual stimuli (flash) and 24 bimodal (beep + flash) stimuli were presented with the same SOAs and each SOAs six times. Pairs of auditory stimuli were presented eight times with each SOA two times (this was put at the end of the task mainly as a sound control condition). Additionally, eight single sounds, six single flashes and six single bimodal stimuli were showed as well. 24 SIFI were presented and, in order to induce a visual illusion with sound, each beep preceded or followed the flash with the same SOAs six times in a random order during the session. The other beep was always congruent with the presentation of the visual stimuli. Statistical analyses were carried out using R (R Core Team, 2014). Due to sample size and non-normal distribution of the variables, non-parametric analyses were carried out. Graphics were done using ggplot2 [19].

2.3 Results

Concerning the SIFI task, we conducted a Mann-Whitney non parametrical test to compare the two groups (AN vs. control) regarding accuracy (i.e., ratio between number of correct responses out of number of total given responses), for each SOA (70ms, 110ms, 150ms, 230ms) and for total responses regardless the SOA. Moreover, we carried out Wilcoxon Signed Rank test to compare accuracy rates across SOAs and presentation modalities. Descriptive statistics for all conditions and groups is reported

in Table 2. All comparisons were reported in the images below with relative significant values.

Table 2. Mean and standard deviation for accuracy ratio (number of correct hits/total of stimuli) in all conditions for both groups.

| Presentation modality | SOA | Patients with AN | | Controls | |
|-----------------------|-------|------------------|-------|----------|-------|
| | | Mean | SD | Mean | SD |
| auditory | 70ms | 0 | 0 | 0.444 | 0.424 |
| | 110ms | 0 | 0 | 0.555 | 0.463 |
| | 150ms | 0 | 0 | 0.962 | 0.073 |
| | 230ms | 0 | 0 | 0.981 | 0.055 |
| | Total | 0 | 0 | 0.754 | 0.191 |
| visual | 70ms | 0.704 | 0.341 | 0.780 | 0.441 |
| | 110ms | 0.167 | 0.186 | 0.890 | 0.333 |
| | 150ms | 0.074 | 0.168 | 0.833 | 0.353 |
| | 230ms | 0.055 | 0.117 | 0.890 | 0.333 |
| | Total | 0.250 | 0.155 | 0.847 | 0.248 |
| Bimodal Illusion | 70ms | 0.018 | 0.055 | 0.462 | 0.309 |
| | 110ms | 0.018 | 0.055 | 0.425 | 0.344 |
| | 150ms | 0 | 0 | 0.518 | 0.428 |
| | 230ms | 0 | 0 | 0.703 | 0.297 |
| | Total | 0.009 | 0.018 | 0.527 | 0.277 |
| Bimodal No Illusion | 70ms | 0.314 | 0.327 | 0.814 | 0.194 |
| | 110ms | 0.055 | 0.083 | 0.962 | 0.111 |
| | 150ms | 0.037 | 0.073 | 1 | 0 |
| | 230ms | 0.037 | 0.111 | 0.981 | 0.055 |
| | Total | 0.111 | 0.119 | 0.962 | 0.038 |

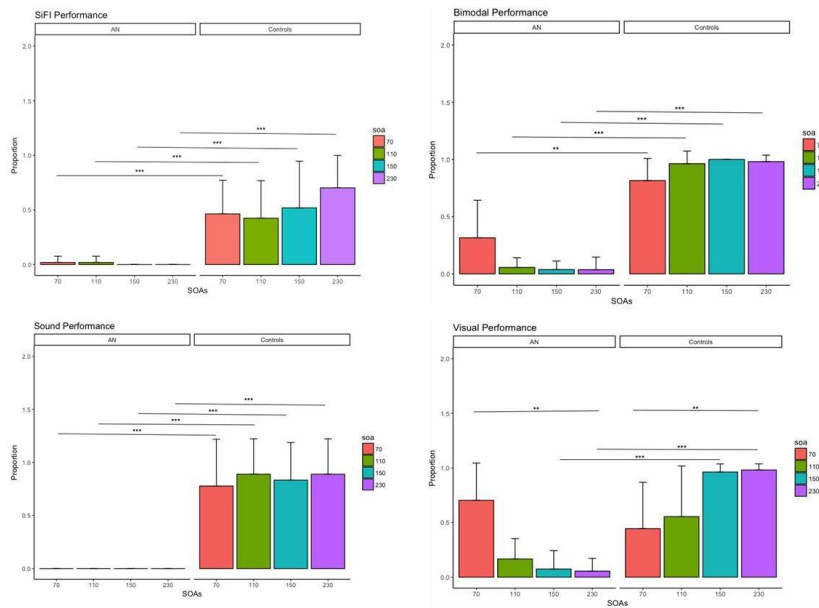


Figure 1. Histograms with error bars (SD) represent Wilcoxon Signed Rank comparisons among SOAs (70ms; 110ms; 150ms; 230ms) in each presentation modality (SIFI with illusion; Bimodal without illusion; visual; auditory) and Mann-Whitney comparisons between groups (AN vs. Healthy women) concerning accuracy rate responses. $p < .05^*$; $p < .01^{**}$; $p < .001^{***}$.

3. Discussion and conclusions

We compared patients with AN and age-matched controls regarding the ability to integrate visual-auditory stimuli using the SIFI illusion task. Generally, patients with AN were less accurate compared to controls for each SOA (70ms, 110ms, 150ms, 230ms) and for each presentation modality (visual, auditory and bimodal). Patients with AN provided a higher number of incorrect responses compared to healthy women. An exception concerned a shorter time interval between the onset of two visual stimuli (from 70ms to 110ms) in which no significant differences with the controls' performances emerged. On the other hand, impaired performance of ANs emerged in visual trial with longer SOAs (150ms, 230ms).

Crucially, ANs were never able to detect the double sound in the auditory condition. In the visual condition, patients with AN reported higher number of correct responses compared to the other two modalities. Their impairment emerged in longer visual SOAs, as well as for the bimodal condition across all SOAs. Their Temporal Binding Window was very brief compared to healthy control. This result is the opposite compared to what Scarpina et al. [11] found for obese patients. Since multisensory integration ability is related to the way we perceive and remember our body, a further step should be to test the link between specific body image and body schema distortions and ability to integrate not only audio-visual stimuli, but also other sensory modalities. This work opens a new domain of analysis of EDs sensory disturbances by integrating also an unrepresented but key component, such as the auditory modality.

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Evaluation of cybersickness in a passive walking virtual reality cognitive exercise

Anne CABRAL^{a,1}, Nusrat CHOUDHURY^a, Catherine PROULX^a,
Rola HARMOUCHE^a, Elicia KOHLENBERG^a, Patricia DEBERGUE^a
^a*Simulation and Digital Health, Medical Devices Research Centre, National
Research Council Canada, Boucherville, Québec, Canada*

Abstract. bWell is an interactive immersive research platform targeting cognitive assessment and remediation, developed at the National Research Council Canada. Following a common need from collaborators for scenes with user being passively displaced while seated, the present study evaluates the tolerability of a stroll scenario with imposed head movement while the participant is physically seated. Twenty-six healthy adults performed three exercises containing linear and sinusoidal walking vection with or without an attention task forcing yaw head movement. Results indicate that the system is generally well tolerated. There was a significant difference in reported cybersickness symptoms between the different exercises with a higher level of symptoms reported when angular acceleration was present. With regards to the severity of the symptoms, no obvious link has been observed. The progression of symptoms was not always linear and could be grouped in three different profiles: 1) constant, 2) progression followed by either a plateau or regression and 3) continuous progression. These findings extend the design possibilities and opportunity for bWell cognitive exercises to include more challenging motion patterns, including passive displacement and angular visual scanning with a more vulnerable population.

Keywords. Virtual Reality, Cybersickness, Cognitive, Motion Sickness Susceptibility, Fast Motion Sickness Scale, Simulator Sickness Questionnaire

1. Introduction

While virtual reality (VR) is still in the early stages of use in clinical practices, its potential is difficult to ignore. It allows for ecologically valid clinical interventions in a controlled, safe environment with the generation of objective measures of intervention efficiency. Examples of applications [1] include fields like psychotherapy [2; 3], cognitive training [4-8], relaxation [9; 10] and rehabilitation [11-15]. However, lack of scientific evidence and risk of cybersickness are among the factors still slowing down the adoption of VR in clinical environments, especially since vulnerable populations may be concerned [16; 17]. The National Research Council Canada (NRC) is currently developing bWell, an interactive immersive software platform targeting cognitive assessment and remediation [18]. To minimize the risk for cybersickness, exercises are designed as static scenes, using teleport locomotion techniques [19] when displacement is required. Recently, clinical collaborators expressed a need for exercises imposing displacement in an immersive VR environment while the patient is physically seated and is performing a cognitive task. Such exercises can be useful for some patients (ex: patients in wheelchairs or at risk of falling) or for exploring a virtual world that is considerably larger than the physical space available. However, increased risk of cybersickness due to navigation is a concern.

¹ Corresponding Author, anne.cabral@cnrc-nrc.gc.ca.

In an earlier study [18], it was shown that the static exercises were well tolerated by healthy adults under short exposures. The present study aims to investigate cybersickness in a healthy population when using bWell for longer durations, closer to what a typical clinical setting could be, and with more challenging motion conditions

2. Background

Cybersickness has been described as a visually induced motion sickness (VIMS) due to a mismatch between the vestibular and visual systems. The presence of vection (visual illusion of self-motion) in VR is thought to be a factor in this mismatch [20]. Certain participant characteristics such as gender, age and motion sickness susceptibility have also been identified as factors affecting cybersickness [20; 21]. The Simulator Sickness Questionnaire (SSQ) is commonly used to assess VIMS, and captures type and severity of symptoms. SSQ can be grouped into nausea (SSQ_{nausea}) and oculomotor (SSQ_{oculo}) symptoms [22]. The Fast Motion Sickness (FMS) scale is used to capture sickness progression [23]. Both the maximal (FMS_{max}) and the last (FMS_{last}) measure are kept for the analysis [24]. Objective measures of cybersickness such as physiological signals [25] and postural sway [20; 26], have shown promise, though the sensitivity and accuracy of such measures is yet to be established.

3. Methods

a. Simulation exercises

Participants were asked to take part in three VR simulation exercises which are part of the bWell platform. In all scenes, users are personified with a self-avatar taking a nature stroll and encouraged to make active head movements. In exercises 1 and 3, the self-avatar walks in a straight line at constant velocity (1.4 m/s). In exercise 2, the self-avatar follows a sinusoidal path with the same constant linear velocity as in exercise 1, in addition to a sinusoidal angular velocity and acceleration. Exercises 1 and 2 impose a controlled yaw head movement in the form of a continuous attention task requiring the user to follow a light beam moving in an arc (± 70 degrees, positioned in front and on the ground). In exercise 3, no head movement is imposed (Figure 1). At the beginning of the exercise, the self-avatar is standing in place and begins walking, slowly ramping up to the prescribed speed.

The exercises were built to include movements that induce vection (linear and angular) and head movement (forced or free) typically done during cognitive tasks. The experiment was designed to test the effect of the different movements on cybersickness. The exercises excluded movement known for inducing VIMS symptoms, such as sharp curves, linear acceleration (ex: quick start/stop) and high velocities, as they are unlikely to be representative of the targeted applications [24; 25].

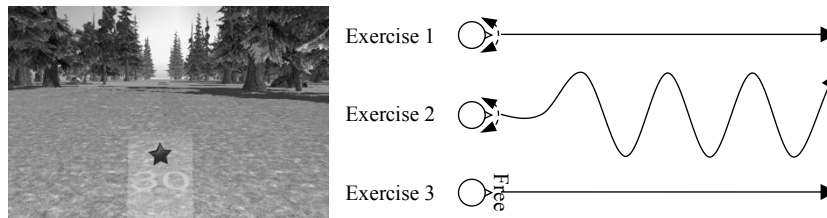


Figure 1: Schematic illustration of experimental parameters and VR Stroll scene with sweeping light

b. Participants, set-up and measures

Healthy adult volunteers (n=26, f=9/m=17, age=33-62 years, mean=45.5 years, SD=7.5 years) were recruited by email. Each participant was made aware of the risk of cybersickness, was free to stop at any time, and signed a consent form approved by the NRC Research Ethics Board. Participant stratifying data including the short motion sickness susceptibility questionnaire (MSSQ-short) [27] were collected before the session.

A within-subjects study design was used. All participants performed the three exercises in a semi-randomized order predetermined by gender and MSSQ. The study lasted a total of 40 mins, with 8 mins per exercise. During the experiment, the participants were wearing an HTC Vive Pro headset installed on a Dell Aurora R5 computer and were seated in a fixed chair with their feet on the floor. Between exercises, a variable break was scheduled allowing participants to recover from cybersickness, if any, using $FMS > 5$ as the threshold for the onset of sickness [24].

Symptoms were measured using the SSQ and FMS scale. The SSQ was administered right before the session (baseline) and immediately following the completion of each exercise. The score was calculated as the sum of each item in the scale and a subjective technique for determining the threshold for high symptoms was used (SSQ=16) [22]. The FMS rating was recorded after asking the user: "How do you feel?" with specific anchors (0-5: no sickness (some symptoms), over 5: low-level (symptoms of uneasiness and/or dizziness), over 9: mid-level (nausea), over 15: severe sickness (20 being vomiting)). This was done before the start of the exercise, at every minute during the exercise, and at the end of the exercise.

4. Results

a. Symptoms and sickness

Twenty-five participants completed the three exercises ($\overline{FMS}_{max}=3.7$, $SD=3.2$, $\overline{SSQ}=1.6$, $SD=3.0$). One session was interrupted by a participant who completed only the first three minutes of the last exercise (exercise 2, $FMS_{last}=9$, $SSQ=10$, $SSQ_{nausea}=10$, $SSQ_{oculo}=0$). Six participants reported no SSQ symptoms. Ten reported both oculomotor and nausea symptoms, while seven experienced only nausea symptoms and three only oculomotors. One participant experienced a high-level of symptoms ($SSQ=20$, $FMS_{max}=13$). All 16 symptoms in SSQ were reported, with only one symptom reported as severe (Eye Strain). Overall, the 4 symptoms most often reported in the SSQ included Eye Strain, General Discomfort, Stomach Awareness and Nausea (in order).

Five participants reported no symptoms ($FMS_{max}=0$) consistently during the three exercises. The number increases from five to seven when $FMS_{last}=0$ is considered. Twenty one participants reported symptoms lower than the defined onset for sickness ($FMS_{max}<6$), four reported low level of sickness and one reported mid-level sickness. The progression of FMS values was not always linear and could be grouped in three different profiles: 1) constant, 2) progression followed by either a plateau or regression of sickness and 3) continuous progression. The typical profiles recorded during the completion of the exercises are shown in Figure 2 for specific participants.

Cybersickness tended to resolve quickly between exercises (73% resolved in less than three minutes). Analyses revealed a high correlation between the SSQ and both the FMS_{max} and FMS_{last} ratings (respectively, Kendall $\tau=0.56$ and $\tau=0.54$). This finding is consistent to what has been reported in literature [24]

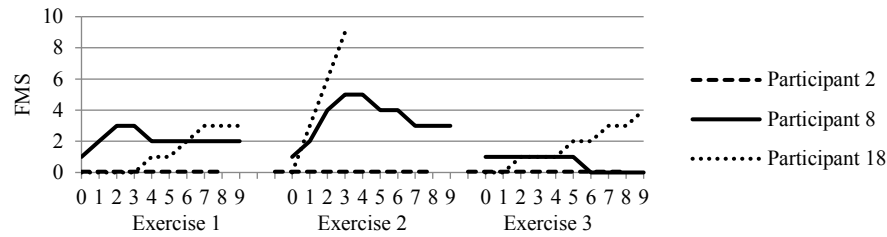


Figure 2 Typical symptom profiles exhibited during the performance of an exercise: constant (participant 2), plateau/regression (participant 8) and progression (participant 18).

b. Participant characteristics

Figure 3 presents the reported SSQ and FMS_{max} values for all participants and all exercises, as a function of their motion sickness susceptibility. A large range of MSSQ values were reported among the participants. Those who reported a high susceptibility to motion sickness tolerated the exercises similarly to those with lower MSSQ ratings. In all exercises, a correlation between the MSSQ and the presence of cybersickness is observed. The FMS is more strongly correlated ($MSSQ-FMS_{max} \tau=0.53$ $MSSQ-FMS_{last} \tau=0.51$) than the SSQ ($MSSQ-SSQ \tau=0.33$, $MSSQ-SSQ_{nausea} \tau=0.36$ $MSSQ-SSQ_{oculo} \tau=0.09$). However, with regards to the severity of the symptoms, no obvious relationship has been observed.

Amongst the five participants who reported some level of sickness ($FMS_{max}>5$), no trend with gender or age was observed. Interestingly, all of the participants in this group had some level of VR experience. Three out of five had average to high level of experience, one had a fair level of experience and one had a very high level of experience with VR (owns a headset) and also played games over 15 hours per week.

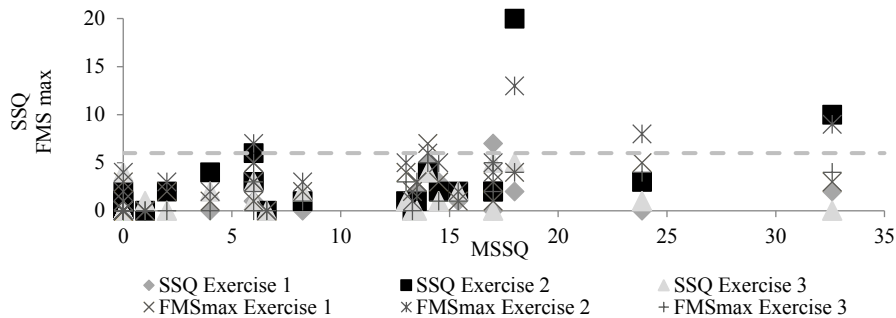


Figure 3 Symptom severity with respect to participant motion sickness susceptibility (dotted line represents the onset of sickness defined at $FMS_{max}>5$).

c. Exercise-specific results

Figure 3 shows that the symptom level remained generally below the onset of sickness, even for the passive angular acceleration imposed in exercise 2. Still, it was observed that almost all highest FMS and SSQ scores were obtained within this exercise. Only one participant obtained a mid FMS score with exercise 1. All FMS scores reported in exercise 3 were below the onset. The Friedman test indicated that there was a difference in reported symptoms in the different exercises. This was seen for each of the measures: SSQ ($\chi^2=6.26$, $p=0.044$), FMS_{max} ($\chi^2=17.44$, $p<0.001$) and FMS_{last} ($\chi^2=24.81$, $p<0.001$). Differences between all three exercises were found in the FMS_{last} with higher levels of symptoms in exercise 2 versus 1, 2 versus 3 and 1 versus 3 (respectively $p=0.008$, $p<0.001$ and $p=0.008$). The FMS_{max} and SSQ demonstrated differences between two of the exercises, with both showing a higher degree of symptoms in exercise 2 versus 1 (respectively $p=0.002$ and $p=0.029$) and exercise 2 versus 3 (respectively $p<0.001$ and $p=0.042$). The FMS and SSQ showed no trend in symptoms between the first,

second and third exercises, indicating that the randomization of the trial order prevented carryover or habituation effects.

5. Discussion

The bWell exercises examined in this study were well received by healthy adults. A low level of oculomotor and nausea symptoms was reported with participants comparatively reporting more nausea symptoms. A link was found between motion sickness susceptibility and the presence of symptoms but not with the severity. A portion of the participants experienced sickness predominantly in the second exercise; which was most likely due to the winding path (angular vection). Another factor was the presence of active angular head movements in exercises 1 and 2. No sickness was reported in the freeform walking scene (exercise 3).

As shown in Figure 2, the symptoms progressed following three different profiles. Some participants experienced symptoms at a constant level. Others experienced a rise, which can be explained by a time accumulation effect. Of interest, the participant that abandoned mid-trial did not report the highest FMS_{max} . Rather, this user had a fast rate of symptoms increase (0 to 9 in three minutes), combined with a high susceptibility ($MSSQ=32.6$). Thus, rate of symptom progression may be interesting to consider as a second criteria to the threshold ($FMS=15$) for ending VR immersion [24]. Some participants appear to stabilize or recover during the exercise. This behavior can be explained by habituation or adaptation during the exercise. This last profile is in contradiction with the general hypothesis that symptoms increase with time during a single exposure as concluded by previous studies [28]. However, it is in concordance with some studies that observed that the symptoms begin to decrease or remain stable after a certain level or amount of time [28]. This highlights the need to have a continuous evaluation of sickness during simulation.

6. Conclusion

The present work investigated the tolerability of exercises imposing linear and sinusoidal vection in addition to head movement. Overall, the motion conditions (both passive and active) were well tolerated at walking speed. This was observed for different user characteristics, including participants susceptible to motion sickness. This finding means that an individual prone to motion sickness should not necessarily avoid VR exercises. Future exercise designs should consider the possibility to continuously adapt and minimize motion conditions especially at the onset of sickness. Being able to establish a relationship between user and cybersickness risk profile could extend the reach of VR usage for assessment and remediation of cognitive impairment.

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Interactive Immersive Virtual Environments Cause Relaxation and Enhance Resistance to Acute Stress

Stefan LISZIO ^{a,1} and Maic MASUCH ^a

^a *Entertainment Computing Group, University of Duisburg-Essen, Germany*

Abstract. Being immersed in a natural virtual environment (VE) can increase relaxation and mood even in situations of stress, anxiety, or pain. Prior studies have shown that the level of immersion moderates these restorative effects. We assume that actively engaging with the VE, for instance when playing games, reinforces immersion since it strengthens the sense of presence and forces the attentional focus to the virtual world. To examine this assumption, we conducted a study ($N = 57$) for which we developed a VR app (a virtual beach) that has two modes: a non-interactive mode and an interactive mode that consists of two casual games. We compared the influence of both modes on physiological (heart-rate variability) and psychological measures of stress and affect to a control group. Relaxation and positive affect were significantly increased in the interactive VR condition compared to the non-interactive and the control group. Furthermore, we hypothesized that deep immersion, relaxation, and joy evoked by the interactive VE enhance resistance to a subsequent stress situation. Hence, all subjects were stressed using a VR Trier Social Stress Test (VR-TSST) after the mood induction. While the assumed effect is less clearly observable, we found that the experience of spatial presence in the VR app is a significant predictor of positive feelings during the stress phase. We conclude that interactivity may be an important factor for the relaxing effect of natural VEs and immersion and playful interaction can help to cope with acute stress.

Keywords. Interactivity, Natural Virtual Environments, Stress, Mood Induction, Relaxation, Games, TSST, Virtual Reality, Heart Rate Variability

1. Introduction

Natural virtual environments (VE) presented in virtual reality (VR) can distract from stressors and help to find relaxation and joy, even in situations of great pain and emotional distress [1,2]. It has been shown that higher levels of immersion in a calm VE result in deeper relaxation and increased positive affect [3,4], supporting the hypothesis that immersion consumes cognitive resources necessary for experiencing stress, anxiety, or pain [5].

¹Corresponding Author: stefan.liszio@uni-due.de

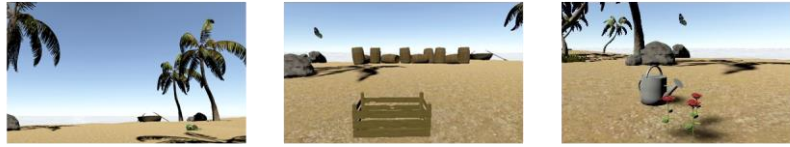


Figure 1. The VE contains typical audio-visual elements of a beach, animations and random events to realism and naturalness.

Figure 2. Mini-game 1: The player has to pick up a coconut from the box and throw it to destroy the wooden barrels.

Figure 3. Mini-game 2: First, the player has to plant and water the flowers. Then she has to pick the flowers and feed them to the turtle

Furthermore, presence and emotions seem to be interrelated, that is an in-creased sense of presence amplifies affective responses to the VE which in turn enhance the emotional engagement with the VE resulting in a higher sense of presence [6]. To increase these restorative effects, influencing characteristics of such VR applications must be examined. We assume that interactivity of the VE reinforces immersion since interacting with the virtual world increases the experience of spatial presence and consumes additional cognitive resources. Furthermore, while studies demonstrated that immersion supports distraction from acute strain [5], as well as recovery from prior strain [7], little is known about the persistence of this effect in following situations.

Thus, we investigate whether interactivity increases the relaxing and mood-enhancing effect of natural VE. Therefore, we developed a VR application which has two modes: an interactive and a non-interactive mode. In both modes, the user experiences a serene beach scenario. While the non-interactive mode only allows viewing the VE, in the interactive mode it is possible to play two games in the same scenario. Furthermore, we target the question of whether using such a playful, immersive VE as preventative measures increases resistance to acute psycho-social stressors. If this assumption could be confirmed, this would validate the use of interactive natural environments in VR to prepare people for stressful situations such as exams, medical procedures, or other threatening scenarios (i.e. flights or dangerous working environments) by restoring emotional resources and providing relief in advance.

2. Method

2.1. Stimulus Material

2.1.1. The Virtual Beach

To investigate the influence of interactivity in immersive VE, a VR app offering the possibility either to be observed passively or for an active, playful activity is needed. Since we did not find an existing application fulfilling these requirements, we developed our own VR app. We decided for an animated virtual beach scenario (Figure 1) since this type of natural VE has been successfully used in prior studies to induce relaxation [8]. Besides the visual elements, typical natural background noises were added to increase the realism of the scene. The application was designed as a seated experience for Oculus Rift and Touch controllers. In the *non-interactive mode*, participants only view this scene. To avoid this becoming too monotonous, some seemingly random events have been added (e.g. a falling coconut, a crawling turtle, flying butterflies).

The same events occur in the interactive mode. The *interactive mode* comprises two additional consecutive mini-games. The games were designed as casual games, that is, the game mechanics should be not too complex but also not too easy. By trying to balance challenge and simplicity of the game design, we attempted to stimulate the experience of flow, positive affect and thus relaxation [9]. In the first game, the player must pick up and throw coconuts on wooden barrels to destroy them (Figure 2). When all barrels have been destroyed, the second game starts. In this game, the player needs to plant and water flowers to feed a turtle (Figure 3). The Oculus Touch controllers allowed incorporating physical movement (e.g. grabbing, throwing) for interaction. Such *incomplete tangible controllers* [10] can increase the perceived naturalness of controlling the game and may increase spatial presence [11].

2.1.2. The VR-TSST

For a systematic stress induction, we used a VR version of the well-known Trier Social Stress Test (TSST) [12]. The VR-TSST complies with the original protocol and has successfully been used to evoke high levels of psycho-social stress in prior studies [4].

2.2. Objective and Subjective Measures

Heart rate variability (HRV) is a physiological measure associated, along with other physiological and psychological responses, with stress, anxiety, and depression [13]. While low HRV values indicate emotional strain, a high HRV relates to relaxation and subjective well-being respectively [14], we calculated HRV from intervals of heart rate data in each of the experiment's phases using the standard deviation of successive differences (SDSD) method. A heart rate monitor and chest belt were used for data recording. The affective state of the subjects was measured with the Positive and Negative Affect Schedule (PANAS) [15]. Additionally, we used the State-Trait Anxiety Inventory (STAI) [16] to determine current anxiety levels. With regard to the VR experience, the Igroup Presence Questionnaire (IPQ) was used to assess several dimensions of presence [17]. The Simulator Sickness Questionnaire (SSQ) [18] was used for tracking potential negative physiological responses to the use of the VR-hardware as a confounding factor.

2.3. Participants and Procedure

Fifty seven (57) healthy subjects (female = 41, male = 16) aged 18 - 49 years ($M = 23.7$, $SD = 5.67$) participated in this study. All participants were informed that they might experience emotional strain during the experiment. After consenting to take part, the participants answered a screening questionnaire ensuring the physical (e.g. no epilepsy, pregnancy, cardiovascular diseases) and mental health (e.g. no chronic stress, phobias, mental disorders) conditions necessary for the experiment. The participants were randomly assigned to three experimental conditions (interactive VR, non-interactive VR, control group) with 19 subjects in each group. Since the VR app has been developed for the purpose of this study, all subjects can be regarded as novice players.

After fitting the HRV measuring equipment, the experiment started with the first set of questionnaires (demographic data, STAI, PANAS). This phase served as a (1) *baseline* measurement. The subsequent (2) *induction* phase represents the actual manipulation. Depending on the experimental condition, subjects either played the interactive version

Table 1. Mean values $M(SD)$ of physiological and experiential data in each group in the measurements.

| | Measure | Phase | Group | | |
|-----------------|--------------------|-------|---------------|-----------------|---------------|
| | | | Interactive | Non-interactive | Control |
| HRV (ms) | (1) Baseline | | 45.97 (21.17) | 66.13 (30.58) | 55.90 (19.96) |
| | (2) Induction | | 64.73 (23.78) | 36.19 (15.48) | 45.37 (13.88) |
| | (3) Post-Induction | | 55.60 (14.93) | 67.09 (26.81) | 59.35 (15.01) |
| | (4) Stress | | 49.02 (13.24) | 52.18 (20.69) | 47.37 (16.07) |
| State Anxiety | (2) Induction | | 33.89 (7.64) | 34.34 (6.89) | 39.37 (6.05) |
| | (4) Stress | | 48.22 (11.9) | 50.56 (10.51) | 48.89 (9.54) |
| Positive Affect | (2) Induction | | 32.83 (9.43) | 26.73 (9.47) | 28.63 (5.99) |
| | (4) Stress | | 26.55 (7.16) | 24.72 (7.83) | 24.68 (7.51) |
| Negative Affect | (2) Induction | | 11.83 (2.50) | 11.00 (2.03) | 11.74 (1.59) |
| | (4) Stress | | 19.94 (8.72) | 21.33 (6.73) | 18.84 (5.60) |

of the VR app, watched the non-interactive version or were asked to wait before the experiment continued. In all conditions, this phase lasted nine minutes, which is the average time players needed in a pre-testing of the VR app to finish both games. In the (3) *post-induction* phase, subjective measures were again assessed using STAI and PANAS. Subsequently, all participants underwent the procedure of the VR-TSST in the (4) *stress* phase. After that, a final set of questionnaires (STAI, PANAS, SSQ) had to be answered. This study was approved by the ethics committee of the University of Duisburg-Essen.

3. Results

The requirements for parametric testing have been checked (Shapiro-Wilk test, Levene's test, Mauchly's W). If they were not fulfilled, the corresponding non-parametric tests were selected. The analysis of the SSQ data identified two outliers with extremely high simulator sickness values (one in each VR group). Severe simulator sickness can strongly impair the VR experience and, as an additional stressor, interfere with the experimental intervention. Therefore, the data of both subjects were excluded from all analyses.

3.1. Heart Rate Variability

Eleven subjects had to be excluded from the analysis of the HRV data due to measurement errors but were still included in all other analyses. However, the size of the three groups remains balanced (interactive $N = 16$, non-interactive $N = 14$, control group $N = 14$). To validate our methodology and the stimulus material used, we compared the mean HRV values in the four phases of the experiment. Since the data was not normally distributed, we performed a non-parametric Friedman test, which confirmed significant differences between the measurement times, $\chi^2(3) = 20.16$, $p < .001$. The Dunn-Bonferroni post-hoc analysis revealed that the post-induction phase differed significantly from the baseline measurement, $z = .77$, $p = .03$, $r = .12$; induction phase, $z = 1.07$, $p = .001$, $r = .16$; and stress phase, $z = 1.07$, $p = .001$, $r = .16$.

However, since our focus is on the influence of interactivity on relaxation and mood, we compared the mean HRV values of the three conditions in both the induction and the stress phase (Table 1). Again, the prerequisites for parametric testing were not satisfied.

Thus, we performed a Kruskal-Wallis test, which indicated a significant group difference in the induction phase, $H(2) = 14.64, p = .001$. According to a Dunn-Bonferroni post-hoc analysis, the mean HRV values were significantly higher in the interactive VR condition than in the non-interactive VR condition, $z = 17.78, p < .001, r = .69$. In the stress phase, the groups did not differ significantly.

For a deeper analysis of the changes in the HRV values between the experiment's phases, we calculated the difference $\Delta_{\text{baseline-induction}}$ between baseline and induction phase as well as $\Delta_{\text{postinduction-stress}}$ for the HRV changes between post-induction and stress phase. A one-way ANOVA showed that $\Delta_{\text{baseline-induction}}$ differed significantly between the three groups, $F(2, 41) = 21.74, p < .001, \eta^2 = .51$. A subsequent Tukey-HSD test showed that all groups differed significantly from each other. The interactive VR group denoted the highest increase of HRV, $M = 18.75, SD = 20.61$, compared to the non-interactive VR group, $M = 29.94, SD = 20.58, p < .001$, and the control group, $M = 10.54, SD = 20.01, p = .001$. Both the non-interactive and control group denoted a decrease of HRV and differed significantly, too, $p = .041$.

As with the comparison of the absolute values, the HRV changes from post-induction to stress phase were not significant, $F(2, 41) = 1.92, p = .16$. Considering the descriptive values, the interactive VR group denoted the smallest $\Delta_{\text{postinduction-stress}}$, $M = -6.57, SD = 10.21$, followed by the control group, $M = -11.98, SD = 11.42$, and the non-interactive group, $M = -14.91, SD = 13.95$.

3.2. Anxiety and Affect

A Kruskal-Wallis test showed that significant differences in mean STAI values exist between the three conditions in the induction phase, $H(2) = 7.74, p = .02$. Subjects in the interactive VR condition experienced significantly less anxiety than subjects in the control group, $z = 13.35, p = .033, r = .42$. The mean anxiety score of the non-interactive group is as low as the score of the interactive group, yet the difference to the control group is not significant, $z = 11.74, p = .077, r = .37$. A one-way ANOVA reveals that the differences between the state anxiety levels in the three conditions during the stress phase are not significant, $F(2, 52) = .23, p = .80$. According to the descriptive data, the interactive VR group reported the lowest anxiety levels, closely followed by the control group (Table 1). The highest levels were measured in the non-interactive group.

In terms of both positive and negative affect, we found no significant differences neither in the induction nor in the stress phase. The tendency of the mean values of positive and negative affect indicates that the interactive VR group experienced more positive emotions during the stress phase compared to both the non-interactive and the VR group who reported roughly equal levels of positive affect (Table 1). For negative affect, the picture is less clear with the non-interactive VR group having the highest score, followed by the interactive VR group and the control group.

3.3. Presence and Emotions

In order to gain a deeper understanding of the relationship between interactivity, presence and their influence on mood and relaxation in our VR app, we compared both experimental groups (interactive VR vs. non-interactive VR) with respect to their PANAS, STAI, and IPQ scores. An independent two-sample t-test confirmed a signif-

icant difference between both groups concerning their experience of spatial presence, $t(34) = 2.33, p = .03, d = .78$. Thus, the interactive mode of the VR app elicited a higher sense of spatial presence, $M = 4.38, SD = 1.21$, than the non-interactive mode, $M = 3.47, SD = 1.13$.

Regression analysis confirmed spatial presence as a significant predictor of both anxiety, $R^2 = .32, \beta = .57, t(34) = 4.02, p < .001$, and positive affect, $R^2 = .33, \beta = .57, t(34) = 4.09, p < .001$. Moreover, having experienced presence in the VR app also predicts more positive emotions in the subsequent acute stress situation, $R^2 = .17, \beta = .41, t(34) = 2.61, p = .013$.

4. Discussion

The observed physiological stress responses indicate that interactivity plays an important role in the relaxing, mood-enhancing effect of VE presented in VR. However, the results of our study reveal the complex relationship between interaction, presence, emotional responses, and relaxation. We hypothesized that interactivity, for instance in the form of playful elements, may increase the perceived naturalness and believability of the VE. Furthermore, we assume that interacting with the VE requires more cognitive resources than passive observation. Moreover, it may cause a shift of the attentional focus to the virtual world. In this case, interactivity would support immersion and strengthen the experience of presence, bringing the VE closer to reality. While the HRV values of interactive VR and control group in the induction phase were as we expected, the HRV values of the non-interactive VR group decreased compared to the baseline. This is also reflected in the affect values, but not in the anxiety values. However, this contradicts findings from previous studies [8,4]. An explanation is that the subjects were not sufficiently stimulated and possibly disappointed due to the simplicity of the non-interactive scene. Moreover, we found that higher levels of perceived spatial presence in our VR app significantly predict higher levels of positive affect and lower levels of anxiety not only during the induction phase but also during the stress phase. This supports our assumption that interactive immersive VE can have a positive effect on the resistance to acute mental stress. However, the differences in physical and mental stress indicators between the three conditions did not become significant. We observed some contradictions between the objective physiological data and the self-reported experience data in the stress phase. This may indicate that the previous use of the interactive VR app led to an overall more positive emotional handling of the situation, even though the physiological stress level was comparably high in all three conditions. The results must be seen against the background of some methodological limitations. A rather small sample size may be the reason for some differences in the examined variables being non-significant. Moreover, theoretically expected effects may have been distorted by confounding factors. Furthermore, a more precise recording of the HRV progression during the stress phase could be insightful since it would allow identifying subtle differences in the HRV change throughout the entire phase. The simplicity of the VR app, especially of the non-interactive mode, may have not resulted in a level of cognitive immersion and engagement high enough to distract the subjects from the laboratory setting. Thus, it is possible that a more sophisticated application could be more effective. In this respect, it may also be that the intensity of the negative reactions triggered by the VR-TSST masked possible positive effects of the VR app.

5. Conclusion

The results of this study suggest that interactivity may be an important characteristic of a natural VE influencing its effects on affect and recreation. Adding playful elements to a virtual beach scene increased both physiological and psychological indicators of relaxation and positive mood compared to a non-interactive scenario. Although these differences became less visible during the subsequent psycho-social stress phase, we assume that the deeper immersion and increased sense of presence have a positive impact on the emotional handling of a following stress situation. Due to some limiting factors, a follow-up study is necessary to provide further clarification.

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SECTION V

CLINICAL OBSERVATIONS

Cybertherapy is a field that is growing rapidly due to today's technology and information boom.

Virtual reality and advanced technologies have been used successfully to in a variety of healthcare issues, including treatment of anxiety disorders and phobias, treatment of eating and body dysmorphic disorders, neuropsychological assessment and rehabilitation and distraction during painful or unpleasant medical procedures.

The novel applications of these technologies yield many advantages over traditional treatment modalities, and the disadvantages that accompanied the first trials of virtual reality are quickly being addressed and eliminated.

Virtual reality peripherals such as data gloves, physiological monitoring and Internet worlds are swiftly demonstrating their usefulness in cybertherapy applications.

Wiederhold & Wiederhold, 2004

Craving and Anxiety Responses as Indicators of the Efficacy of Virtual Reality-Cue Exposure Therapy in Patients Diagnosed with Alcohol use Disorder

Alexandra GHÎȚĂ^a, Olga HERNÁNDEZ-SERRANO^b, Jolanda RUIZ^a, Miquel MONRAS^c, Lluïsa ORTEGA^c, Silvia MONDON^c, Lidia TEIXIDOR^c, Antoni GUAL^c, Bruno PORRAS-GARCÍA^a, Marta FERRER-GARCÍA^a, & José GUTIÉRREZ - MALDONADO^{a 1}

^aDepartment of Clinical Psychology and Psychobiology, University of Barcelona

^bDepartment of Physical Therapy, EUSES University of Girona

^cAddictive Behaviors Unit, Hospital Clinic of Barcelona

Abstract. *Introduction:* Virtual Reality (VR) technology has shown promising results as an assessment and treatment instrument in substance use disorders, particularly in attempts to reduce craving. A common application of the VR technology in treatment is based on cue-exposure therapy (CET). Following from previous results, the present case series is part of a larger project aiming to test the efficacy of the Virtual Reality-Cue Exposure Therapy (VR-CET) versus Cognitive-Behavioral Therapy (CBT). *Method:* Eight patients between ages 40 and 55 ($M_{age} = 49$, $SD = 5.54$) from the Addictive Behaviors Unit at the Hospital Clinic of Barcelona participated in this study after providing written informed consent. Patients were randomly assigned to the VR-CET group (three patients) or the CBT group (five patients). The protocol of the clinical trial consisted of a pre-treatment session (the initial assessment session), six sessions of CBT or VR-CET, and a post-treatment session (post-assessment session). The VR-CET sessions consisted of exposure to alcohol-related cues and environments aiming to reduce anxiety and craving responses to alcohol-related stimuli. The CBT sessions consisted of classical standardized therapy for the treatment of addictions, as previously applied in other clinical trials. In the pre- and post-treatment sessions, patients completed several measures of alcohol craving and anxiety and visual analog scales (VAS) during VR exposure. *Results:* Our data indicated a significant reduction in both groups in all scores of craving and anxiety responses, as assessed by the different instruments. In addition, the VR-CET group obtained lower scores on anxiety and craving responses than the CBT group. *Conclusions:* In this ongoing project, the first phase of the clinical trial showed significant improvements in terms of craving and anxiety reduction in both groups, emphasizing that VR-CET can be as efficient as CBT. In addition, patients in the VR-CET group obtained slightly better scores than patients in the CBT group, suggesting the clinical potential of the VR technology in the treatment of substance use disorders. We propose that VR-based CET can be a useful complement to existing treatment methods for AUD patients.

Keywords. Alcohol use disorder, anxiety, craving, virtual reality, assessment, cue-exposure therapy, cognitive-behavioral therapy

¹ Corresponding author: jgutierrezm@ub.edu

1. Introduction

Empirical studies have suggested that alcohol craving and the related anxiety interfere with treatment outcomes in alcohol use disorder (AUD) patients. Targeting alcohol cravings, a commonly used psychological treatment method is cue-exposure therapy (CET). CET relies particularly on ideals of Pavlovian conditioning, indicating that repeated unreinforced exposure to alcohol-related cues may disrupt and extinguish the urge to consume alcohol (craving) [1]. Although this technique has been widely used, the outcomes of different studies are inconsistent, mainly because the exposure involves limited alcohol-related cues in a safe and secure environment, a circumstance that restricted the later generalization of the effects of the therapy to daily-life activities of the patients. Based on the principles of cue-exposure, Virtual Reality (VR) technology has shown promising results as an assessment and treatment instrument in substance use disorders, particularly in attempts to reduce craving. The outcomes of studies implementing VR in the treatment of AUD patients [2] have emphasized its clinical potential as a complementary instrument in substance use disorders. VR facilitates the responses of individuals within a safe, secure environment that ensures high ecological validity. The current study is part of a larger project aiming to test the efficacy of Virtual Reality-Cue Exposure Therapy (VR-CET) versus Cognitive-Behavioral Therapy (CBT) in a multi-site clinical trial in patients diagnosed with AUD considered resistant to treatment as usual (TAU). The case series included in the present study represent the first phase of the clinical trial, targeting responses of alcohol craving and anxiety as indicators of the efficacy of VR- CET versus CBT.

2. Method

2.1 Participants

Eight patients between ages 40 and 55 ($M_{age} = 49$, $SD = 5.54$) from the Addictive Behavior Unit of the Hospital Clinic, Barcelona participated in this study after providing written informed consent. Ethical approval was obtained from the Institutional Review Board of the University of Barcelona and the Hospital Clinic of Barcelona. Dual diagnoses consisted of anxiety, depression and borderline personality disorders. In addition, patients self-reported their use of tobacco, cannabis and cocaine in the last month prior to the experiment. Pharmacotherapy of the patients included disulfiram, anxiolytics, antidepressants and antipsychotics. The inclusion criteria were an AUD diagnosis, with particular emphasis on resistance to TAU (i.e., patients with at least one failed attempt to cease alcohol consumption within six months after completion of treatment), ambulatory treatment for at least two years, and a minimum of three-day abstinence prior to the first assessment session. Exclusion criteria were severe cognitive impairment, severe co-morbid psychopathology (e.g., schizophrenia), opioid addiction, epilepsy or pregnancy.

2.2 Instruments

- *Alcohol Use Disorder Identification Test* (AUDIT) [3]: a ten-item scale used to assess alcohol consumption severity.
- *Multidimensional Alcohol Craving Scale* (MACS) [4]: a self-report scale exploring the intensity of alcohol craving experienced by the participant in the previous week.
- *Multidimensional Alcohol Craving Scale – Virtual Reality*. (MACS-VR): an ad-hoc modified version of the MACS used to assess the intensity of alcohol craving experienced during VR exposure.
- *State-Trait Anxiety Inventory* (STAI) [5]: a questionnaire assessing the individual's level of anxiety at a particular moment (state) and in general (trait).
- *Visual Analog Scales* (VAS): self-report scales during VR exposure, used to indicate cue-induced craving levels (VAS-C) and cue-induced anxiety responses (VAS-A) on a scale from 1 to 100.

- **Hardware:** the VR equipment consisted of an Oculus Rift head-mounted display (HMD), sensors, Touch controllers and a computer compatible with the VR technology (INTEL(R) Core(TM) i7 – 2600 CPU, 16.0 GB RAM, Operating System 64bits, processor x64, graphic card NVIDIA GeForce GTX 1080 Ti).
- **Software:** The “ALCO-VR” software (Figure 1) was created considering multiple variables for triggering alcohol craving (sounds, social interaction, moment of the day etc.), based on a previous study [6]. The ALCO-VR platform consisted of two parts: assessment and therapy. Both stages started with a hierarchy of exposure from the lowest-rated environment with the lowest-rated alcoholic drink to the highest-rated environment and highest-rated drink. The ALCO-VR consisted of four VR alcohol-related environments: restaurant, bar, pub, and at-home, and a menu of 22 alcoholic beverages. All the environments were specifically created to simulate real-life scenarios based on patients’ experiences.



Figure 1. Images of the ALCO-VR environments.

2.3. Procedure

Patients were randomly assigned to the VR-CET group (three patients) or the CBT group (five). The protocol of the clinical trial consisted of eight sessions: a pre-treatment session (the initial assessment), six one-hour sessions of CBT or VR-CET and a post-treatment session (post-assessment). The VR-CET sessions consisted of cue-exposure to alcohol-related cues and environments of the ALCO-VR software aiming to reduce anxiety and craving responses to alcohol-related stimuli. The CBT sessions consisted of classical standardized therapy for the treatment of addictions. In the pre-treatment session, significant data of the anamnesis were recorded such as dual diagnoses, medication, abstinence data (supported by urine analyses), other substance use (illicit or licit) during the month prior to the experiment and any alcohol consumption (Table 1). Patients were then asked to complete several self-report scales of alcohol craving and anxiety, such as the AUDIT, STAI (the trait part), and MACS questionnaires. Subsequently, patients were exposed to the assessment part of the ALCO-VR software, in which they could choose their preferred alcoholic beverages and approach them from all angles. During VR exposure, every 20 seconds, patients were asked to report their cue-induced anxiety and craving on the VAS-A and VAS-C. After this stage, patients completed the MACS-VR and the state part of the STAI.

Olfactory stimuli corresponding to each drink were introduced during the exposure. Previously prepared alcoholic beverages were transferred on cotton pads and placed on the table close to the participant every time a new alcoholic drink appeared during the exposure. The post-treatment session repeated the procedure of the pre-treatment session almost identically, except for the anamnesis and the completion of AUDIT. After each session of assessment or therapy, patients received a short debriefing aiming to reduce their craving and anxiety levels and to minimize any later alcohol consumption.

3. Results

Table 1 presents descriptive data of the patients randomly assigned to the VR-CET or CBT groups. The AUDIT scores may change depending on the abstinence period of each patient because it was designed specifically to depict hazardous drinking patterns in the individual in the last year. Therefore, total scores above 20 indicated a severe AUD. The total scores of patients 7 and 8 suggested a moderate AUD or harmful drinking patterns, while patient 4's score might suggest a mild drinking pattern, but it was interpreted as a disorder in remission mainly because of the patient's long-term abstinence.

Table 1. Descriptive data of the patients assigned to the VR-CET/CBT groups.

| Patient | Age | Gender | Group | Dual diagnosis | Medication | Abstinence (days) | Other substances | AUDIT |
|---------|-----|--------|--------|--------------------------|---|-------------------|----------------------------|-------|
| 1 | 49 | Male | VR-CET | None | Anxiolytics | 42 | Tobacco, cannabis, | 28 |
| 2 | 49 | Female | CBT | BPD, anxiety, depression | Anxiolytics, antidepressants | 38 | Tobacco, cannabis, cocaine | 36 |
| 3 | 55 | Female | CBT | None | Anxiolytics, antidepressants | 245 | Tobacco | 33 |
| 4 | 54 | Female | VR-CET | None | Antidepressants | 360 | Tobacco | 2 |
| 5 | 44 | Female | VR-CET | BPD | Anxiolytics, antipsychotics | 5 | Tobacco, cannabis, cocaine | 38 |
| 6 | 51 | Male | CBT | BPD, anxiety, depression | Anxiolytics, antipsychotics | 28 | Tobacco, cannabis, | 36 |
| 7 | 40 | Female | CBT | BPD | Anxiolytics, antidepressants, antipsychotics, | 42 | Tobacco | 14 |
| 8 | 55 | Male | CBT | BPD | Disulfiram | 15 | Tobacco | 16 |

*BPD, Borderline Personality Disorder; Other substances (referring to substances other than alcohol consumed in the month prior to therapy).

Table 2 shows the results of the STAI, MACS and MACS-VR questionnaires in the pre and post VR-CET/CBT. In the pre-treatment session, all patients obtained higher scores of craving and anxiety. Higher STAI scores indicated higher levels of anxiety. The STAI results suggested moderate levels of anxiety in the VR-CET group (in both subtests) and in the CBT group on the state subtest, while the trait part of STAI indicated clinically significant anxiety in the CBT group; however, groups obtained lower scores on STAI (on both subtests), indicating the efficacy of the treatments. We emphasize the low scores obtained by the patients in the VR-CET group on the state subtest of the STAI, which suggest mild state-anxiety after the treatment. Regarding alcohol craving, the MACS scores in the pre-treatment session in both groups suggested a moderate level of craving in the week prior to the experiment. In the post-treatment assessment session, both groups obtained mild alcohol craving scores. In addition, the MACS-VR scores indicated a severe craving level in the pre-treatment session. These scores were lower in the post-treatment assessment session, with a mild level of craving in the VR-CET group and a moderate level in the CBT group

Table 2. Assessment of anxiety and craving responses in the pre-post treatment (VR-CET versus CBT).

| | VR-CET | | CBT | |
|------------|---------------------|--------------------------|------------------|-------------------|
| | Pre VR-CET M(SD) | Post VR -CET M(SD) | Pre CBT M(SD) | Post CBT M(SD) |
| STAI-trait | 21 (13) | 18.33 (9.81) | 43 (7.31) | 21.8 (14.82) |
| STAI-state | 16 (14.17) | 7.67 (10) | 20 (16.41) | 16.2 (8.61) |
| MACS | 23 (6.8) | 20.67 (9.6) | 35.6 (10) | 18.8 (5.4) |
| MACS-VR | 36.33 (13.86) | 18.67 (9.86) | 42.2 (10.8) | 25.4 (11.67) |

The data for anxiety and craving levels reported on the STAI, MACS and MACS-RV questionnaires were consistent with those for cue-induced anxiety and craving responses reported on the two VASs (Figures 2 and 3). Our data indicated a significant reduction in both groups in cue-induced anxiety and craving responses. As both figures indicate, scores of cue-induced anxiety and craving responses were lower in the VR-CET group than in the CBT group. In addition, patient 3, in the CBT group, presented similar scores for craving in the pre- and post-CBT assessment sessions, and higher scores for anxiety in the post-CBT assessment.

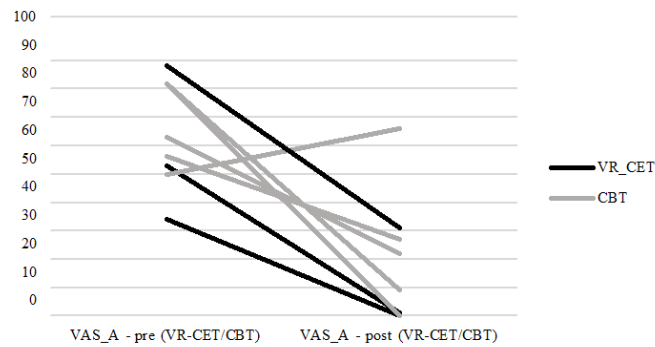


Figure 2. Cue-induced anxiety responses reported on VAS-A.

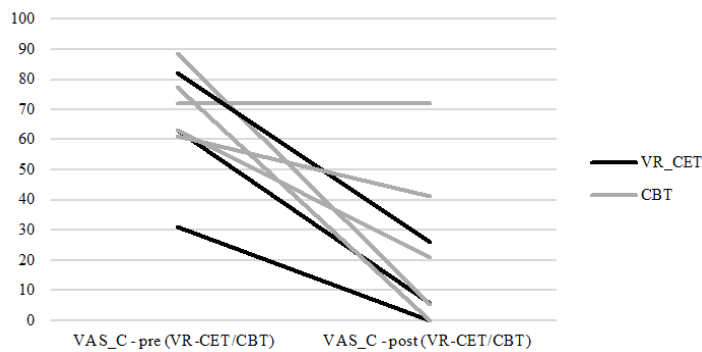


Figure 3. Cue-induced alcohol craving responses reported on the VAS-C.

4. Conclusions

Our data indicated improvements in various measurements of anxiety and craving in both groups and suggest that the VR-CET approach was as efficient as the CBT approach in this study. We highlight the craving and anxiety responses in the VR-CET group, which obtained better scores on the VAS-C and VAS-A than the patients in the CBT group. We interpret these data at post-treatment as a result of a desensitization process regarding alcohol content, and an indication of the clinical potential of VR technology in AUD treatment. As this study emphasized the first phase of a clinical trial, there are important limitations to be mentioned such as gender imbalance, dual diagnosis, medication and abstinence period, that may potentially influence our data.

The present study is an ongoing project and these data indicate promising results in terms of craving and anxiety reduction. We propose that CET based on VR can be a useful complement to existing treatment methods for AUD patients.

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Attentional Bias Assessment in Patients with Alcohol Use Disorder: an eye-tracking study

Alexandra GHIȚĂ^{a,1}, Bruno PORRAS GARCÍA^a, Manuel MORENO^b, Miquel MONRAS^c, Lluïsa ORTEGA^c, Silvia MONDON^c, Lidia TEIXIDO^c, Amadeu OBACH i VIDAL^c, Antoni GUAL^c, José Antonio AZNAR CASANOVA^b, Marta FERRER GARCÍA^a, Paola BERTOMEU PANISELLO^a & José GUTIÉRREZ MALDONADO^a

^a*Department of Clinical Psychology and Psychobiology, University of Barcelona*

^b*Department of Cognition, Development and Educational Psychology, University of Barcelona*

^c*Addictive Behaviors Unit, Hospital Clinic of Barcelona*

Introduction: Alcohol use disorder (AUD) represents a major general health concern with important consequences for individuals' psycho-social functioning. Many studies suggest that cognitive processes such as attentional bias (AB) are heavily involved in the phases of acquisition, maintenance and relapse precipitation in AUD. AB is described as an implicit selective attention when processing visual information in favor of desired cues, which may elicit craving for alcohol and facilitate drinking-related behaviors. In line with recent studies of the applications of human-computer interaction in the field of psychology, the current study aimed to assess attentional bias towards alcohol-related images using eye-tracking technology. Specifically, we explored the first gaze towards alcohol-related images versus neutral images in patients with short-term and long-term abstinence. **Method:** 24 outpatients ($M_{age} = 53$, $SD = 11.65$) from the Addictive Behavior Unit of the Hospital Clinic of Barcelona participated in the study. The inclusion criteria were diagnoses of AUD and normal or corrected-to-normal visual acuity. Participants were divided according to their abstinence period, with the cut-off point being set at four months. Fourteen patients had been abstinent for less than four months ($M = 1$, $SD = 0.96$), and 10 for longer than this period ($M = 14$, $SD = 8.17$). The self-reported abstinence period was supported by the results of urine analyses performed in all patients. Participants completed the Alcohol Use Disorder Identification Test ($M = 19.75$, $SD = 9.34$) and the Visual Attention Task (VAT). The VAT consisted of images related to alcohol consumption versus neutral images such as office objects. The EyeTribe eye-tracking technology was used to record eye movement activity during the VAT. **Results:** Our data indicated a statistically significant difference between patients with short-term and long-term abstinence regarding their first fixation towards alcohol-related and neutral images. Patients abstinent for less than four months had a tendency to look first at images related to alcohol consumption, whereas patients abstinent for more than four months were more likely to look first at neutral images, regardless of their AUDIT score. **Conclusions:** Patients with short-term abstinence had a greater AB than patients with long-term abstinence. The first gaze seems to be a sensitive parameter for differentiating between patients with low and high AB. The use of eye-tracking technology suggests that AB is important in clinical assessment and should be addressed in treatment as well as in relapse prevention. We consider that the eye-tracking technology is a promising instrument for assessing current addictive behavior. **Keywords.** Attentional bias, eye-tracking, alcohol use disorder

1. Introduction

Alcohol use disorder (AUD) is a major general health concern, with important consequences for individuals' psycho-social functioning [1]. Many studies suggest that

cognitive processes such as attentional bias (AB) are heavily involved in the phases of acquisition, maintenance and relapse precipitation in AUD [2-4]. It has been suggested that AB may be an important variable in terms of abstinence period [3]. AB is described as an implicit selective attention when processing visual information in favor of desired

¹ Corresponding author: alexandraghita@ub.edu

cues [5]. It has been suggested that this implicit cognitive processing may elicit craving for alcohol or an intense desire to consume it [6] and may further facilitate drinking-related behaviors [7]. A growing body of literature emphasizes that AB has clinical implications in substance craving and should be addressed in the assessment [8], treatment [3] and relapse prevention [9] of addictive behaviors.

There is considerable interest at present in the application of new technologies in the field of clinical psychology and particularly in substance use disorders [10,11]. The eye-tracking (ET) technology is a useful tool for exploring eye-movement activity in relation to drug-seeking behaviors [4]. It complements classical methods to explore AB such as the Stroop task or the visual probe task [5]. Although ET has been implemented in various studies, for instance, obesity [12], bulimia nervosa [13] or anorexia nervosa [14], tobacco use disorder [15] or cocaine use [16], more research is needed to gain greater insights into its usefulness as a clinical instrument in addictive behaviors. Despite the fact that there are many publications on eye-tracking and alcohol use in general population, there is less research focused on the applications of eye-tracking in clinical settings with patients diagnosed with alcohol use disorder [17].

The current study aimed to assess AB towards alcohol-related images using ET technology. Specifically, we examined the first gaze towards alcohol-related images versus neutral images in patients diagnosed with AUD with short-term and long-term abstinence.

2. Method

a. Participants

Twenty-four outpatients ($M_{age} = 53$, $SD = 11.65$) from the Addictive Behavior Unit of the Hospital Clinic of Barcelona participated in the study after providing informed consent. The inclusion criteria were diagnosis of AUD and normal or corrected-to-normal visual acuity. Participants were divided according to their abstinence period, with the cut-off point being set at four months. Fourteen patients had been abstinent for less than four months ($M = 1$, $SD = 0.96$), and 10 for longer than this period ($M = 14$, $SD = 8.17$). The self-reported abstinence data were supported by the results of urine analyses performed in all patients.

b. Instruments

- *Alcohol Use Disorder Identification Test (AUDIT)* [18]. The Spanish version of AUDIT [19] is a 10-item scale that determines the severity of alcohol dependence and risk consumption. Responses to each item are scored from 0 to 4 and the maximum score is 40.
- *Visual Attention Task (VAT)*. The VAT comprises images related to alcohol consumption versus neutral images such as office objects. Alcohol-related images were selected based on the Spanish National Health Survey on Alcohol Consumption 2012 (Encuesta Nacional de Salud 2011/12. Consumo de alcohol) [20], which found beer to be the most consumed alcoholic beverage, followed by wine and liquors. Neutral images were office objects like colorful pencils, sticky notes, writing boards and other office-related images. The 144 stimuli (12 images related to alcohol x 12 neutral images) were presented to the subjects as a false visual memory task. This false task consisted of 18 trials (eight pairs of images per trial) in which the subjects had to state whether they had seen a

certain image or not. All pairs of images were counterbalanced, that is, each image appeared the same number of times on both sides of the screen. Each pair of images appeared on the screen for three seconds. After each pair of images, a gray-background image appeared for one second with a fixation point in the center of the screen aiming to return to a focal point.

c. Procedure

Participants were informed of this study during their regular visits with their appointed psychiatrist or psychologist. If they agreed to participate, they were referred to the researcher in charge of the study. First, they were informed about the technology used in the study and then they were asked to sign the informed consent. Personal data such as AUD history, medication and last consumption data were also collected. Reported medication included disulfiram, anxiolytics and anti-depressants. Patients were then asked to complete the AUDIT ($M = 19.75, SD = 9.34$) and the VAT. The VAT was displayed on a 19-inch monitor. The distance between the eye-tracking device and the participant was 60 cm. A chin rest was used to avoid head movements. All participants were administered a calibration task in the beginning in order to correctly map eye positions. Subsequently, instructions appeared on the screen informing participants that they were about to explore neutral and alcohol-related images. After each trial, participants were asked to report whether a certain image on the screen belonged to the previously presented trial and answered “yes” or “no”. The procedure lasted approximately 20 minutes. To record eye movement activity during the VAT, we used the EyeTribe eye-tracking technology.

d. Statistical analysis

Open and Gaze Mouse Analyzer (Ogama) software was used to analyze the raw EyeTribe eye-tracking data and to determine areas-of-interest (AOI) of each image. As a common form to determine AB is by exploring first gaze, this variable was computed within each AOI of images. Then, the Student t test was applied to explore the differences between patients’ AB according to their abstinence period using the SPSS Statistical Package (v.23).

3. Results

T test for independent samples showed that there was a statistically significant difference between patients with short-term and long-term abstinence, $t(22) = 2.49, p = .02$. Figure 1 indicates that patients with short-term abstinence showed a bias in their first fixation towards images related to alcohol, but patients with long-term abstinence did not.

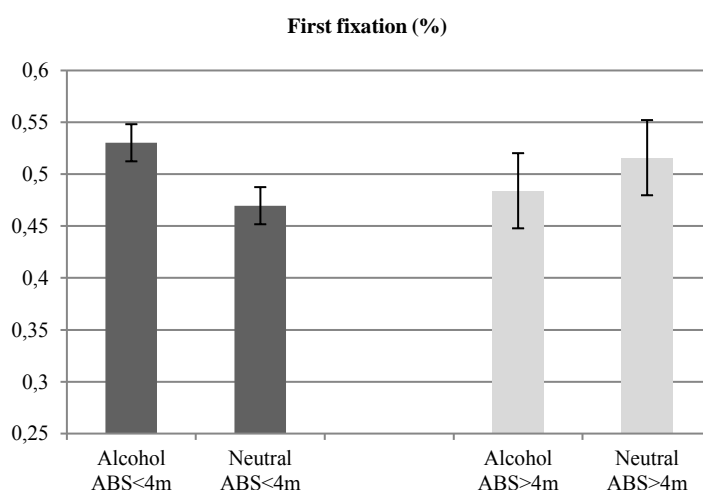


Figure 1. AB data in patients with AUD with ± 4 ABS (abstinence) months

4. Conclusions

A statistically significant difference was found between AUD patients with short-term and long-term abstinence (± 4 months) in terms of their first fixation towards alcohol-related images and neutral images. Patients who were abstinent for less than four months had a tendency to look first at images related to alcohol consumption, whereas patients abstinent for more than four months did not show any differences between alcohol-related images and neutral images. These findings corroborate those of previous studies using the visual probe task [21], the Go/No-Go Association Task [22], or the Stroop paradigm [23], which have supported AB towards alcohol-related images in individuals with alcohol misuse. AB modulates alcohol-seeking behaviors [24] and alcohol craving [25], resulting in approach behavioral tendencies [17], which may further increase the motivation to drink alcohol [3]. As our results corroborate those of previous research, we consider that AB towards alcohol-related content should be targeted in treatment approaches, as well as in prevention programs.

Interestingly, patients with long-term abstinence showed a slight tendency to look first at neutral images as it can be appreciated in Figure 1. This confirms previous work in which long-term abstinent patients displayed a negative bias when they focus their selective attention towards the control images and implicitly showed an inclination towards avoidant behavior. It has been suggested that this avoidance tendency is an outcome of patients' own perceptions regarding the loss of their self-control over alcohol consumption [25]. This may indicate that the less patients acknowledge alcohol-related stimuli, the less able they are to build new coping skills for use when they are engaged in real-life situations with alcohol content [26]. The results of this study show that patients with short-term abstinence had a greater AB than patients with long-term abstinence. The first gaze seems to be a sensitive parameter for differentiating between patients with low and high AB. The use of the eye-tracking technology suggests that AB is important in terms of clinical assessment and should be addressed in treatment as well as in relapse prevention. We conclude that the eye-tracking technology is a promising instrument for assessing current addictive behavior.

5. Acknowledgments.

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Public Speaking Training in Front of an Imaginary or Virtual Audience: A randomized controlled trial

Ni KANG^a, Ding DING^{a,1}, Dwi HARTANTO^a, Willem-Paul
BRINKMAN^a, and Mark A. NEERINCX^{a,b}

^a*Delft University of Technology, Netherlands*

^b*TNO Perceptual and Cognitive Systems, Netherlands*

Abstract. When preparing for a public speech, practicing with an audience is suggested to be effective in enhancing speech performance. However, it is often impractical to organize an audience to practice a presentation. Virtual reality can provide a solution, i.e., practicing with a virtual audience. This paper studied this practicing technique for enhancing speech performance and people's training satisfaction. A randomized controlled trial ($n = 40$) was conducted to compare practicing in front of a virtual audience with another practicing technique whereby the presenter had to imagine an audience while practicing. Individuals practiced their presentations in three training sessions with either a virtual audience or an imaginary audience. Participants' performance was assessed in an assessment session where they delivered their speech in front of a human audience. The results showed that individuals seemed to benefit more from a virtual audience than an imaginary audience in reducing speech anxiety. The clearest benefit of practicing with a virtual audience was the satisfaction it gave. Participants were more positive towards training with a virtual audience regarding both the training process and its effect on their presentation ability. We anticipate that virtual audiences can be beneficial in motivating individuals to practice their presentation skills.

Keywords. Public speaking training, virtual audience, speech performance, self-efficacy, intelligent virtual agents

¹Corresponding Author: d.ding-1@tudelft.nl. 1

1. Introduction

Whether we are talking about our research at a conference, making a speech at a friend's wedding, or making a proposal in a business meeting, we have to speak in public from time to time. How well we have delivered a presentation affects the way people think about us and the message of the presentation. For example, people tend to regard presenters as more credible and intellectual when they have more eye contact with their audience during presentations [1], and people are more likely to believe the presenters and be persuaded

when the speech is fluent and well organized [2]. To deliver a good speech, preparation is necessary.

Among all the speech preparation activities, Menzel and Carrell [3] specifically found that the amount of rehearsals in front of an audience and the amount of experienced anxiety was associated with the quality of the speech performance. Moreover, a study by Ayres et al. [4] indicated that practicing with an audience helps to decrease public speaking anxiety and increase the willingness to speak.

Although practicing with an audience is suggested to be effective in enhancing speech performance, it is often impractical to organize an audience to practice a presentation. This problem can be solved by virtual reality, providing presenters with a virtual audience. The use of virtual audiences has already been suggested for several application domains, such as therapy for social phobia [5] or anxiety disorders [6]. Interaction with a single or group of virtual characters can affect people in a manner similar to that of interaction with real people. For example, people have reported anxiety when speaking to one or several virtual character(s) [7] or giving a presentation in front of a virtual audience [8]. The presence of a virtual audience has also been found to affect people's performance as a real audience did [9]. Without a visible audience, imagination can also affect people's emotion and performance. Both virtual audiences and imaginary audiences have been used to treat social anxiety disorder and were found comparatively effective in reducing social anxiety [10]. Many researchers also found positive correlations between rehearsal in front of audiences and performance [3,11]. Moreover, some studies [12,13] reported that imagination of a performance, or mental rehearsal of the process, can help to improve the performance. Success in performance can also boost self-efficacy beliefs [14]. Still, practicing with an imaginary audience holds a number of drawbacks when compared to practicing with a virtual audience. First of all, the imagery task itself has some limitations, such as requiring a great deal of attentional resources and being difficult to control. Furthermore, practicing a presentation with an imaginary audience requires individuals to perform two tasks simultaneously: presenting and imagining. However, as dual-task performing requires more attentional resources, the problem of capacity overload may arise, which may deteriorate the performance of both tasks [15].

To the best of our knowledge, little research has been reported on the use of virtual audiences to improve speech performance. This study, therefore, intends to investigate this practicing technique for enhancing public speaking performance, focusing especially on its effectiveness and people's training satisfaction. The empirical study compared practicing in front of a virtual audience with another practicing technique whereby the presenter had to imagine an audience while practicing. The following hypotheses are formulated:

People who practiced in front of a virtual audience (H1) perform better, (H2) are less anxious, (H3) find the practice method more satisfying, and (H4) hold more positive beliefs of their self-efficacy than those who practiced with an imaginary audience.

2. Method

A public speaking training course was organized on the university campus. In this individual course, participants were instructed to practice their own presentations in one of two ways: practice in front of a virtual audience (i.e., VR condition), or practice with an imaginary audience (i.e., IM condition). To compare the effects of the practicing methods, a between-subjects design was employed.

2.1 Materials

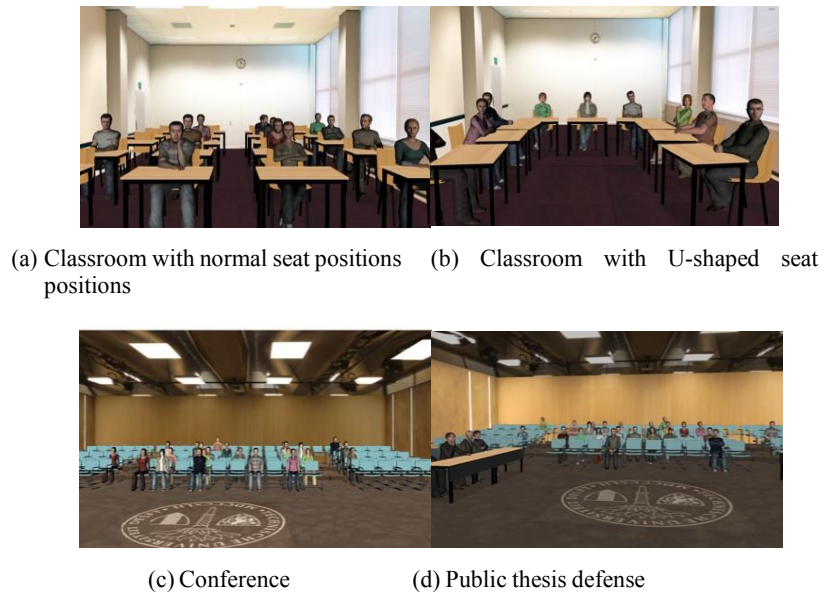


Figure 1. Screenshots of different scenarios

In the VR condition, participants could select out of four different virtual environments to match the presentation setting they were targeting. They were a classroom with normal seat arrangement, a classroom with U-shaped seat arrangement, a conference hall, and a setting for a public PhD defense (Figure 1). A parameterized expressive audience behavior generator [16] was used to create an expressive virtual audience. The behavior generator was accomplished based on statistical models abstracted from observation of real audiences. The generated behavior was modulated by the audience members' personality (extroversion, agreeableness, openness, neuroticism, and conscientiousness), attitude towards the topic (interest, approval, eagerness for information, criticism, and impatience), mood (valence, arousal, and dominance), and energy level, which were also collected in the observation. The virtual audience showed different attitudes by their postures and facial expressions. In this study, participants could select an audience type, namely a positive, neutral, critical, or bored looking audience, to practice coping with the audience. The perception of the four audience types have been validated in a previous user study [17]. Besides selecting an audience type, participants could also select whether an interrupting event would occur during the rehearsal of their presentation such as drilling noises or mobile phone rings. In each training session, at the most, only one interrupting event was triggered around half-way through the speech. For example, if the duration setting was 5 minutes, the event would occur at 2.5 minutes. After the participants rehearsed the delivery of their talk, members of the audience asked the participants six questions, such as "What motivated you to carry out this research?". Besides rehearsing the presentation, the course also included the use of a virtual coaching system in both conditions. A virtual coach provided information about presentation structure, body language during speech, and visual aids. The coach also helped participants to reflect on and improve their presentations.

2.2 Measures

Presentation Performance (PP). The rubric for oral presentations developed by the University of Wisconsin–Madison [18] was used to evaluate people’s speech performance and presentation content after the training. The rubric consisted of ten items, which were rated on a four-point scale from 1 (poor) to 4 (excellent). The rubric consisted of four items evaluating the presentation content, five delivery-related items evaluating both non-verbal and verbal skills, and one timing item. In this study, the timing item was excluded as the presentation lengths and their timing requirement varied between participants.

Personal report of confidence as a speaker (PRCS) [19]. It is a 30-item self-report scale, which assesses both behavioral and affective responses to public speaking situations. The questions are answered in a true–false format, and the questionnaire score ranges from 0 (i.e., no fear of public speaking) to 30 (i.e., highest level of fear). This measure was used to investigate whether individual characteristic was associated with the effect of training.

Length of answers (LA). As behavioral assessment for social anxiety [20], the lengths of the presentation and answers to the questions was taken as a measure for confidence or avoidance behavior in the question phase of the assessment session.

Presence response (PR). To measure how well people were involved in the virtual or imaginary public speaking scenario, a three-item questionnaire on presence response was adapted from the one used in a study by Pan et al. [21]. All the items were rated on a seven-point scale from 1 (not at all) to 7 (very much).

Heart rate (HR). Heart rate is a physiological measure of experienced anxiety of people [22]. To measure the elicited fear responses during presentations, participants’ heart rate was monitored continuously in each session.

Subjective unit of discomfort (SUD) [23]. This item measures the levels of anxiety experienced by the participants. It is rated on a scale from 0 (no anxiety at all) to 10 (the highest level of anxiety that you can imagine).

Utility questionnaire (UQ). To investigate how satisfying and useful people found the practicing methods, a 12-item utility questionnaire was designed consisting of five items evaluating the practice process and seven items on the effectiveness in improving presentation performance. All the items were rated on a seven-point scale from 1 (strongly disagree) to 7 (strongly agree).

Self-efficacy (SE). A one-item self-efficacy assessment was applied to measure self-efficacy in public speaking following the suggestions of Bandura [24]. The question was formulated as: Supposing that now you need to give the presentation you are preparing for in the real situation, please rate how certain you are that you can successfully give the presentation. The item was rated on a scale from 0 (highly certain cannot do) to 10 (highly certain can do).

2.3 Procedure and apparatus

A total of 48 participants (16 females) were recruited throughout the university campus, while eight participants (5 in VR condition, 3 in IM condition) dropped out during the experiment, the analysis only included the data of 40 participants (13 females) who completed the whole experiment. Each condition involved 20 participants (7 females in VR condition and 6 females in IM condition). Their ages ranged from 20 to 42 years ($M = 27.5$, $SD = 4.6$).

Before the individual training course started, participants were asked to fill in questionnaires on PRCS and SE. To ensure the comparability of the participants in the two conditions, a matched pairs design was employed to assign the participants randomly to either VR or IM condition based on their gender and PRCS scores. The training course includes three training sessions followed by a session where participants gave their presentation to a human audience. These three sessions were scheduled over three to ten working days. The first training session and presentation in front of the human audience were scheduled on separate days, participants were allowed to schedule the second and the third session on the same day with at least a one-hour interval between the sessions to reflect on and improve their presentation.

Each training session included a coaching phase and a practice phase. In the coaching phase of first session, the participants interacted with the virtual coach. This was followed by rehearsing their own presentation in the practice phase. In the VR condition, before the presentation, participants chose a virtual environment, set the attitude of the virtual audience, and defined whether an interrupting event would occur during the presentation. The virtual environment was projected on a projection screen (330*250cm) by an EIKI EIP-200 projector. The participants then presented their presentations to the projected virtual audience and answered the questions asked by the virtual audience. In the IM condition, participants were instructed to look at the blank projection screen and to imagine an audience similar to a real situation. The participants were also instructed to think of possible reactions of the imaginary audience and possible questions from the audience. The participants were requested to keep the imaginary audience in mind when rehearsing their presentation. For both conditions, the participants needed to score their SUD every three minutes from the beginning of the presentation. After finishing the whole session, the participant rated SE and PR during the presentation. The procedure for the second and third session was similar, except that rehearsal and coaching phases were reversed.

In the assessment session, participants first rated SE and then delivered their speech in front of an audience of two people. One of the audience members was an experimenter. Following the presentations, the question-and-answer (Q&A) phase began. Both audience members then independently rated the participants' speech performance while the participants rated their SUD during the presentation, SE, and UQ. Participation in the course was voluntary. The experiment was approved by the university ethics committee.

3. Data preparation and analysis

To measure the rating consistency between the two raters on speech performance, Cronbach's alpha was calculated for the delivery items ($\alpha = 0.85$) and content items ($\alpha = 0.76$). As all the ratings showed acceptable consistency, the score for delivery and content dimensions were obtained by averaging the ratings from the two raters. Cronbach's alpha was calculated respectively for PR, utility questionnaire on practice process, and utility questionnaire on performance outcome, ranging from 0.84 to 0.95. Due to the good consistency between their items, the mean value of the items within each questionnaire was taken as a single measure of that questionnaire. All analyses were carried out with R version 3.4.2 with t-tests, multivariate ANOVA (MANOVA), and repeated measures ANOVA. When conducting ANOVA, practice condition was always included as a between-subjects factor. All the experiment data, the R scripts, figures and output files can be found online [25].

3.1. Results.

To check whether pre-experimental differences existed between the conditions, independent t-tests were performed. The results (Table 1) showed no significant differences between participants in VR condition and IM condition in PRCS, age, and self-efficacy before training.

Table 1 indicates that no difference was found between the two training conditions with regard to the presentation performance: the content and the way the participants presented the presentation in front of human audience. However, Table 1 indicates a significantly higher PR rating in the VR condition than in IM condition in the first training session and a similar trend for assessment session. A mixed ANOVA on PR with time of measurement as within-subjects factor found a significant main effect of measuring time ($F(3, 114) = 34.25, p < 0.001$), while for condition, no significant main effect was found ($F(1, 38) = 3.59, p = 0.07$). Detailed comparisons also showed that PR in the assessment session was significantly higher ($p < 0.001$) than PR in other sessions.

To study how participants' anxiety changed over the sessions, analyses were conducted on mean values of HR and mean values of SUD during the three practice phases and the SUD score given after the assessment session. A two-way mixed ANOVA was conducted respectively on HR and SUD, with time of measurement as the within-subjects factor. The results showed significant main effects of time of measurement on both HR ($F(2.18, 82.83) = 18.70, p < 0.001$) and SUD ($F(1.91, 72.64) = 4.85, p = 0.01$), but no significant main effect of condition or interaction effect was found. Detailed comparisons were conducted respectively on HR and SUD between different sessions and the final presentation. The results showed that both HR ($p < 0.001$) and SUD ($p < 0.02$) in the assessment session were significantly higher than those measured during the practice sessions, whereas either HR or SUD during practice sessions did not differ significantly from each other. This suggests that the anxiety experienced in front of a real audience was much stronger than the anxiety experienced with a virtual audience or an imaginary audience. Nevertheless, the mean SUD scores in practice sessions were all significantly above 2.5 ($p < 0.01$), suggesting that participants at least experienced some level of anxiety when practicing.

Table 1. Descriptive statistics of the measures, Mean (SD), and results of independent t-tests.

| Measure and phase/dimension | | Condition | | Effect size <i>r</i> |
|---|-------------------------|---------------|--------------|----------------------|
| | | VR | IM | |
| PRCS | | 12.85(5.88) | 12.85(5.75) | 0.00 |
| Age | | 26.85(3.38) | 28.10(5.56) | -0.13 |
| Self-efficacy | Before Training session | 6.10(1.55) | 6.10(2.22) | 0.00 |
| Presentation performance (PP) | Delivery | 3.09(0.42) | 3.05(0.35) | 0.05 |
| | Content | 3.30(0.44) | 3.32(0.33) | -0.03 |
| Presence response (PR) | Training Session 1 | 4.68(1.19) | 3.83(1.11) | 0.35* |
| | Training session 2 | 4.85(1.23) | 4.50(1.45) | 0.13 |
| | Training session 3 | 5.02(1.01) | 4.35(1.55) | 0.25 |
| | Assessment session | 6.15(0.75) | 5.63(1.08) | 0.27 |
| HR | Training session 1 | 87.55(9.87) | 87.34(10.06) | 0.01 |
| | Training session 2 | 89.29(10.19) | 89.74(9.10) | -0.02 |
| | Training session 3 | 88.81(12.14) | 89.84(9.90) | -0.05 |
| | Assessment session | 101.99(20.68) | 101.86(16.6) | 0.00 |
| SUD | Training Session 1 | 3.71(2.24) | 3.84(1.78) | -0.03 |
| | Training Session 2 | 3.85(2.28) | 3.78(2.58) | 0.01 |
| | Training Session 3 | 3.55(2.51) | 3.74(2.68) | -0.04 |
| | Assessment session | 4.50(2.33) | 5.15(2.52) | -0.13 |
| Utility questionnaire (UQ) | Process-related | 5.48(0.92) | 4.46(1.47) | 0.38* |
| | Outcome-related | 5.29(1.09) | 3.85(1.65) | 0.46** |
| Length of answers (LA) in total (seconds) | | 173.31(56.90) | 132.99(60.4) | 0.32 |

* $p < 0.05$, ** $p < 0.01$.

The lengths of the answers to the four questions from the audience were analyzed by a two-way mixed ANOVA with the question sequence as a within-subjects factor. The results revealed no significant difference ($F(1, 24) = 3.07, p = 0.09$) between the conditions.

A MANOVA was conducted on the two aspects (i.e., process and outcome) of utility questionnaire (UQ). The analysis found a significant effect for practice condition ($F(2, 37) = 5.17, p = 0.01$). Separate univariate ANOVA revealed that both process-related utility ($F(1, 38) = 6.97, p = 0.01$) and outcome-related utility ($F(1, 38) = 10.58, p = 0.002$) were rated significant higher in VR condition than in IM condition.

To study how self-efficacy changed over the practice sessions and the assessment session, a mixed ANCOVA was conducted. The analysis included two within-subjects factors: time of measurement and pre-or-post measurement. Finally, self-efficacy measured before the start of the course was taken as the covariates. The results showed significant main effects for time of measurement ($F(2, 16, 79.97) = 11.51, p < 0.001$), for pre- or post-measurement ($F(1, 37) = 18.43, p < 0.001$), and for self-efficacy measured before the course started ($F(1, 37) = 35.99, p < 0.001$), and significant interaction effects between time of measurement and self-efficacy before the course ($F(2, 16, 79.97) = 5.81, p < 0.01$) and between pre-or-post measurement and self-efficacy before the course ($F(1, 37) = 9.77, p < 0.01$). This suggested that delivering presentations, whenever for practice or the final presentation, help individuals to strengthen their efficacy beliefs on public speaking.

4. Conclusions and discussion

This study compared two practice conditions for public speaking: practice with a virtual audience (VR) and practice with an imaginary audience (IM). Although the findings provided no support for the first hypothesis (H1), considering factors such as the study's relatively small sample size, it cannot be ruled out that presentation performance would enhance after practicing with a virtual audience compared to an imaginary audience. The gain of practicing with a virtual audience however was found in the confidence of giving a presentation, specifically in answering questions. Here the analysis found a trend towards longer answers in the VR condition than in the IM condition. This finding therefore provides some support for the hypothesis that practicing with a virtual audience could reduce anxiety (H2). However, no support for this was provided by the analyses of the anxiety reported by participants or their heart rate. Still, the clearest benefit of practicing with a virtual audience was the satisfaction it gave compared with the imaginary method (H3). Participants were more positive towards training with a virtual audience and they were also more positive about the effect this training would have on their presentation ability. The presence response findings might explain this. Participants indicated to feel and behave more like presenting in front of a human audience when practicing with a virtual audience than with an imaginary audience. Although training increased participants' self-efficacy, practicing with a virtual audience or imaginary audience seemed similarly effective in accomplishing this and therefore no support for H4 was found.

Like any empirical study, this study has some limitations that should be considered. First, the study's sample size was relatively small considering the effect size observed. Second, practicing was not studied in isolation but in combination with a training provided by a virtual coach. Although in principle it was possible to study only the practicing part of training without offering additional educational support, this might be essential for helping trainees to reflect and learn from their presentation experience. The latter has been observed in several studies [26,27] that compared guided and unguided discovery learning. Third, in this study, the reported speakers' confidence, measured with PRCS, was found only correlated with self-efficacy but not with other measures such as anxiety or performance. Thus, PRCS might not be a key measure for this study. Another limitation could be the lack of control over how participants made use of the virtual audience or the imaginary audience. Many participants found it very difficult to keep the imagination through the whole presentation. The final limitation was that one rater was aware of the condition the participant was in, makes the experiment a single-blind study. The main scientific contribution of the work presented is the insight that practicing with a virtual audience improves training enjoyment and presentation performance in the eyes of trainees. In the end, this might be even a more instrumental asset than actually improving the presentation. When preparing a speech, people with higher levels of speech anxiety seem often reluctant to rehearse their presentation [28]. Therefore, getting them to practice would be an essential step forward as practicing with audiences improves the presentation [11], reduces anxiety, and increases willingness to speak in public [4]. In this context, a virtual audience could therefore make an important impact.

5. References

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Pain Reduction with VR in Indigenous vs Urban Patients in Ambulatory Surgery

José Luis MOSSO VÁZQUEZ^{a, b1}, Gregorio TOMÁS OBRADOR^b, Dejanira MOSSO LARA^c, José LUIS MOSSO LARA^d, Brenda K. WIEDERHOLD^{e, f, g}, Verónica LARA VACA^c, Ian MILLER^g, Mark D. WIEDERHOLD^e, Aaron MICHAEL^h, John LANGE^h, Sean YU GILLETTEⁱ

^a College of Medicine, Mohammed Bin Rashid University of Medicine and Health Sciences, Dubai, United Arab Emirates

^b Universidad Panamericana, School of Medicine, Mexico City

^c Hospital Angeles México, Mexico City

^d Universidad Anahuac, School of Medicine, Mexico City

^e The Virtual Reality Medical Center, San Diego, California, USA

^f The Virtual Reality, Medical Institute, Brussels, Belgium

^g Interactive Media Institute, San Diego, California, USA

^h Department of Health and Human Performance, Berea College, Berea, Kentucky, USA

ⁱ Department of Chemistry, Berea College, Berea, Kentucky, United States

Abstract. The current report presents comparisons of pain reduction and heart rate response using supplemental virtual reality (VR) pain distraction between 22 indigenous and 22 urban patients during ambulatory surgery. Material and methods. Forty-four (44) patients participated under full informed consent. Half (n = 22) were indigenous peoples and half (n = 22) were urban patients (those residing in Mexico City). For the urban group, a surgeon performed ambulatory surgeries with local anesthesia to remove lesions in soft tissues, such as lipomas, cysts located in the head, neck, back, shoulders, arms, limbs, and abdomen. For the indigenous group, operating rooms, intravenous line, analgesics, and sedatives were not used. Materials included laptop-linked virtual reality, PlayStation, Smartphones and Google Cardboard goggles alongside virtual environments such as Enchanted Forest, The Sea, Lake Valley, Jurassic Dinosaur and Coast Space VR. Results. Pain scale indicated 2.92 before, 1.67 during and 0.67 after for indigenous participants, and 5.8 before, 3.32 during and 1.48 after for urban participants. Heart rate responses in indigenous were 80.42(before), 78.5 (during) and 72.42 (after) and urban responses were 74.07 (before), 68.53 (during) and 73.1(after). Discussion. Indigenous patients presented more pain reduction during ambulatory surgery without intravenous lines, analgesics or sedatives and required recovery time or hospitalization. Supplemental VR during medical and surgical procedures is discussed in light of cultural, economic and psychological variables associated with medical care in Mexico.

Key words. Virtual Reality, Outpatient Surgery, Indigenous Communities.

1. Introduction.

The Mexican population recently surpassed 129 million. There are nearly 7 million indigenous people in 62 communities and there are 456,774 indigenous people in Guerrero

state alone, comprised of Nahuatl, Mixteco, Zapoteco and Me'Pahh communities. In 2015, the Me'Pahh community represented 20.1% of Guerrero State population. The current project served the Me'Pahh community in the el Tepeyac village and Malinaltepec town. Malinaltepec is the poorest region of Latin America and is approximately 16–18 hours away from Mexico City by car. Malinaltepec town has a general hospital without

¹ Corresponding author: jmosso@up.edu.mx

essential services such as emergencies, general surgery, gynecology-obstetrics, internal medicine and pediatrics. Organized crime in the mountainous regions limit the routes to indigenous communities making these expeditions difficult and limiting indigenous people's options for medical treatment.

Today, virtual reality (VR) is making surgical procedures simpler and safer [1]. VR in medicine began with many applications in medical procedures followed by surgical procedures as described by Mosso et al. [2]. Since the 2004 report by Mosso and colleagues [2], technological improvements have made VR even more useful in reducing pain and anxiety in patients. In the beginning, researchers used large, cumbersome equipment, but as technology progressed, portable devices such as PlayStation, and mobile phones became useful. Currently, portable devices, such as Google Cardboards and Oculus Go, provide greater resolution and immersion, as well as *free* smartphones apps. These technological developments have helped combat high healthcare costs and are spreading to various medical domains. Recently, neurosurgeons in France used VR to explore brain structures associated with vision during surgery with awake patients [3]. Ambulatory surgery is a technique to remove lesions in the skin, fat, muscles, or easy access areas with the benefit of discharging patients from the hospital in the same day [4-12]. This helps operating rooms avoid high costs in hospitalization and medications like sedatives. The cost to remove lipomas in a conventional outpatient surgery in Mexico City is approximately \$28,288.00 Mexican Pesos (MP), or \$1,604.00 USD, at public health hospitals (HGR No. 25 of Instituto Mexicano del Seguro Social, IMSS). The same service in small private hospitals is \$31,257.00 MP (\$1,736.50 USD) and in a larger private hospital in Mexico City can be as much as \$36,522.0 MP (\$2,029 USD). The current report brought this service to the Me'Pahh indigenous community for free.

2. Methods.

The report integrates two groups, indigenous Me'Pahh and urban patients from Mexico City. Twenty-two indigenous people participated under full informed consent. Six used mobile phone and Google Cardboard to view the VR, five used a laptop-linked Head Mounted Display (HMD), and eleven viewed the virtual environments. on a PlayStation. Twenty-two urban patients participated, all using the laptop-linked HMD to view the VR. Virtual environments for the Google Cardboard included *Jurassic Dinosaur VR3D*, *Coast Space VR3D*, and *In Mind VR 3D*. Patients using the HMD viewed *Enchanted Forest*, developed by the Virtual Reality Medical Center (San Diego, CA, USA). The PlayStation environment was Lake Valley, produced at University of Milan (Italy). Under informed consent, patients underwent outpatient surgeries located in the head, neck, shoulders, chest, arms, abdomen wall, and legs [Figures 1-4]. Patients with lesions in the eyes and face were excluded because they could not use the VR.

2.1. Surgical technique.

2.1.1. Preoperative.

Two weeks before surgery, urban patients received instructions on the surgical technique and the use and advantages of VR equipment. Indigenous participants did not receive this introduction.

2.1.2. Intraoperative.

During the procedure, a patient lies on the operating table, the surgical area is cleaned with betadine and subsequently covered with sterile cloth. At the same time, the surgeon sets up the VR equipment, placing HMD on the patient's head, connecting with smartphone,

PlayStation, laptop, or Google Cardboard. Xylocaine was then administered in soft tissues. Cutting, dissection, removal and hemostasis are performed and then the tissues are stitched while each patient viewed VR environments. In the cases where we used the laptop, an assistant helped patients navigate using the mouse. In case of Google Cardboard, each patient held the viewer and moved his or her neck and head in order to navigate. Using the smartphone, patient don't use their hands to navigate, instead, they watch passively. Once the procedure is finished, the surgical field is covered with gauzes, and in some cases, a bandage.

2.1.3. Postoperative.

Urban patients were seen one week later for suture removal at the hospital. Indigenous participants were seen by different physicians in a clinic 2 hours away. Anti-inflammatories (Paracetamol 500 mg) and antibiotics (Dicloxaciline 500 mg) were prescribed.

2.1.4. Measures.

The current report utilized a visual analog scale to measure pain on a scale of 0 (no pain) to 10 (extreme pain). Physiological monitoring equipment also recorded patient heart rates as an objective measure of stress and anxiety.

3. Results.

Forty-four outpatient surgeries assisted with VR were divided in two groups: Indigenous and urban groups. Participants ranged from age 9 to 77 (mean age = 47.46) in indigenous and from 30 to 88 (mean age = 47.07) in the urban group. Indigenous patients reported an average pain. of 2.92 before, 1.67 during and 0.67 after surgery. Urban participants reported pain levels of 5.8 before, 3.32 during and 1.48 after. The virtual environment that reduced pain the most in the indigenous group was Enchanted forest (delivered via the laptop-linked HMD), followed by the sea scenario (delivered via the laptop-linked HMD) Lake Valley (delivered via PlayStation and Smartphone), and *Jurassic Dinosaur* (Google Cardboard). All VR environments were found to be effective at reducing pain and discomfort. Heart rate (HR) responses in the indigenous group were 80.42 (before), 78.5 (during) and 72.42 (after), while urban patients measured 74.07, 68.53 and 73.1 before, during and after the procedure, respectively. These results are presented in **Table 1**.

4. Discussion.

With 100% VR acceptance in both groups, we observed high pain reduction in indigenous compared to urbans with a 1.65 difference on the pain scale. Indigenous HR responses presented greater stability with little difference before, during and after the procedure. This HR stability may be explained by farmers' emotional stability as they are not exposed to stressors present in urban environments. Anxiety is greater in urban patients because they live under high stress in Mexico City and their emotions demonstrate variable responses in HR. Complete vital signs were measured in urban patients because all medical equipment was available. This was not possible in the indigenous community. For these reasons, the indigenous patients did not use intravenous (IV) lines, analgesics or sedatives, and had no recovery time in a hospital.

As technology advances, VR will become more immersive, helping to distract from pain. during medical and surgical procedures even more. As the cost of equipment decreases and the equipment becomes easier to use, applications of VR pain distraction will increase. The

current report of 22 surgeries using VR in the Me`Pahh indigenous community saved each patient approximately \$1,311.05 USD or \$23,599.0 MP. These numbers suggest that VR can help reduce 30% of expenses for public health hospitals, 26% for small private hospitals, and 17.11% for large private hospitals in Mexico City [Table 2]. VR systems are not invasive devices for patients, and they do not compromise surgical or anesthesia techniques. Overall, VR is an adjunctive tool to improve surgical services, decrease costs and improve the patient's level of comfort both physiologically and subjectively.

Table 1. Pain and heart Rate HR differences between indigenous and urban patients.

| | Before | During | After |
|------------------------|--------|--------|-------|
| Pain Indigenous | 2.92 | 1.67 | 0.67 |
| Pain Urbans | 5.8 | 3.32 | 1.48 |
| HR Indigenous | 80.42 | 78.5 | 72.42 |
| HR Urbans | 74.07 | 68.53 | 73.1 |

Table 2 Comparative costs benefits in lipoma removing in outpatient surgery in 2018. MP Mexican Pesos. 1 USD=18 MP

| Hospital | Approach | normal | Saving with VR | % save |
|--|----------|-------------------------------|------------------------|--------|
| Indigenous community | Costs | 23,599.0 MP (1,311.05 UDS) | MP (1,311.05 UDS) | 100% |
| Public health Regional Hospital (IMSS) | | 28,288.0 (1,604.00 USD) | 8508.0 (472.66 USD) | 30.07% |
| Small and private hospital in Mexico City | | 31,257.0 MP (1,736.5 USD) | MP (347.33 USD) | 26% |
| Big and private hospital in Mexico City | | 36,522.0 MP (2,029 USD) | MP (347.33) | 17.11% |



Figure 1. Me`Pahh male under ambulatory surgery assisted with VR Scenario. El Tepeyac community.



Figure 2. Me’Pahh female under ambulatory surgery assisted with VR Scenario iPhone’s Apps into Google Cardboard.



Figure 3. Urban patients. Public Hospital number 25 s from IMSS . Mexico City.



Figure 4.Urban patients. Private Hospitals. Mexico City.

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Virtual Reality Pain Mitigation During Elective Cesarean Surgical Delivery

José Luis MOSSO VÁZQUEZ^{a,b1}, Dejanira MOSSO LARA, Verónica LARA VACA^{d,e}, Brenda K. WIEDERHOLD^{e,f,g}, Ian MILLER^g, Homero RIVAS^a, Mark D. WIEDERHOLD^g.

^a*College of Medicine, Mohammed Bin Rashid University of Medicine and Health Sciences, Dubai, United Arab Emirates*

^b*Universidad Panamericana Mexico City*

^c*Hospital Angeles México*

^d*Gynecology and Obstetric Hospital, Luis Castelazo Ayala Number 4, IMSS*

^e*Medical Center November 20, ISSSTE*

^f*The Virtual Reality. Medical Center, San Diego CA USA*

^g*Interactive Media Institute, San Diego, CA USA*

Abstract. We present supplemental virtual reality (VR) relaxation to reduce pain and anxiety during elective cesarean delivery in 4 young women under epidural analgesia. **Methodology.** Four women voluntarily participated in a VR relaxation group (mean age = 28.5 years) and four women in a control group (mean age = 30.5 years). VR relaxation was initiated for the placement of the epidural block and cesarean procedure until the gynecologist extracted the newborn from the uterus. The mother's vital signs and pain were measured using physiological monitoring and a visual analog scale before, during and after anesthesia placement and during and after cesarean surgery. Participants viewed an 'Enchanted Forest' virtual environment. Three of the four patients' husbands participated by navigating the virtual environment for his wife using a game controller. **Results.** Patients presented 91.89 % pain reduction in the VR group—a remarkable result under regional anesthesia. Patients in the control group presented 61 % increases in pain. **Conclusions.** VR supplemented pain mitigation provides high levels of satisfaction to mothers during elective cesarean delivery and carries no risk for the newborns. The current report highlights an innovative contribution to womens' healthcare.

Key words. Cesarean Section, CyberTherapy, Virtual Reality, local anesthesia.

1. Introduction.

Cesarean section procedures extract the product of conception and its annexes ovular through a laparotomy of the uterine wall. Depending on the obstetric history of the patient, it could be a first, iterative, or previous procedure. A first cesarean procedure, is defined as one that is performed for the first time. An iterative cesarean is one that is practiced in a patient with history of two or more cesareans. A previous cesarean indicates a previous history of a cesarean procedure. Additionally, depending on surgical indications cesarean sections can be either emergency or elective. An emergency procedure is practiced to solve or prevent a maternal or fetal complication in the critical stage. An elective procedure is one that is planned to be carried out on a date determined by some medical indication and

performed before labor begins [1]. The most important long-term maternal benefit of cesarean delivery is potential protection of the pelvic floor, reducing the incidence of

¹ Corresponding author: jmosso@up.edu.mx

incontinence of stool, flatus, and urine, as well as pelvic-organ prolapse [2]. According to surgical techniques, cesarean procedures can be corporal or classic (The incision is vertical and made in the uterine body), body segment, (the incision is vertical and is made on the segment and part of the uterine body), Beck type and arciform segment (transverse incision of the lower segment) or Kerr type, which is the surgical technique most used for its advantages of producing less hemorrhage and allowing an easy opening and closing of the uterine wall. The decision to conduct a cesarean section is based on combinations of maternal and fetal indicators. For mothers, a cesarean procedure is chosen if there is any of the following:

- Dystocia of bony parts (cephalopelvic disproportion)

- Pelvic narrowing, asymmetric or deformed pelvis, bone tumors of the pelvis

- Soft tissue dystocia

- Congenital malformations

- Tumors of the body or uterine segment, cervix, vagina and vulva that obstruct the birth canal, prior surgery of the segment and / or uterine body, including previous caesarean operations, prior surgery of the cervix, vagina and vulva that interferes with the proper progress of labor.

- Dystocia of the contraction.

- Hemorrhage, nephropathies, heart disease, high blood pressure or diabetes mellitus, etc.

Fetal indicators of cesarean section include the following:

- Fetal macrosomia that conditions disproportion cephalopelvic alterations of the situation

- Presentation or attitude fetal,

- Umbilical cord prolapse, fetal suffering, fetal malformations incompatible with delivery,

- Prolonged pregnancy with contraindication for childbirth

- Postmortem Cesarean section.

Sometimes, a combination of fetal and maternal complications arise, including:

- Syndrome of cephalopelvic disproportion

- Preeclampsia/eclampsia

- Multiple pregnancies

- Amniotic infection

- Maternal-fetal isoimmunization.

Maternal mortality in the United States has increased from 10 per 100,000 to 14 per 100,000 from 1998 to 2004 [3]. Cesarean delivery is now the most common operation in the United States, with a substantial recent increase from 27.6% to 29.1% in 2004. In 2007, nearly one-third (32%) of all births were cesarean deliveries, up from just 5.8% in 1970 [4].

During cesarean surgeries under regional anesthesia, women are conscious and awake with their arms fixed beside the surgical table, left with few options other than staring at the ceiling. Throughout the procedure, they hear what the surgical team members are talking about, yet nobody is explaining to them what is happening throughout the surgery. Without distractions, the women pay close attention to the surgical procedure, concerned, waiting until the newborn cries for the first time. This often leads to great anticipation, even stress, as mothers wait to hold the newborn in their arms. Healthcare systems attempt to provide excellent services, as it helps to decrease stress and improve the mother's happiness. This includes having husbands with their wives during delivery. In the current project, the husband put the head mounted display (HMD) on his wife in order to view the virtual reality (VR) relaxation environment and used a game pad to navigate the VR world. The objective is to reduce stress and anxiety before newborn delivery in order to reduce pain. and other complications during the surgical procedure.

Virtual Reality.

Surgical applications of VR began in 2004 with the work of Dr. Jose Luis Mosso Vasquez in Mexico, who shared results of VR applications of pain distraction during ambulatory surgeries to remove infected tissues in urban and indigenous patients. Similar approaches have been applied for colposcopies in gynecology, resulting in decreased anxiety and pain. Recently, VR has demonstrated utility during cesarean sections before newborn delivery.

2. Methodology.

Four pregnant women participated under full informed consent (mean age = 28.5) with elective cesareans performed using the Kerr cesarean technique. One public healthcare hospital and one private hospital participated in this study. The visual analog scale (VAS) was used to measure pain and anxiety (0= no pain/anxiety, 10 = high pain/anxiety). All patients received epidural analgesia and the VR HMD was used during the cesarean procedure until the newborn was taken from the uterus. One participant's husband participated by moving the controller joystick to help his wife navigate the virtual environment.

Virtual Reality. Group

Case 1.

A pregnant young female pregnant (20 years old) was admitted to the labor room at the gynecology and obstetrics Tlatelolco Hospital of the IMSS in Mexico City at 14:15 hours with 4 cm of cervical dilation (CD). Intravenous oxytocin was administered and then the patient was passed to the operating room for cesarean section. At 16:35 hours, the VR HMD and Enchanted Forest VR environment were set up, with patient at 6 cm of CD. The epidural block was placed with 2% xylocaine with 7 cm of CD at 17:35 hrs. At 18:00 a male newborn with 40 weeks of gestation was born by cesarean with a double cord around the neck, 3320 gr weight, 51 cm length, Apgar 9-9, and skull perimeter 34.5 cm. Pediatric conventional reanimation for newborn was performed successfully with no complications.

Case 2.

A pregnant young female (32 years old) was admitted to the operating room at the gynecology and obstetrics private Hospital in Mexico City at 7:00 hours due to restriction in intrauterine growing of the fetus. VR HMD was placed at 7 am during epidural block and during the cesarean section for 30 minutes. At 8:23 a female newborn with 38.5 weeks of gestation was born with no complication in the operating room, 2400 gr weight, 45 cm length, Apgar 9-10, and skull perimeter 34 cm. Pediatric conventional reanimation for newborn was performed successfully with no complications.

Case 3.

A 29-year-old pregnant female was admitted to the delivery room for elective cesarean surgery (patient requests an elective cesarean) with 0 cm of cervical dilation and intravenous oxytocin was administered at 5:00 hours. The VR HMD was placed at 0 cm with no CD (6:00 hours), and epidural block is administered in the operating room. A male with 38 weeks of gestation was born with 2870 gr weigh, 48 cm length, Apgar 9-10, and skull perimeter 34.5 cm. Conventional reanimation for newborn was performed. Mother's husband was seated

beside the patient to control joystick for virtual navigation. The duration using the HMD-VR was 1 hour, using 1 virtual scenario: the Enchanted Forest.

Case 4.

A 33-year-old pregnant female was admitted to the delivery room for elective cesarean surgery with 0 cm of cervical dilation (5:00 hours) and intravenous oxytocin was administered. The VR HMD was placed at 0 cm with no CD (15:20 hours), and an epidural block was administered in the operating room. A male with 40 weeks of gestation was born with 3140 gr weight, 50 cm length, Apgar 9-10, and skull perimeter 34.5 cm. Conventional reanimation for newborn was performed. Mother's husband was seated beside the patient to control joystick for virtual navigation. The duration with the VR HMD was 50 minutes, using 1 virtual scenario: the Enchanted Forest.

Control Group (no VR).

The control group was comprised of four young pregnant women with 40 weeks of gestations who were candidates for cesarean delivery.

Case 1.

A 29-year-old pregnant female was admitted at the delivery room for elective cesarean surgery with 0 cm CD (5:00 hours) and intravenous oxytocin was administered. At 0 cm dilation with no CD (7:00 hours), an epidural block was administered in the operating room. A male with 38 weeks of gestation was born with 3140 gr weight, 50 cm length, Apgar 9-10, and skull perimeter 34.5 cm. Conventional reanimation for newborn was performed. Mother's husband was seated beside the patient.

Case 2.

A 38-year-old pregnant female was admitted to the delivery room for elective cesarean surgery with 1 cm CD (7:00 hours) and intravenous oxytocin was administered. At 1 cm with no CD (8:00 hours), an epidural block was administered in the operating room. A male with 40 weeks of gestation was born with 3405 gr weight, 50 cm length, Apgar 9-10, and skull perimeter 34.5 cm. Conventional reanimation for newborn was performed. Mother's husband was seated beside the patient.

Case 3.

A 27-year-old pregnant female was admitted to the delivery room for elective cesarean surgery with 0 cm CD (11:00 hours) for transverse newborn position. Intravenous oxytocin and an epidural block were administered in the operating room. A male with 38 weeks of gestation was born with 2700 gr weight, 48 cm length, Apgar 9-10, and skull perimeter 33 cm. Conventional reanimation for newborn was performed. Mother's husband was seated beside the patient.

Case 4.

A 28-year-old pregnant female was admitted to the delivery room for elective cesarean surgery with 0 cm CD (11:00 hours) for transverse position newborn. Intravenous oxytocin and an epidural block were administered in the operating room. A male with 38 weeks of gestation was born with 2500 gr weight, 50 cm length, Apgar 9-10, and skull perimeter 32 cm. Conventional reanimation for newborn was performed. Mother's husband was seated beside the patient.

Technique.

In labor, the VR HMD is placed on the mother’s head and is linked to a laptop. There are 3 VR scenarios (Enchanted Forest, Cliff , and Castle) that the mother can choose from. The surgical resident or the mother’s husband helped navigate the virtual environment using a game console controller joystick. In the epidural anesthesia the HMD was fitted with patient laying down in dorsal decubitus. Then, the anesthesiologist maneuvered the patient into lateral decubitus and fetal position to place the catheter for the epidural anesthesia. The VR HMD remained in operation after the catheter placement. In the operating room, with the patient lying on the operating table, the VR HMD remained on the head of the patient. Scrub nurses prepared the patient together with the gynecologist and residents. Next, the husband was invited to sit next to his wife and use joystick to control her virtual navigation and the gynecologist began the surgery. Once the surgery was complete the VR HMD was removed from the patient so she could listen to and see her newborn. The gynecologist extracted the newborn from the uterus and laid the baby down on the patient’s abdomen for one minute to facilitate fetal transfusion while the pediatrician prepared to conventionally reanimate the newborn. After surgery, the mother went to recovery and the husband and pediatrician went to the nursery with the newborn.

3. Results.

In the 4 cases in the VR group (average age 28.5), pain during cesarean delivery under epidural analgesia decreased 91.89 % aided with VR [Table 1, Figure 1]. In the control group (average age 30.5) pain increased 61% [Table 2, Figure 2]. Overall all patients experienced reduction in stress and anxiety using VR. All four VR patients viewed the Enchanted Forest environment. All full terms infants were born in healthy conditions, only requiring conventional reanimation. No complications were presented in across all participants (VR and control). The average time mothers viewed VR was 20 to 30 minutes before the delivery. All patients went home in the third day with their babies in a healthy condition and a medical assessment at one week post-birth also indicating no complications.

Table 1.Before, during cesarean and after cesarean delivery pain ratings of VR group.

| Case | Age | Before | During | After | VR Equipment |
|---------|------|--------|--------|-------|---------------|
| 1 | 20 | 9 | 1 | 0 | HMD Laptop |
| 2 | 32 | 10 | 0 | 0 | HMD Laptop |
| 3 | 29 | 10 | 0 | 0 | HMD Laptop |
| 4 | 33 | 8 | 2 | 0 | HMD Laptop |
| Average | 28.5 | 9.25 | 0.75 | 0 | |

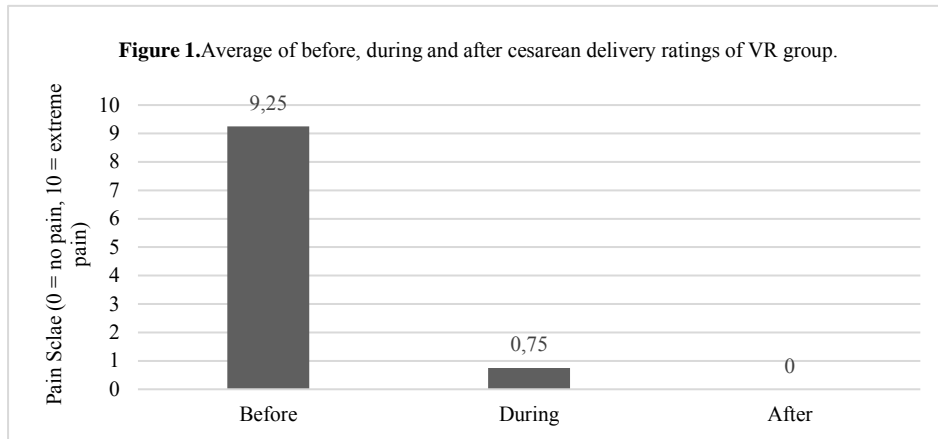
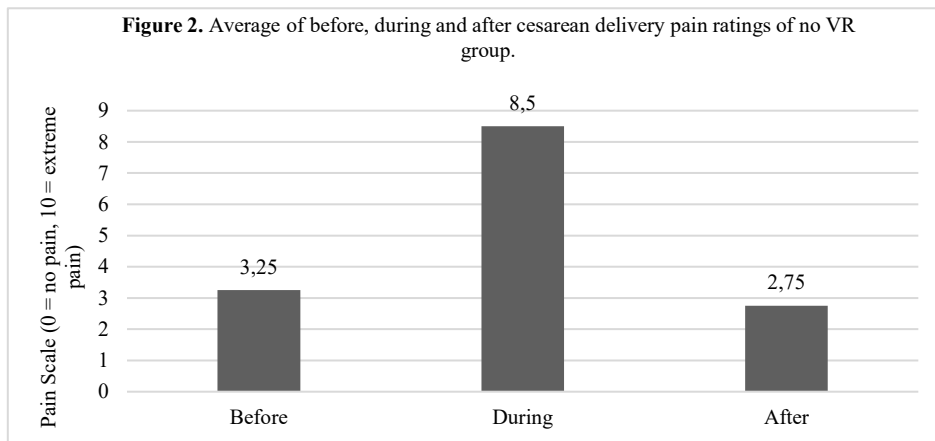


Table 2. Before, during and after cesarean delivery pain. ratings of no VR group.

| Case | Age | Before | During | After |
|---------|------|--------|--------|-------|
| 1 | 29 | 5 | 10 | 5 |
| 2 | 38 | 8 | 10 | 0 |
| 3 | 27 | 0 | 7 | 3 |
| 4 | 28 | 0 | 7 | 3 |
| Average | 30.5 | 3.25 | 8.5 | 2.75 |



4. Conclusions

VR is a powerful tool to reduce anxiety and pain during elective cesarean surgical deliveries under epidural analgesia. The success of this technique requires the correct epidural placement by the anesthesiologist and pre-procedure education on this technique for the mother and husband. Otherwise, it would be necessary to administer sedative intravenous medications that does not permit the patient to maintain consciousness and subsequently use the VR HMD. The four reported elective cesarean cases produced satisfactory results without complications. The report does not suggest that this technique be utilized in emergency cesareans that involve major abdominal surgery, which is associated with higher rates of surgical complications and maternal rehospitalization, or when complications arise requiring neonatal intensive care unit admission (e.g. acute fetal distress, premature detachment of placenta accrete, hemorrhages, cephalopelvic disproportion, twin pregnancy, coagulopathy disorders, risk of uterine rupture (5-7) as other disorders).

Overall, the current report highlights an innovative use case of VR in women's healthcare—during elective cesarean sections. It was essential to have the husband of the mother present in order to control the joystick for virtual navigation in the operating room because the protocol does not permit the mother to move her arms, hands or fingers for all intravenous lines, sensors, and other equipment. Also the presence of the husband helps give the mother security and more confidence. In the future we will work to continuously improve the delivery of virtual reality to the surgical practice. Aggregated comments from patients suggest that many of the mothers would like to see the infant, and we will address this by adding an augmented reality capability which will allow viewing the newborns face. This close interaction is important for the continued development of a close bond, and will reduce any sense of isolation that could be present. Overall however, the reduction in pain, and discomfort was a major outcome of the study.



Figure 3. Labor room, epidural analgesia and cesarean surgery (left to right), case 1.



Figure 4. Husband navigating for his wife during elective cesarean delivery, case 3.

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SECTION VI

WORK IN PROGRESS

It is important to emphasize the importance of developing technological strategies (such as artificial intelligence or augmented reality) that can provide either new enhanced experiences or technological systems also nurtured by artificial intelligence techniques developed by humans.

These new mixed ICT tools might evolve into experts in “helping others,” with the objective of making our net-shared experience increasingly more competitive, creative, and capable in the task of helping others. Of course, this has significant ethical implications, which will also need to be explored at greater depth.

*Botella, Riva, Gaggioli, Wiederhold, Alcaniz,
and Banos, 2012*

The Link between Digital Disconnection and Death Anxiety: a Preliminary Study

Dave HARLEY^{a,1}

^aUniversity of Brighton, UK

Abstract. This study considered whether being ‘digitally disconnected’ would provoke death anxiety amongst a small group of smartphone users. 37 undergraduate students completed an online survey and then took part in controlled experiments assessing their death thought accessibility, shyness and sociability in relation to a connected versus disconnected state. Results showed that death thoughts increased with disconnection when the smartphone’s importance to self-esteem was taken into account. Shyness increased with digital disconnection, but sociability was unaffected. The implications of how this reframes our understanding of smartphone dependency are discussed.

Keywords. Smartphone dependency, death anxiety, digital disconnection, shyness, sociability

1. Introduction

Smartphones have become a ubiquitous part of everyday life with many of us now conducting our lives through them often in conjunction with social media. Increasingly we rely on these digital environments to express how we feel and to explore and manage our social relationships. However, there is growing concern that our reliance on these digital environments may be having a detrimental effect on our social and psychological functioning with studies showing excessive smartphone use leading to loneliness, [1] depression, stress and anxiety [8].

The social benefits of smartphones are perhaps undeniable, allowing perpetual contact with friends and family wherever we may be on the planet. However, increasing integration of the smartphone into everyday life can lead to a preoccupation with the device that discounts the significance of face to face social interactions in favour of digital ones. It has been shown that the mere presence of a smartphone is likely to interfere with the quality of conversations [13] and the enjoyment of face to face interactions more broadly [7]. The social effects of smartphones even continue when they are switched off and not in use, with even moderate smartphone users experiencing stress and anxiety when they cannot access their phones [6] a phenomenon that has been described as *nomophobia* or ‘no mobile phone’ phobia [11].

Making sense of our psychological relationship with smartphones is not straight forward with it being deeply personal and social at the same time as it is a source of dependency. Some researchers have attempted to frame these relationships in terms of behavioural addiction likening excessive smartphone use to that seen in gambling or gaming addiction [12], and explaining the symptoms of nomophobia in terms of withdrawal. However, given the implicit assumption of internet connectivity in most everyday situations and the prevalence of smartphone dependency in the general population is it appropriate to pathologise such behaviours in this way? Increasingly it is the digital self that acts as the

¹ Corresponding author: d.a.harley@brighton.ac.uk.

fulcrum for self-expression and social connection in everyday life. Separation from our digital selves becomes an existential concern rather than simply about access to smartphone-

based technological interaction. In this study our relationship with smartphones is explored as an existential issue, acknowledging the digital self as a prerequisite for dealing with everyday life.

a. Terror Management Theory (TMT)

Terror Management Theory proposes that it is the inescapable fact of our own death that drives everyday attitudes and behaviours. According to Solomon, Greenberg and Pyszczynski [17] we avoid the inevitability of our own death by maintaining *cultural worldviews*, that is, a set of beliefs about reality that allow us to persist (in a literal and symbolic sense) beyond our own death and give us an ongoing sense of immortality. It is cultural worldviews that underpin our evaluations of self-esteem in relation to religious belief, ethnicity, nationality, our close relationships, political persuasion, etc. In this study we consider how smartphone use operates as an embodied expression of a *digital worldview*, where users anticipate a world of perpetual and global interconnection, maintaining digital selves that are extended (in terms of knowledge and awareness of other places and people) and persistent (beyond the immediate present).

Research on TMT has shown that when we are prompted to think about our own death we are likely to assert our cultural worldview more strongly in a bid to quell the fear it instils in us (the mortality salience hypothesis: [17]). This can result in quite unexpected and contradictory behaviours. When situations remind us of our own mortality we find that: voters are likely to become more conservative as this political orientation represents a more fixed cultural perspective [2]; we are all likely to become more ageist because older people remind us of our own mortality [18] and we are likely to become more shy and introverted [9, 15], turning to established relationships for reassurance of who we are.

TMT also proposes that challenges to one's cultural worldview will increase awareness of death by acting as proxies for mortality salience (the death thought accessibility hypothesis: [17]). Studies show that statements undermining one's cultural values or the stability of close relationships will increase one's awareness of death [14]. In this study it is the *digital worldview* that is challenged by disconnecting participants from their smartphones with an expectation that this will increase their awareness of death and provoke a reassertion of other aspects of their cultural worldview.

b. The Current Study

This study considers whether challenging smartphone users' *digital worldview* (by removing their smartphones) will affect their awareness of death and reinforce the importance of close relationships for symbolic immortality, resulting in an increase in shyness and a reduction in sociability

Hypotheses to be tested:

- 1) Digital disconnection will increase death thought accessibility
- 2) Digital disconnection will increase shyness
- 3) Digital disconnection will decrease sociability

2. Method

2.1. Participants

37 Psychology undergraduates took part in the whole study with participation acting as course credit for their degrees at the University of Brighton, UK. There were 9 male and 28

female participants with ages ranging from 18 to 52 years of age ($M = 23.5$ years, $SD = 7.8$ years). All participants owned and used a smartphone.

2.2. *Materials and Procedure*

The study consisted of two parts with an online survey followed by a face to face lab study some weeks later. The online survey captured demographic information (age and gender), the regularity of smartphone use over a typical day (using a 7 point Likert scale from 'not at all' to 'constantly') and how important the smartphone was for the participant's self-esteem (using a 4 point Likert scale from 'not important at all' to 'very important').

Once the online survey was completed participants could sign up individually for the lab-based part of the study. This was presented as an investigation into the effects of smartphone use on problem solving behaviour to negate any demand characteristics. Prior to arrival participants were randomly assigned to one of two groups (digitally connected or disconnected) on the basis of a coin toss. Upon arrival both groups were asked to establish a smartphone connection with a friend before continuing with the study. This was done in order to establish a baseline 'connected' condition where participants' habitual digital connections were available to them (all participants were able to do this successfully). They were then asked to consider a series of hypothetical social situations detailed on a printed sheet. Briefly these were: 1) waiting at a bus stop with strangers where the bus had broken down; 2) arriving at a pub to meet friends who were busy talking with people they had never met before; 3) attending a language class on their own having previously attended with a friend and 4) needing to invite people to their new house in order to help decorate it. These situations were chosen as typical situations in which smartphone use might be expected.

Participants were asked to imagine themselves in each of these situations and assess the levels of shyness and sociability they would experience in their current 'connected' state by using the 13-item Cheek and Buss Shyness scale [4] and the 5-item Cheek and Buss [5] Sociability scale. These responses were captured using a visual analogue scale to limit participants' ability to remember their future self-assessments in the rest of study.

Next the participants were allocated to either the connected or disconnected condition. In the connected condition participants kept their smartphones and were asked to ensure that their friends were still available online, whilst in the disconnected condition participants' smartphones were turned off and removed from the room (in a similar manner to the 'phone' versus 'phoneless' conditions of other smartphone studies [e.g. 7]). A short filler task followed which involved completing a Soma puzzle for a maximum of five minutes. This activity served to maintain the perception of the study as being about problem solving and provided an important time delay which previous research has identified as necessary for bringing death into consciousness [3]. Awareness of death thoughts was then assessed using a word-fragment completion task; a technique used in past research on TMT [10]. In this task, six out of the twenty-five word fragments can be completed as either death-related words or neutral words. Death awareness is measured in terms of how many of these words are completed with death in mind, e.g. CO _ _ SE would be completed as CORPSE rather than COURSE.

Participants were then asked to reassess their levels of sociability and shyness in relation to the same hypothetical situations used previously (this time taking into account the experience of digital disconnection for the experimental group).

3. Results

3.1. *Smartphone Use*

All participants were regular smartphone users with 96% of them using their phones on at least an hourly basis. The mode for regularity of use was 5-10 times per hour.

3.2. Effects of Digital Disconnection

The effects of digital disconnection were assessed in relation to three measures: death thought accessibility, shyness and sociability. Death thoughts were slightly higher for those who were digitally disconnected ($M = 2.19$) than those who remained connected ($M = 2.43$).

Table 1. Death thought access in relation to connected condition

| Connected Condition | M | SD | N |
|---------------------|------|------|----|
| Connected | 2.19 | 1.28 | 16 |
| Disconnected | 2.43 | 1.25 | 21 |

Shyness rose substantially for the disconnected group ($M^{\text{before}} = 48.29$, $M^{\text{after}} = 55.19$) whilst dropping slightly for the connected group ($M^{\text{before}} = 56.74$, $M^{\text{after}} = 56.11$).

Table 2. Shyness scores in relation to connected condition

| Connected Condition | Before | | After | | N |
|---------------------|--------|-------|-------|-------|----|
| | M | SD | M | SD | |
| Connected | 56.74 | 21.68 | 56.11 | 21.30 | 16 |
| Disconnected | 48.29 | 26.21 | 55.19 | 26.34 | 21 |

Sociability increased slightly in both the connected ($M^{\text{before}} = 26.88$, $M^{\text{after}} = 27.59$) and disconnected conditions ($M^{\text{before}} = 29.75$, $M^{\text{after}} = 30.54$).

Table 3. Sociability scores in relation to connected condition

| Connected Condition | Before | | After | | N |
|---------------------|--------|-------|-------|-------|----|
| | M | SD | M | SD | |
| Connected | 26.88 | 12.03 | 27.59 | 12.26 | 16 |
| Disconnected | 29.75 | 8.42 | 30.54 | 9.96 | 21 |

3.3. Hypothesis 1: Digital Disconnection and Death Thought Accessibility

A one-way ANCOVA was used to assess the effect of digital disconnection on death thought access whilst also controlling for the effect of the importance of participants' smartphones on their self-esteem. The main effect of digital disconnection was not statistically significant here $F(1, 34) = 0.123$, $p = 0.727$ but the importance of participants' smartphones for their self-esteem did predict death thought access $F(1, 34) = 4.471$, $p = 0.042$, showing a medium effect size ($\eta^2 = 0.116$). When the connected conditions were analysed separately the relationship between these variables became even more pronounced for the disconnected group, showing a significant correlation for this group alone.

Table 3. Spearman's correlations showing the relationship between smartphone-based self-esteem and death thought access for each condition

| Connected Condition | Correlation Coefficient | Sig. | N |
|---------------------|-------------------------|-------------|----|
| Connected | $\rho = 0.158$ | $p = 0.559$ | 16 |
| Disconnected | $\rho = 0.501$ | $p = 0.021$ | 21 |

Within the disconnected group smartphone-based self-esteem was also found to be correlated with the regularity of smartphone use ($\rho = 0.527$, $p = 0.014$).

3.4. Hypothesis 2: Digital Disconnection and Shyness

A 2 way repeated measures mixed ANOVA established that shyness was significantly higher for those that were digitally disconnected $F(1, 35) = 6.44, p = .016$, with a medium effect size ($\eta^2=0.155$).

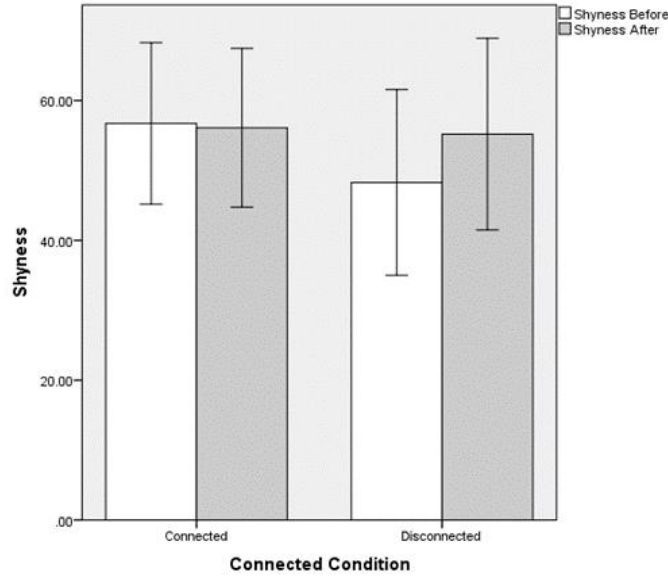


Figure 1. Shyness in relation to connected condition.

3.5. Hypothesis 3: Digital Disconnection and Sociability

A 2 way repeated measures mixed ANOVA showed that there was no significant difference in sociability as a result of digital disconnection $F(1, 35) = 0.001, p = .972$.

4. Discussion

The current study considered the effects of digital disconnection on death thought access, shyness and sociability, hypothesising that terror management processes would be at play when the *digital worldview* of smartphone users was challenged in this way. Death thought access increased as a result of digital disconnection but only when participants considered their smartphone important for their self-esteem. This suggests that digital disconnection does provoke existential concerns when smartphone users ascribe to the cultural beliefs that are embedded within the device but not when they merely own and use a smartphone. It is not clear from this study exactly what constitutes a *digital worldview* but it is reflected in an increasing use of smartphones alongside an increasing investment of the self in the digital world. This suggests that smartphone ‘dependency’ may be an expression of this implicit worldview rather than just a behavioural addiction.

Digital disconnection also increased shyness irrespective of a users’ relationship to their smartphone. This highlights pre-existing existential concerns that supersede the *digital worldview*; the anxiety buffering effect of close relationships [14]. In supporting perpetual contact with family and friends smartphones have amplified the buffering effect of these close relationships. Digital disconnection emphasises the increasing dependence on those we know and trust but increases the shyness experienced around strangers. Interestingly sociability was not affected by digital disconnection suggesting that shyness may only be a temporary issue with the willingness to connect with others still intact.

5. Conclusions

This study examined some of the social effects of smartphone dependency and set out to explain these in terms of death anxiety and terror management [17]. Smartphone (digital) disconnection was shown to act as a proxy for mortality salience increasing access to death thoughts in cases where participants' smartphones were important for their self-esteem. Smartphone disconnection also increased shyness across the board whilst having no effect on sociability.

It should be borne in mind that this was a small-scale preliminary study and whilst these results provide food for thought they should still be accepted with some caution. The study was limited in terms of its sample size, age range and cultural specificity. These factors all limit the generalisability of its findings. However, this study does show how alternative 'existential' approaches such as those relating to TMT can offer explanations of smartphone dependency that move beyond those grounded in behavioural addiction. To take these ideas further future studies will need to employ larger, more diverse samples and consider death anxiety as a motivation for habitual smartphone use rather than as was found here - a reaction to non-use.

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TwitterOSINT: Automated Open Source Intelligence Collection, Analysis & Visualization Tool

Mary Ann HOPPA^a, Scott M. DEBB^{a1}, George HSIEH^a, Bigyan KC^a

^aNorfolk State University, Norfolk, Virginia USA

Abstract. TwitterOSINT (Open Source Intelligence) is a tool for extracting and visualizing open source data that is publicly available online directly from Twitter (i.e., *Tweets*). This paper discusses two use cases developed as TwitterOSINT proofs-of-concept: an academically oriented cybersecurity defense strategy that involved monitoring emergent trends about cybersecurity vulnerabilities and threats as they developed in near-real time, and an exploratory data collection scenario to track keywords relevant within cyberpsychological research. Findings indicate TwitterOSINT can collect and process relevant English text from Twitter users' publicly available Tweets in near-real-time, and that the tool is adaptable to diverse disciplines where a free (or low-cost) option is needed to collect diverse open source big data.

Keywords. Open Source Intelligence, big data, social media, Twitter, TwitterOSINT

1. Introduction

Individuals follow keywords and hashtags in electronic media for a variety of reasons—everything from ordinary mainstream entertainment to civil rights and social justice movements. For example, in the United States, the #MeToo movement gained significant momentum via social media. [1], as did Black Lives Matter [2]. Capturing trending events on social media, and especially emerging trends that might go “viral” (i.e., are seen by large numbers of social media consumers over a relatively short time) afford researchers opportunities to observe and analyze social phenomena and major cultural influencers in near real-time.

Going viral, whether it is the result of a social trend or the outcome of a targeted and well-funded marketing campaign, requires the cyberspace equivalent of word-of-mouth “spreading across individuals and communities, growing exponentially with each cycle” [3, p. 163]. Social media has the ability to change the cultural norms that underlie whole societies (e.g., hashtag activism [4]), similar to the way newspapers, radio, and television helped document and shape worldwide events in decades past. Understanding the highly intricate and interconnected web of online communications that occur to facilitate the shaping of our present day world requires a very high-level view of what is otherwise an enormous pool of interconnected variables. The term “big data” refers to extremely large data sets that contain a variety of data points embedded within a complex structure, and where that structure also may inhibit data discovery, transfer, analysis and visualization [5]. Information gathered from publicly available sources such as news, blogs and social media can be referred to as open source intelligence (OSINT), and sources of OSINT can easily produce

¹ Corresponding author: smdebb@nsu.edu

hundreds of millions of new data points daily. When downloaded for some secondary purpose, the repository of information can be thought of as big data. An unprecedented evolution of the classic observational study is occurring in social science, essentially allowing the observer (of human behavior) to examine what occurs in public places, leveraging the power of automation by relying on technology to record millions of people's direct reports from across the world, and at any given time. This form of big data analytics uniquely relies on publicly accessible end-user data and computerized capabilities to sift those data which potentially offer billions of points for examination.

Not only are there an overwhelming amount of data to examine, but this much raw data is typically beyond what a human being is capable of processing manually. Because it overwhelms the analyst's ability to understand the potential relevance of valuable data that is nonetheless readily available, big data creates a form of cognitive overload for humans trying to discover useful, actionable information. More so, big data can easily prohibit a human from acting on significant data in a timely fashion. Consider, for example, that Twitter is an obvious OSINT data source given readily available access to its user-generated data (i.e., online postings on the Twitter social media platform) and services [6] and commands a traffic volume that consists of as high as 100 million characters per minute—approximately 6,000 posts per second at a maximum of 280 characters per post [7].

2. Background and Related Work

Intelligence data has a significant temporal component, meaning whoever is interpreting the data must discern and react to its relevance while it is still useful and efficacious to do so. In other words, intelligence is only useful if it is acted upon quickly enough to make a difference with regards to the desired outcome. This is true in many contexts. For example, in business, the speed of deriving market insights based on big data analytics enables strategic opportunities and competitive advantages over competitors [8,9]. In healthcare, public agencies and medical researchers interact with patients and study people's habits and preferences by mining their data [10]. In cybersecurity, big data analytics is integral when applied to the detection of emerging threats [11,12].

Large corporations and governmental entities might be able to afford the hardware, software, and human personnel costs associated with high-powered analytical tools. Commercial examples of OSINT collection and analysis tools include Recorded Future (www.recordedfuture.com), SpiderFoot (www.spiderfoot.net), Hootsuite (www.hootsuite.com), and Infongen (www.infongen.com). Challenges to adopting these tools include cost (from thousands to tens of thousands USD) and the proprietary nature of their implementations. In addition to cost constraints, it can be very difficult for the average researcher to adapt any of these tools to the peculiarities of their operational environments. To overcome this challenge, TwitterOSINT is a technological capability that was developed at Norfolk State University (Norfolk, Virginia, USA) that can help analysts and researchers extract and visualize useful OSINT from the informal English text typically found in postings in near real-time. TwitterOSINT is implemented using publicly available software and topically relevant natural language processing (NLP) artifacts, and for the purposes of this study, Twitter's *Tweets* as the source of all input data.

TwitterOSINT offers a new, alternative solution since it is built entirely of tools freely available in the public domain, and itself is a free software application. It brings together publicly available tools for NLP, machine learning, information extraction and visualization to solve a big data problem in OSINT. Ultimately, TwitterOSINT reduces and transforms an otherwise overwhelming volume of information to graphic representations that are practicable for an analyst or researcher to quickly analyze, interpret and act upon.

An added challenge to the automated processing of OSINT data sources like Tweets arises from the mix of formally and informally expressed content. For example, to achieve brevity, many Tweets include abbreviations, emoticons, acronyms and short phrases as opposed to carefully crafted, grammatically correct sentences. NLP aims to convert human language into a formal representation that is easy for computers to manipulate. Most NLP

tools are built to handle formal, well-formed human language sentences. This is still quite challenging given the semantic complexity of even simple human language. For more technical details about NLP and a historical overview of its evolution, see [13-15]. The addition of informality in OSINT makes interpretation even more difficult and ambiguous; however, the ultimate goal of TwitterOSINT is not to solve NLP, but to transform big data into actionable information. For that reason, the current project focused on integrating existing, proven tools to address each facet of the overall problem—such as NLP and visualization—instead of developing new software solutions for them.

It should be noted that Twitter provides application programming interfaces (APIs) that allow third-party software developers to use various Twitter data and services as building blocks to create their own applications. There are paid subscription and premium (pay-as-you-go) APIs that are “full-fidelity” (i.e., all tweets are made available). These often are suitable for extensive analytics and enterprise business use [16]. This project used Twitter APIs that were free, and accordingly, only provided a subset of all global Tweets available. A rough rule of thumb states that the number of tweets retrievable by the free APIs from the full-fidelity Twitter stream is one percent (1%). The actual number of Tweets retrieved, and whether they include all potentially relevant Tweets, depends in practice on the configuration of the developer application, the characteristics chosen for retrieving tweets via the APIs, and the amount of real-time Twitter traffic during the sampled time period [6]. The overall metrics of the free APIs proved sufficient for this initial exploration of the TwitterOSINT concept.

3. Methodology

For staying current on trends and developments, highlighting expertise, and networking (both online and in person) professionals, researchers and scientists in many disciplines rely upon Twitter. Cybersecurity thought leaders and professionals share comments on threats and software products. Social scientists are using Twitter as a new data source and to make their findings more accessible. Therefore, the utility of TwitterOSINT—to capture and extract relevant data—was investigated via two use cases: a mock cybersecurity defense strategy that involved collecting and monitoring trends about vulnerabilities, threats, attacks, and countermeasures as they developed in near-real time; and an exploratory data collection scenario drawn from cyberpsychology relying only on keyword references.

TwitterOSINT uses Twitter’s standard streaming API which allows it to collect and index tweets as they are being posted in near-real time [17]. During the early stages of TwitterOSINT’s development, three groups of 500 tweets each chosen at random from the limited fidelity Twitter stream were manually examined to identify properties common to tweets relevant to the planned use cases. These patterns, such as hashtags, keywords and significant concepts, were used to provide configuration information to the API and NLP tools used by TwitterOSINT. In addition, this analysis helped suggest the kinds of graphical representations of relevant Twitter data that would make the retrieved information easier for human analysts to quickly interpret. For example, a visualization like a tag cloud (shown later) makes the most frequently occurring terms obvious to the analyst.

As shown in Figure 1, after TwitterOSINT uses the Streaming API to collect tweets, several stages of filtering are applied to eliminate tweets that are not of interest for further processing. This is done through the specification of keywords, phrases, and hashtags in TwitterOSINT, as well as by specifying a relevant timeframe. In essence, we are deliberately trying to winnow down the number of data points by removing tweets that may contain key words or phrases, but with a larger context to the tweet that is ultimately irrelevant to a specific research question.

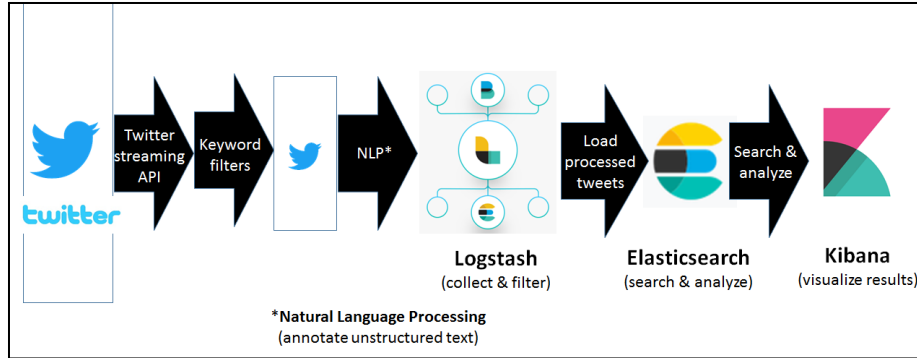


Figure 1. TwitterOSINT architecture.

The Stanford NLP library (<https://stanfordnlp.github.io/stanfordnlp/>) powered by domain corpora (i.e., large collections of text used to study topically-specific language in context) is used to segment the text Tweets into words and phrases, to label them according to parts of speech, and to analyze their meanings for the purpose of eliminating the irrelevant Tweets. The analyzed Tweets, including date, username, text and annotations, are stored in a format that is processible by the remaining tools, which makes it easier for TwitterOSINT to pass them from one tool to the next. Logstash, Elasticsearch and Kibana are open-source Amazon Web Services (AWS) used for analyzing and displaying information in TwitterOSINT, and for this project, were run on the AWS “free tier” (see <https://aws.amazon.com/free/>).

TwitterOSINT uses Logstash as a pipeline to load processed tweets into Elasticsearch, an analytics and local search engine for whatever large volumes of data are passed to it. Kibana is an analytics and visualization tool that supports searching, viewing and interacting with data stored in Elasticsearch indices. TwitterOSINT uses Kibana to create a dashboard of data visualizations such as bar and line graphs, scatterplot diagrams, pie charts, and maps. Additional technical details about how TwitterOSINT uses these underlying AWS technologies can be found in [17].

4. Findings

a. Use Case 1: Cybersecurity Intelligence



Cybersecurity industry leaders recommend social media, as an expedient way to stay informed about the latest security threats, hacks and data leaks [18]. Typical examples in Twitter include curated content accounts from online forums (e.g., @Peerlyst); official accounts from security organizations (e.g., @NISTcyber); and the personal accounts of experts and educators (e.g., @SchneierBlog, @BrianKrebs). Naturally, user-generated online activity increases during periods of time when cybersecurity incidents are occurring. These observations suggested TwitterOSINT’s usefulness to cybersecurity analysis. For this study, TwitterOSINT was configured for intelligence collection in this domain using a list of terms and concepts relevant to the cybersecurity risk assessment community such as *vulnerability* and contextually-related phrases such as *software vendor* and *software product*. A huge corpus derived from entries in the National Vulnerability Database (<https://nvd.nist.gov/>)—a U.S. government repository of standards-based cybersecurity vulnerability management data—was also included to help the NLP components recognize additional relevant terms beyond those specifically identified by the researchers in this study (e.g., *malware* and *scam*).

Recall that on average, there are 500 million Tweets per day. The additional filtering that was applied reduced the source data from the raw input amount available across the Internet by many orders of magnitude, to less than 200 tweets. In practice, an error rate of about 15% is typically observed, comprised of both false negatives (Tweets that contained

relevant intelligence but were eliminated during filtering) and false positives (Tweets that did not contain relevant intelligence but were not eliminated during filtering) [19]. Manual analysis revealed that actionable information in many of the false negatives were present in the retained tweets; therefore, information loss (from inadvertently ignoring relevant tweets) and noise (from irrelevant tweets still in the pipeline) was relatively insignificant.

Figure 2 shows an excerpt of relevant raw data outputted by the program from Tweets collected by TwitterOSINT based on the described configuration. Although displayed entries are limited to Tweets that were selected and indexed during the sourcing procedure (as opposed to all available tweets in Twitter’s full database) there is still too much data for a typical human to quickly discern any act on in real-time. However, this overabundance of information is effectively managed through offering alternative visualizations in TwitterOSINT.

| All Relevant tweets ▾ | Count ▾ |
|--|------------|
| "Bulk messaging #malware in #Facebook Messenger" https://t.co/SzcEktl09 #InfoSec #Security #CyberSecurity #CyberAttack #CyberWar #Hacker | 2 |
| "VMware Puts Security at the Heart of its Software" https://t.co/qawGaGXlBk #ransomware #malware #security... https://t.co/iaRiXjsXAd | 1 |
| "Why the US Government Shouldn't Ban Kaspersky Security Software" https://t.co/E2iz1ecZBy #tech #malwaretech #CyberSecurity #virus #Malware | 1 |
| #Avira Antivirus Pro 2017 is the best virus protection https://t.co/D3RP5LGDaV | 1 |
| #Canadian university loses \$10m in #phishing scam - BBC News https://t.co/XubkE6OjFP #CyberSecurity #dataprotection https://t.co/5xrH3oxQWm | 1 |
| | 101 |

Export: [Raw](#)  [Formatted](#) 

1 2 3 4 5 ...20 »

Figure 2. Relevant tweets discovered by TwitterOSINT.

Figure 3 shows examples of representative visualizations. The *count aggregation* (top left of the Figure) lists the number of relevant tweets in the user-specified time period. A large increase in this number from a previous time segment may indicate an emerging event that merits further investigation. The *pie chart* (right) shows the distribution of the most significant keywords in the Tweets. This parameter helps the analyst locate online postings that have information about a specific threat. The *tag cloud* (lower-left) is a visual representation of free form text [20]. The importance of each tag (single keyword or phrase) is shown with font size and color and is based upon the significant term counts. In the TwitterOSINT visualization, the analyst can click on a term in the tag cloud to display all the raw data inputs for the observed period that contained that keyword.

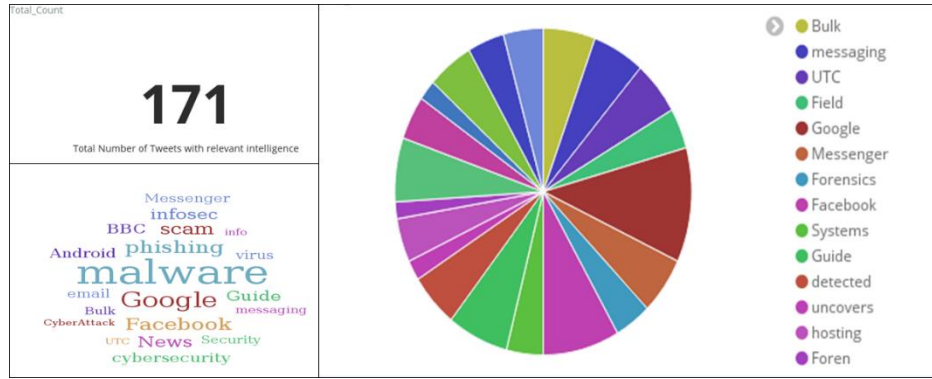


Figure 3. TwitterOSINT visualizations for cybersecurity keywords.

b. Use Case 2: Cyberpsychology Research

To demonstrate its potential utility to social scientists, TwitterOSINT was reconfigured with several keywords and terms relevant to cyberpsychology, including *cybertherapy*, *cyberbullying*, *cyberaddiction*, *cyberbehavior*, and *cybercrime*. Minimal NLP filtering was set up because unlike the cybersecurity use case, no *cyberpsychology*-specific NLP corpus yet exists. This approach served to emulate how a researcher might use TwitterOSINT for an exploratory look into open sources of big data to determine whether selected concepts and terms are relevant or trending on social media and therefore pertinent to a unique research question.

Figure 4 shows representative visualizations created by TwitterOSINT based on the selected terms during one week of data collection in late June 2019. It should be noted that while hashtags are not case sensitive in Twitter (i.e., “#hashtag” is the same as “#HashTag” and so on), TwitterOSINT is case-sensitive, therefore, terms like “CYBERBULLYING” and “cyberbullying” are indexed separately. There was considerable relevant Twitter traffic, which is a positive indicator that the platform could serve as a useful OSINT for cyberpsychology researchers, at least in areas related to the experimental keywords specified in this use case.

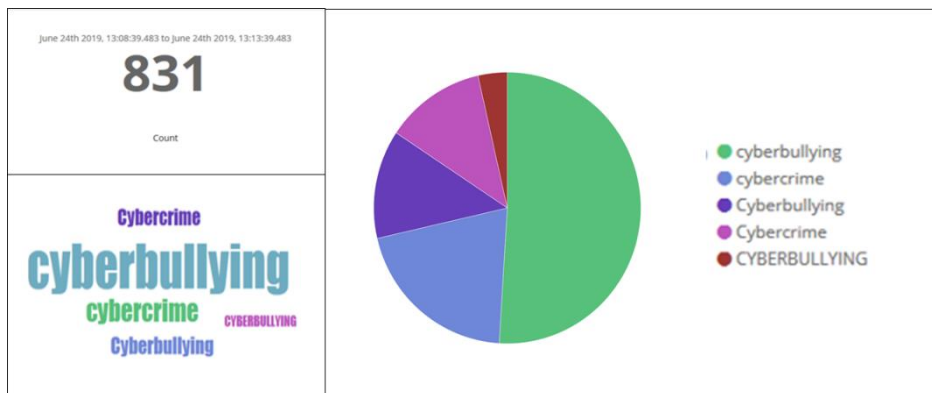


Figure 4. Exploratory TwitterOSINT visualizations for cyberpsychology research..

5. Discussion

Technologies that rely on big data analytics such as artificial intelligence and machine learning can be expected to significantly transform OSINT collection and processing in the coming years. The practical benefits of using TwitterOSINT for exploratory big data analysis are immediate and multi-fold. The goal of this project was to show the efficacy of an automated cybersecurity threat intelligence collection and analysis system for analyzing

Tweets in near-real time. The use cases reported here show that objective has been realized. The findings additionally demonstrate how TwitterOSINT's architecture is readily adaptable to diverse sources and topics. That is, TwitterOSINT can be immediately implemented as a low-cost option for exploring social-media-based activity.

The use of NLP also provides a tremendous advantage for researchers seeking to capture the collective voice of large swaths of society. Being able to collect *big data* that also are limited to relevant content facilitates speedier collation and reporting of results. The ability to rely upon existing NLP libraries is highly dependent on the specific discipline area, as can be seen in the use cases reported in this paper. The use of corpus lexicons enable TwitterOSINT's NLP to be more effective in social science or clinical applications, helping to ensure OSINT projects are not simply overcomplicated basic web searches.

Social media facilitates a one-to-many communication style in which users publish their thoughts, feelings, behaviors, and opinions potentially to a global audience. The perception of anonymity derived from being part of a crowd with constant access to social media reduces impulse control. This in turn promotes emotional expressions and self-disclosures that might not otherwise occur in "real-world" interactions and research situations [21], creating potentially billions of pieces of "over-shared" data for researchers to retrieve and analyze.

TwitterOSINT's use of the AWS free tier puts the computing power of cloud-based big data analytics into the hands of any researcher, even those without sophisticated on-site computing platforms or expertise in big data technologies or computer programming. This presents opportunities to gain insights into new research methods and findings that go beyond what could be attained with traditional observational studies or self-report surveys. In addition, the potential for TwitterOSINT to help scale studies to include large global populations makes it possible to transcend the limits of a single culture or community, and consequently points to greater applicability of findings.

6. Limitations and Future Directions

TwitterOSINT currently is limited to English language Tweets. This constrains its ability to be a universal tool across languages and countries. An immediate improvement would be to extend it to process other languages, written characters, and shorthand expressions from other cultures. There are additional opportunities to incorporate multiple OSINT sources, and to explore even richer metadata contained within these data sources. Such enhancements will enable more comprehensive modeling of online human behavior that are applicable across populations. Lacking domain-specific corpus also limits TwitterOSINT to keyword searches to identify relevant source data in various contexts. To this end, additional corpus need to be developed in diverse domains, such as cyberpsychology, to enrich its NLP analysis.

A capability also could be added whereby TwitterOSINT sends alerts based on user-selectable conditions that can be detected automatically during data analysis and visualization. A user-friendly, point-and-click interface could be developed to make the program easier to reconfigure keywords and NLP artifacts needed to tailor TwitterOSINT for specific projects. This is especially true for exploratory studies where parameters need to be modified multiple times and with relative ease. Future investigations should also more closely examine any impacts of false-negative and false-positive data filtering and ways to minimize and mitigate them.

Researchers and analysts are seeking new insights and answers from big data. In many cases, highly complex, multi-stage and domain-specific processes—including trends over time, comparing data about particular events of interest to others, recognizing co-occurrences of terms or values, and myriad other calculations—will be needed to discover timely, useful, actionable information. As stated at the outset, TwitterOSINT is a tool for extracting and visualizing open source data. It serves as an enabling building block, that is, one step in a larger solution. Future efforts can be focused on identifying integrations of TwitterOSINT with other freeware for tackling additional use cases and their big data analytics challenges.

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Virtual Reality Air Travel Training with Autistic Individuals – Design considerations and future directions

Ian T. MILLER^{a1}, Catherine S. MILLER^b, Brenda K. WIEDERHOLD^{a,c}, Mark
D. WIEDERHOLD^c

^a *Autism Center of Excellence, Interactive Media Institute, San Diego, CA.*

^b *Speech Tree Therapy Center, Chula Vista, CA*

^c *Virtual Reality Medical Center, La Jolla, CA*

Abstract. Autism Spectrum Disorder (ASD) is the fastest growing developmental disability in the United States, according to the Centers for Disease Control and Prevention. Previous research points to the utility of virtual reality (VR) to address core deficits in communication and restrictive, repetitive behaviors or interests (RRBI) in autistic populations. The current paper presents a set of design considerations and future directions from two pilot studies exploring the application of virtual reality-based air travel training in autistic children, adolescents, and young adults. The paper discusses improvements in the design and display of virtual environments in light of sensory sensitivities or processing difficulties, as well as different approaches in scripting narratives that guide users through training environments. Since the purpose of these two pilot studies was to facilitate functional communication and improve air travel skills, we also present findings and a brief discussion on next steps and improvements in measurement techniques. Overall, the current report highlights the unique advantages of mobile VR to help ease the burden of service and care providers in the treatment of ASD. VR is a useful and effective tool that is improving the lives of autistic individuals and disrupting the status quo of service delivery.

Keywords. Virtual Reality, Autism, Air Travel, Design

1. Autism Spectrum Disorder

In the United States, one in 59 children, and one in 37 boys, have a diagnosis of autism by age 8 [1]. This is an increase over previous estimates by the Centers for Disease Control and Prevention (CDC), now classifying autism spectrum disorder (ASD) as the fastest growing developmental disability in the country [1, 2]. Treatment plans and goals for ASD are highly variable and individualized due to the condition's inherently heterogeneous symptomatology. The American Psychological Association's (APA) *Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition* recognizes autism's variability but

¹ Corresponding author: ian@interactivemediainstitute.com

identifies a cluster of shared symptoms, or core deficits, across cases [3]. These include (1) *deficits in communication*, like responding incongruously in conversation, misinterpreting nonverbal interactions, or having difficulty building age-appropriate friendships, and (2) *the presence of highly restrictive or repetitive behaviors or interests (RRBI)*, including but not limited to being highly dependent on routines, hypersensitive to environmental changes, or perseverating on specific items and ideas [3].

Previous works by Interactive Media Institute and other researchers substantiate these core deficits in relation to difficulties processing contextual information and deducing appropriate responses [4, 5]. Since autistic individuals have difficulty discerning salient cues in dynamic environments (e.g. social situations, restaurants, one on one interaction), their interpretation of the appropriate behavioral response is likely to be inaccurate [5]. Due to deficits in communication, when internal responses to environmental cues are incongruent,



Figure 1. Interaction with the ticket counter representative.

stress, anxiety, and RRBI emerge as coping mechanisms and communication strategies [4]. However, these maladaptive forms of communication have profound impacts on an individuals' ability to navigate scenarios and interact on a daily basis. Research suggests that virtual reality (VR) is a well-suited technology to teach transferrable functional communication skills (i.e. expressing basic wants and needs) in dynamic environments [4, 6-9] (Table 1).

2. Current Report

Using these frameworks, Interactive Media Institute created a VR-based air travel training module to help autistic children, adolescents and young adults learn how to navigate a complex airport environment. News reports across the country highlight the difficulties that autistic individuals and their families face when traveling. Long lines, unpredictable wait times and irregular schedules, sights, sounds and a plethora of other travelers create an overabundance of stimuli and inhibit an autistic individual's ability to communicate their basic wants and needs. Previous publications report the outcomes of two preliminary trials conducted in November 2018 [10] and March 2019 [11]. The current report shares a series

of lessons learned from those trials, including VR design and display, measurement strategies, and implications in treatment accessibility.

2.1 VR Design & Display

2.1.1 Stimuli

Variable sensory sensitivities of autistic individuals require specific virtual environment design considerations. First, when attempting to teach generalizable skills, it is important to present a virtual environment that *looks like* its real-world counterpart. However, designers must be cognizant not to overstimulate users audially or visually. Thus, our VR air travel module was designed with such specifications in mind.

Table 1. VR to Teach Social Communication and Daily Skills in Autistic Populations (Select Literature) [6-9]

| Authors | Topic | Method | Key Finding |
|-------------------------------|--|--|--|
| Mesa-Gresa P et al. 2018 [6] | Systematic review on the efficacy of VR for autistic children and adolescents | 31 articles met review criteria and were selected for analysis | The studies examined suggest moderate evidence about the effectiveness of VR-based treatments in ASD. The promising results and the advantages of VR should encourage the scientific community to develop new VR-based treatments. |
| Adjorlu A et al. 2018 [7] | VR to teach social skills to autistic children | Two clinicians who currently apply VR Social Stories were interviewed on the medium's feasibility and effectiveness to teach social skills. | Clinicians had overall positive perceptions of the efficacy of VR to teach social skills. Based on the feedback given to researchers, VR can be used as a tool to teach social skills to children diagnosed with ASD, though more robust research is needed. |
| Simões M et al. 2018 [8] | VR-based public transportation training for autistic adolescents | 10 autistic young adults participated in 1-3 bus riding VR sessions for up to 15 minutes. 10 typically developing peers served as a control. | Significant improvements in autistic children's knowledge of the bus riding process (skill acquisition), reduction of electrodermal activity (a metric of anxiety), and a 94% completion rate. |
| Rosenfield NS et al. 2019 [9] | Feasibility of VR-based social conversation skills practice with autistic children | Two children, aged 5 and 7 participated in one 15-minute session. | Researchers effectively demonstrated that our VRE is an acceptable, feasible system that promoted social conversation by carrying out a technology probe with a small sample of two users. VR allows us to customize a unique experience, considering each individual's needs, abilities, and preferences. |

For example, we included background noises of an airport, like people talking, announcements over the intercom, and airplanes taking off. Conversely, we limited the display of extraneous visual stimuli, such as additional avatars. Instead, we chose to help users to focus on the most important cues within the environment and thus only included airport workers at the check in counter, security, gate, and flight attendant on the airplane (Figure 1). Rosenfield and colleagues [9] took a similar approach in creating their VR conversation skill module. They report that this design style was intriguing to participants, who said things like “Wow, it’s like being in a cartoon!” [9]. Ultimately, cartoon-like animations may be more conducive to attentiveness and learning in younger populations

since they are familiar with such styles in their everyday lives (e.g. gaming and television shows), though more research is needed.

While the results from our research and others emphasize the efficacy of basic graphics and limited audio stimuli, it is also important that practice effects be controlled for, especially in procedures that require multiple interactions with the virtual environment. For example, our VR air travel environment was the same for every participant throughout each of the three training sessions. Simões et al. [8], teaching bus riding skills to young adults, took a different approach. Instead of experiencing the exact same bus ride every time, the researchers gradually introduced new stimuli as participants displayed improved ability to navigate the virtual environment. Considering autistic individuals' insistence on sameness or routine, it seems beneficial that a training environment be malleable, so participants can learn how to adapt to ever changing scenarios. Thus, future applications of our VR air travel module will include the capability of adding and subtracting stimuli according to each participant's displayed skills.

2.1.2 Scripting a Narrative

Both of our previous studies utilized a *narrative script* to model functional communication (i.e. how to respond to basic questions or what questions to ask) and guide participants through each of the air travel steps. Traditional ASD interventions focused on facilitating communication also apply this strategy, the most famous being Social Stories [12]. Scripting presents participants with a description about a skill or context that helps the learner anticipate way might occur during a given activity and “improve their ability to appropriately participate in the activity” [13]. Scripting is one of the most effective strategies to address social and communication outcomes in autistic children and adolescents [13].

Between our first [10] and second [11] trials, we altered how the narrative script was delivered to help streamline the procedure. In our first trial, the script was read by a therapist while the participant viewed the VR. In the second trial, the script was pre-recorded and overlaid onto the virtual environment. We suspect that this shift in narrative delivery helps make the intervention more intriguing and keeps participant's attention on the virtual environment. Instead of fragmenting their attention between the virtual environment and therapist speaking to them in the room, participants could solely focus on the virtual environment and automated narrative script. Moreover, when the script was overlaid onto the virtual environment, participants were more interactive with the avatars and items in the environment, another advantage of a prerecorded script. Based on these observations and other literature, future iterations of our VR training environments will continue to include a prerecorded overlaid narrative script. We will continue to refine the scripts to elicit more reciprocal communicative behaviors from participants, such as posing more questions from avatars and modeling more functional language within the environment.

2.1.3 Viewing Virtual Reality

While some users reserve the term ‘virtual reality’ solely for content viewed in head mounted displays (HMDs), like the Oculus Rift or HTC Vive, most definitions of VR in research are broader [14]. These headsets offer the highest degrees of fidelity, immersion, and *presence* within a virtual environment. However, when taking into account factors like accessibility for persons with disabilities and costs associated with high end headsets, what constitutes VR is broadened. Thus, our two VR air travel trials use definitions of VR as content viewed on screen media (e.g. tablet devices and smartphones), in an HMD, or a

combination of both, like the Samsung Gear VR, which inserts a smartphone into an HMD to display virtual environments, as supported in previous literature [14]. In our research trials, one of the primary objectives is creating cost-effective and accessible intervention tools. As a result, we delivered the VR air travel training using a smartphone and Google Cardboard HMD (Figure 2). At a price of only \$7 US, and accounting for the ubiquity of smartphones, the combination of these devices suited our objectives well. Moreover, sensory sensitivities and viewing preferences of some of our research participants required that the air travel simulation be viewed without an HMD on an iPad. Most other studies investigating VR in autism have similar strategies for the aversiveness of HMDs [6-9], but our application of inexpensive headsets like Google Cardboard was the first of its kind. While immersion and presence are reduced when using these systems, research has found that these factors may not be determinative indicators of skill acquisition or positive VR experiences for users [15]. Given these new insights, future directions of this research should compare the efficacy of interventions being delivered in headsets like the Google Cardboard or Samsung Gear versus those delivered in HMDs like Oculus Rift, alongside a treatment as usual group.



Figure 2. Participants could view the air travel training via the Google Cardboard or iPad. Communication boards were used to help individuals identify vocabulary and emotions throughout the intervention.

2.2 Measurement Strategies

Main objectives of our previous reports included 1) improving functional communication and 2) teaching generalizable air travel skills. With deficits in communication, autistic individuals often have difficulty expressing their inner states, giving rise to RRBI—up to 80% of which serve communicative functions [16]. Thus, it is important that we teach communication strategies that help individuals learn how to express basic wants and needs, identify emotions, and help them navigate complex environments, like an airport. In light of these objective, our previous reports measured types of communication, activity specific vocabulary, and included clinical observations by trained speech-language pathologists. We also tracked attentiveness to the VR intervention and each participant’s ability to complete each of the four airport “checkpoints”: going to the ticket counter, passing

through security, waiting at the departure gate and boarding the airplane. Finally, at the end of each session, we administered a retell test similar to that used by Simões et al. [8]. This test asks participants to retell the steps of the VR activity in order to measure comprehension and retention.

We conducted a number of observations on these measurements, finding room for improvement in future studies. First, participants used a variety of words that were not included in our activity specific vocabulary word bank and thus did not receive credit. Future studies must expand the number of targeted activity specific words. Additionally, pilot study one [10] had lower overall scores on the retell test than pilot study two [11]. There are at least two potential explanations for these retell discrepancies. First, participants in the first study were younger than those in the second and the retell test may have been too advanced for their young ages. A second explanation is raised by Oh, Herrera, and Bailenson who found real world distractions to effect recall of events in VR [15]. As mentioned earlier, the therapist in the first study read the narrative script aloud whereas, in the second study, the script was pre-recorded and overlaid onto the simulation. In reference to Oh and colleagues' findings [15], the script delivery in study one may have been an external distraction that inhibited recall ability of participants.

3. Conclusion

Reflection and scrutinization of previous trials is integral to an effective research program. The current report shares insights and lessons learned from two previous air travel training trials in autistic children, adolescents and young adults. Measured improvements in communication, retell, and skill transfer, are exciting preliminary results that we hope to build upon in future trials. In doing so, it is our objective to validate inexpensive, mobile VR set ups, like the Google Cardboard and smartphone we used, as tools to enhance real-world functioning of autistic individuals. Learning how to communicate in any social situation is integral to an individual's community integration and quality of life. For events like air travel, an accessible and affordable training tool can open doors for individuals and families that have previously been reluctant to participate. As exemplified in our reports and other findings [8, 10, 11], VR can facilitate functional communication, which helps autistic individuals learn to navigate these complex social environments. Moreover, the recent conclusions out of Stanford University's Virtual Human Interaction Lab [15] corroborate our own research studies [10, 11] and provides exciting new support for our application of less expensive HMDs and VR equipment to elicit positive training effects. Given the rapid rise in diagnoses and the acute need for more accessible interventions, mobile VR applications can help streamline service delivery and ease the burden on service providers by facilitating convenient, in home practice. Future directions of this research will continue revising the air travel module, alongside the creation and testing of additional modules such as classrooms, public transportation, doctor's office visits, grocery shopping and more. Using our pre-recorded training simulations, smartphone and Google Cardboard, social learning can occur anywhere, anytime ushering in a new wave of intervention tools that are poised to disrupt autism service delivery.

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Assessing Pain with Virtual Reality: A Pilot Study

Maureen SIMMONDS^a, Kyle LEPAGE^b, Tassilo BAEUERLE^{c,1},

^a*Department of Physical Therapy, University of Texas Health Center, San Antonio*

^b*Virginia Tech, School of Neuroscience*

^c*CognifiSense, Inc.*

Abstract. Pain is a complex phenomenon, notoriously difficult to measure. To date, no definitive biomarker for pain has been identified. We have previously shown that pain compromises task performance involving motion. It is, therefore, plausible that specific motion characteristics could provide a pain proxy. The purpose of this pilot study was to assess the feasibility of using movement characteristics captured in a virtual reality (VR) environment to estimate pain. The study had two Phases. In Phase I we developed a set of tasks in a VR environment which required participants to perform a set of upper limb motions. We tested the tasks on five pain-free adult participants under no-pain (baseline) and experimentally induced pain and fatigue conditions. In Phase II eighteen participants with and without clinical pain performed a set of refined tasks under baseline and experimentally induced pain and fatigue conditions. The results indicate that specific characteristics of human motion – acceleration, duration and a tremor proxy - in such a VR paradigm can be a candidate source of biomarkers for assessing pain, and the impact of pain intensity on specific movement characteristics. We also found that these same motion characteristics differentiated participants with and without clinical pain. The results suggest that motion in VR can be predictive of clinical and experimentally induced pain using measures of motion characteristics (acceleration, duration and tremor).

Keywords. Virtual Reality, Pain, and Movement, Virtual Reality for Pain Assessment, Virtual Reality for Movement Assessment, Pain and Movement.

1. Introduction

Pain is a complex physiological and psychological phenomenon, notoriously difficult to assess or measure. Self-report of pain - usually using 0-10 numerical rating scales (NRS) or visual analog scales - is the current gold-standard for pain measurement. While this method recognizes the uniqueness of the pain experience for an individual at a single point in time, it doesn't, for example, well reflect the variability and bi-directional impact on emotion, cognition and movement over time. It is also subjective. Research to identify a biomarker *specific to pain* that could complement and/or reduce reliance on self-report continues.

A significant body of research has demonstrated that pain is robustly associated with movement compromise (e.g., [1-6]). Pain is associated with relatively slower and stiffer movement patterns, similar to the changes that occur with aging [7,8]. Slow stiff movements are relatively inefficient and fatiguing, and this can contribute to the disabling effect of pain. It is plausible that specific motion characteristics could provide a pain proxy biomarker that could enhance the measurement of pain and mitigate the total reliance on self-report. Virtual reality (VR) provides a novel experimental paradigm in which to test this notion; VR allows for a specific controlled and controllable environment such that repeated and repeatable testing of pain experiences and the effect on movement in three dimensions can be measured. In this study we used a standard method of inducing ischemic pain such that the painful stimulus was known and

¹ Tassilo Baeuerle, Corresponding author, CognifiSense, Inc., 1601 McCarthy Blvd, Milpitas, CA 95035, USA; E-mail: collaborate@cognifisense.com.

controlled (experimental pain). We also induced fatigue during movement using standard weights.

Thus, the purpose of this pilot study was to assess the feasibility of using three-dimensional movement characteristics captured in a VR environment to estimate experimental and clinical pain and reduce reliance on patient self-report. Specifically, the purpose of this study was to use a VR environment and determine the extent to which movement is predictive of self-reported pain; and to compare movement characteristics in clinical and experimental pain conditions and under different fatiguing conditions.

2. Methods

The study used commercially available VR equipment: an HTC Vive, plus a VR-ready ASUS desktop PC with a GTX 980 graphics coprocessor. The study had two Phases.

2.1 Phase I

In Phase I we developed a set of “tasks” in a VR environment which required participants to perform a series of upper limb movements. Each task presented the participant with a “leader ball” in the VR environment and required the participant to use a VR controller to follow that leader ball based on rules defined for the task (e.g., see Follow-the-Leader Task described below). We tested the tasks on five pain-free adult participants under no-pain (baseline), and experimentally induced pain conditions (described below).

Analysis showed that: 1) perceived pain correlates with the magnitude of smoothed motion acceleration ($r = 0.23$, $p = 10^{-26}$); 2) pain correlates with the amount of time taken by a participant to perform a task ($r = 0.20$, $p = 5 \times 10^{-8}$); 3) pain and fatigue are correlated during the tasks (maximum correlation: load + ischemic condition, $r = 0.73$, $p = 0.0$; minimum correlation: load condition, $r = 0.38$, $p = 0.0$); 4) there is a multiplier effect between pain and induced fatigue on the “tremor” of motion after accounting for bulk motion.¹

2.2 Phase II

Based on the results of Phase I, we adapted the design of the tasks to increase the range of motion. Eighteen adult participants were recruited (13 females, 5 males), eight with clinical shoulder pain and ten without pain. Participants with clinical shoulder pain all had recurrent episodic shoulder pain of musculoskeletal origin; these participants reported having no shoulder pain at rest, but pain on movement. All participants were calibrated such that virtual reality trajectories and paths were proportional to participant limb length. The physical attributes of the participants are variable and were consistent with those typically seen from a random sample. Following informed consent, all participants performed two tasks under four different conditions.

Tasks:

1. A “Follow-the-Leader” Task for continuous movement. In the Follow-the-Leader Task the participant had to use the controller to trace behind a leader ball within a certain distance along a confined linear segment path. This allowed us to limit the degrees of freedom of motion and movement strategy.
2. A “Disappearing-Ball” Task for discrete movement. In the Disappearing-Ball Task the leader ball traced the same linear path; however, rather than move slowly along each segment, the leader ball jumped to the end of the segment

¹ Here “tremor” is measured as the standard deviation of the magnitude of the difference of acceleration with smoothed acceleration. The effect is identified by comparing “tremor” between the ischemic and load conditions and between the ischemic and ischemic + load conditions. Ischemic vs. load T-test: $t = -6.8$, $p = 2 \times 10^{-11}$. Ischemic vs. ischemic + load T-test: $t = -8.5$, $p = 10^{-16}$.

- and the user had to reach the leader ball before a timer timed out. This task increased the degrees of freedom; e.g. acceleration and movement strategy.

The movement paths traced by the leader ball was the same for all conditions and all participants.

Conditions:

- Baseline (control condition).
- Induced pain.. A sphygmomanometer cuff was used to induce ischemic pain. The cuff was applied to the arm, and 200 mm Hg pressure was applied and maintained for the duration of the condition (3 minutes) or until the participant wished to discontinue. The range of motion was not restricted by the sphygmomanometer cuff.
- Induced fatigue. Pain is generally associated with weakness. Thus, to better simulate the task challenge for individuals with pain, we included a condition in which all participants performed the tasks wearing a wrist weight (3 lbs. for females and 5 lbs. for males).
- Induced pain plus induced fatigue.

Measures:

- Self-report of pain and fatigue were measured at 30 second intervals throughout task performance using an 0-10 numerical rating scale (0 = no pain / fatigue; 10 = worst pain / fatigue imaginable).
- The three-dimensional motion of the hand controller during the task performance was automatically captured by the HTC Vive.

Procedure: The order of conditions was randomized, with the exception that the baseline (control) condition was always performed first. Each task lasted three minutes per condition, unless the subject decided to discontinue due to pain, or fatigue. There was a three-minute rest between each condition.



Figure 1. Left: VR headset and hand controller, sphygmomanometer cuff and wrist weight. Center: View seen in VR, showing a leader ball prescribing Segment 1 of the movement path in the Follow-the-Leader Task. Right: First three (of 21) segments in the predefined movement path of the leader ball (Phase II).

3. Analysis (Phase II)

In Phase II the goal of our analysis was to (a) investigate the degree to which movement is predictive of reported pain (b) account for the influence of fatigue, (c) compare clinical pain vs. no clinical pain groups, and (d) assess unaccounted-for variance.

3.1 Pain Response Modeling & Analysis

The response variable was taken to be the numeric pain level, which was a number between 0 and 10 reported by the participant every 30 seconds. This response variable was transformed to account for the saturation effects near 0 and 10. Because the motion statistics were computed for every segment, each of which tended to last for seconds, to associate pain response with motion, the reported pain was linearly interpolated to the time at which each of the segments was half complete. This typically yielded 300 pain responses per participant during the Disappearing-Ball Task.

Because the responses r_j range from 0 to 10, we related a linear combination of the covariates to the transformed response variable y_j specified in Eq. (1):

$$p_j = (r_j + \epsilon) / (10 + \epsilon),$$

$$y_j = \log \left\{ \frac{p_j}{1 - p_j} \right\} \quad \text{Eq. (1)}$$

Here ϵ is a small positive quantity. In an attempt to amplify the effect of pain in observed motion we restricted analysis to those segments which were considered more challenging to the participant based upon biomechanical criteria.

Twenty-one models were tested on a per-participant basis to determine the relative importance of covariates and experimental structure upon reported pain. Covariates were selected to account for baseline pain response, the influence of fatigue, tremor¹ and the speed of task completion (min/max acceleration and duration to complete) as well as experimental structure (task/condition). For segment j , each model relates the k^{th} covariate, $c_{k,j}$, to the transformed response y_j , through the following linear combination:

$$y_j = \sum_{k=1}^K \beta_k c_{k,j} \quad \text{Eq. (2)}$$

Here the parameters β_k are estimated from the data using least-squares.

Given a specific model and the estimate β_k , $k = 1, \dots, K$, (see Eq. (2)), an hypothesis test (Wald test for parameter significance) was performed for each k to assess the statistical significance of β_k . Here the test p-value is the probability given H_0 that the test statistic exceeds the absolute value of the observed statistic. For convenience, $-\log_{10}(\text{p-value})$ is plotted (Figure 2, upper-right). Models were selected using the Akaike Information Criterion (AIC). The AIC promotes goodness of fit while penalizing more complex models that have many parameters.

3.2 Across-Participant Heterogeneity

Across-participant heterogeneity was further assessed in two ways: 1) model-performance heterogeneity was assessed by grouping participants into low, medium, and high responding groups, and aggregating model log-likelihood within these groups, and 2) reported fatigue and pain response was characterized using six summary statistics for each of the conditions and tasks and then clustered using unsupervised learning. In the first of these analyses, it was found that sensitive groups, that is groups associated with large pain and fatigue responses, were associated with the best fitting models. This indicates that reported pain is best explained by our chosen covariates when participants respond to the experiment. In the second analysis, the six statistics summarizing pain and fatigue response were computed for each of the tasks and conditions and, for each participant, concatenated to form a candidate bio-signal comprised of 96 numbers. These bio-signals were z-scored and smoothed using a PCA procedure prior to clustering using Campbello et al [9]. The participant bio-signals were grouped according to cluster label (Figure 2, Lower Right).

3.3 Pain-Type Group Analysis

Participants were categorized as having no clinical pain in the ipsilateral limb tested in the experiment (non-clinical-pain group) and those that had clinical pain in the shoulder on the ipsilateral side tested in the experiment (clinical-pain group). To test differences in the relationship between observed participant motion and reported fatigue/pain response, a permutation-based likelihood ratio test was computed. Here, the

¹ In Phase II the tremor proxy from Phase I was refined primarily by removing the contribution of the acceleration vector in the dominant direction to reduce weighting on dominant/prescribed direction.

null model is a relationship between covariates and reported pain that is independent of participant pain type (group). The alternate model introduces twice as many parameters as the null model and allows for a different pain-motion relationship between clinical-pain participants and non-clinical-pain participants (Figure 2, Lower Left).

3.4 Results

The per-participant model fit performance was an excellent or good fit for ten of 18 participants (e.g.; Figure 2, Upper Left). Specifically, in the Follow-the-Leader Task the best fitting model showed excellent or good fits for three and four candidates respectively. A further five candidates showed a good fit for some conditions. In the Disappearing-ball Task, the model showed excellent or good fits for three and two candidates respectively. Heterogeneity and cluster analyses indicate that movement in VR can provide a candidate source of biomarkers for assessing pain. Specifically, these are acceleration / deceleration, duration, and tremor proxy. In addition, models for predicting pain may be improved by including patient cluster variables. Finally, comparison of movement differences across the clinical-pain group vs. non-clinical pain group showed that this VR paradigm can be predictive of clinical and experimentally induced pain, and thus allowed for clustering of individuals in clinical-pain and non-clinical-pain groups.

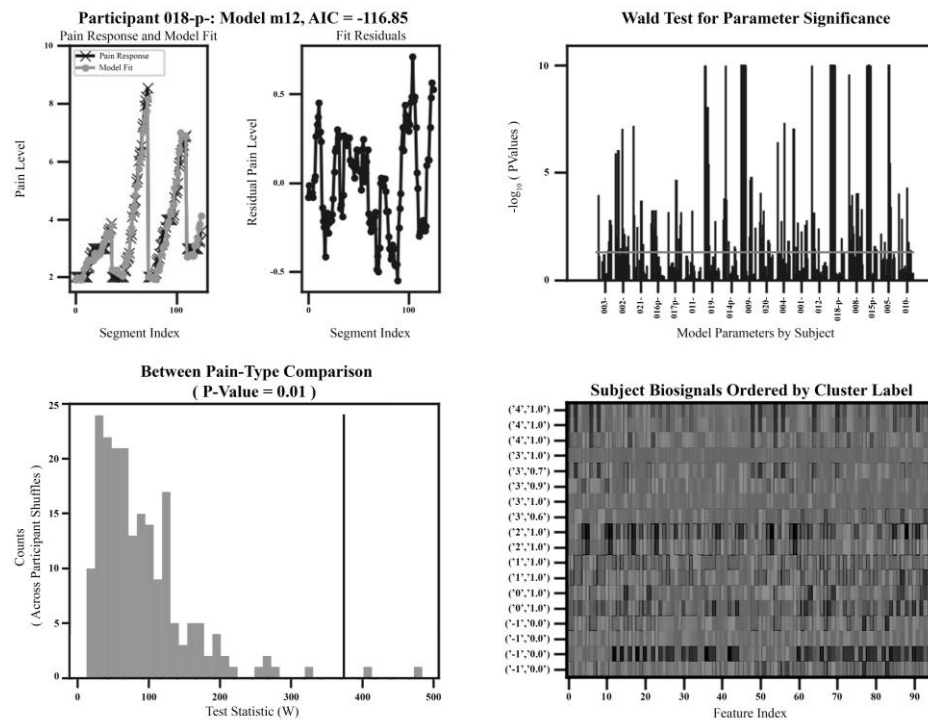


Figure 2. Upper Left: Example fit to pain-response by best-fit model for this participant. Three of eighteen participants exhibit fits of this quality. Upper Right: Log10 P-values. The relative importance of the covariates is participant dependent, indicating across-participant motion-pain response heterogeneity. Lower Left: The between Pain-type (experimental vs clinical pain) group analysis for the selected model for the Disappearing-Ball experiment. The p-value is equal to 0.01, indicating that the relationship between the covariates and the pain response depends upon the Pain-type group. Lower-right: Cluster analysis of participant response. The bottom four participants are labeled as outliers. The clusters identify distinct bio-signal patterns indicating substantial across-participant heterogeneity.

4. Discussion

This was an exploratory proof of concept study. The goal was to investigate the potential of using movement in a VR environment to identify a proxy biomarker for pain. We found that 1) we could use VR to define and measure useful movement tasks, 2) we could identify potential movement characteristics which are biomarker candidates, and 3) we could differentiate people with and without clinical pain using this approach. Thus, the results suggest that this VR approach may have the potential to quantify the impact of

pain on movement, and thereby not only provide a proxy for pain but also provide a potential measure of clinical assessment and outcome, i.e. inform clinical treatment and measure treatment efficacy. Per-participant results further suggest that model accuracy may be greatly increased by (i) characterizing participant type based on personal characteristics such as age, sex, and movement skill and (ii) improving our characterization of human motion. There are a number of limitations to this study; e.g., small sample size; limited measures of movement characteristics; self-report was limited to pain and fatigue (weakness) and thus we could not cluster on other characteristics. A great deal of further study is required to generalize these early results and to develop motion parameters and models which can consistently predict pain across chronic and other pain populations.

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SECTION VII

BRIEF COMMUNICATION

Virtual reality exposure with eye-gaze adaptive virtual cognitions

Ding DING ^{a,1}, Willem-Paul BRINKMAN ^a, and
Mark A. NEERINCX ^{a,b}

^a*Delft University of Technology, Netherlands*

^b*TNO Perceptual and Cognitive Systems, Netherlands*

Abstract. Virtual cognitions are a stream of simulated thoughts that can be rendered in the form of a set of pre-recording audios. People hear the virtual cognitions while immersed in a virtual environment. Although offering virtual cognitions during social skills training in virtual reality can enhance people's self-efficacy and knowledge of social interaction as indicated in previous studies; by not adapting the virtual cognitions to people's focus of attention might limit their efficacy. To address this, we intend to use eye-tracking technology embedded in the head mounted display (HMD) as it gives information about users' focus of attention. In the context of a pre-therapy for spider/snake phobia, our virtual reality exposure system provides user eye-gaze adaptive virtual cognitions. To investigate the effectiveness of such virtual cognitions, an empirical experiment with 24 participants will be conducted. We want to examine with the aid of eye-tracking technology, whether the virtual cognitions could guide people's attention during the virtual reality exposure and affect people's self-efficacy of handling spiders/snakes. Furthermore, with the eye-gaze adaptive virtual cognitions, the exposure experience has the potential to be even more plausible, natural and effective.

Keywords. Eye-tracking, eye-gaze adaptive, virtual cognitions, virtual reality exposure, spider phobia, snake phobia

¹Corresponding Author: Ding Ding, Delft University of Technology, Van Mourik Broekmanweg 6, 2628 XE Delft, The Netherlands; E-mail: d.ding-1@tudelft.nl.

1. Introduction

Virtual cognitions are a stream of simulated thoughts that can be rendered in the form of a set of pre-recording audios. People hear the virtual cognitions while immersed in a virtual environment. Akin to virtual reality that artificially induce sensory experiences to replicate an external physical environment, virtual cognitions aim at reproducing the inner psychological world by artificially offering users cognitive experiences via delivering pre-scripted audios. They can provide people with information on a topic, reflections on the current situation, and motivational encouragement. Inner voice, regarded as “verbal sets, instructions to oneself, or a verbal interpretation of sensation and perceptions” [1], plays a crucial role in conscious thoughts. Utilizing inner voice as a source of reference, virtual cognitions intended to mirror the way internal thoughts form and present in people's mind.

Although previous studies [2] indicate that offering virtual cognitions during social skills training in virtual reality (VR) can enhance people's self-efficacy and knowledge of social interaction, several deficits might limit their efficacy. The virtual cognitions in the system of our previous study [2] are rendered in a fixed model and presented in a fixed sequence. In other words, users hear a predetermined virtual cognition at a specific moment irrespective of their current focus of attention. This might lead to a confusing and unnatural experience. For example, sitting in a virtual meeting room in front of an avatar, a virtual character Tom, users may hear "Now Tom seems to be angry" while they are looking out of the windows. Without users actively directing their focus of attention to virtual cognitions, the conflicts between users' focus of attention and virtual cognitions potentially could lead to a low sense of presence in virtual scenarios. The low sense of presence can be manifested through the low sense of plausibility of virtual cognitions [3]. This is undesirable as the sense of presence contributes to an increase in learning [4]. Moreover, if the content of virtual cognitions is not coincided with users' focus of attention, users would not experience the virtual cognitions as their own, thus effecting the ownership users perceive of the virtual cognitions. Additionally, if virtual cognitions are not coherent with the visual stimuli, people might have to deal with the issue of selective attention and divided attention [5], pay less attention to the content of virtual cognitions, and consequently, it becomes less possible for them to follow the instructions embedded in virtual cognitions.

Moreover, the application context of the virtual cognitions in this study is a pre-therapy of VR exposure. For exposure therapy, presenting a phobic stimulus does not guarantee that the participants will look at them. Without paying attention to the stimulus, there is no efficient exposure to trigger the awareness and processing of the phobic stimulus, not to mention the reduction of fear [6]. Accordingly, knowing how much attention people pay to the phobic stimulus is crucial as it affects the exposure efficacy [7]. Tracking eye movements is usually regarded as a direct measurement of where people deploy their attention. Based on these considerations, we intend to use eye-tracking technology embedded in the FOVE 0 Head Mounted Display (HMD). This offers an opportunity to synchronize virtual cognitions with people's focus of attention.

To sum up, this study intend to answer the research question that whether an exposure in the virtual environment with eye-gaze adaptive virtual cognitions can influence people's eye-gaze shift after hearing an instructional virtual cognition, their attitude towards this virtual experience, such as the plausibility and ownership of these virtual cognitions.

2. System

In the context of a pre-therapy for spider or snake phobia, our virtual reality exposure system provides user eye-gaze adaptive virtual cognitions. When users are trying to avoid looking at the virtual animals, this can be registered via eye-tracking and consequently trigger a spider or snake-related virtual cognition. The virtual cognitions consist of three components: 1). The statement of fact relating to spiders or snakes, such as "The way this spider is moving is a little bit disgusting, but it does not mean you should feel afraid of it.", 2). Self-motivational statements of handling spiders or snakes like "You are strong enough to handle that.", 3). The instructions for looking at spiders or snakes, e.g. "Try to look at the spider a bit longer". These virtual cognitions are pre-recorded by users and will be played back to them during the virtual exposure. Users are also instructed to modify the recording to mimic their inner voice. On this basis, when virtual cognitions are delivered to users, they are coincided with users' focus of attention, which could make users perceive these virtual thoughts originate from themselves, rather than experiencing someone else's thoughts, thus might increase their sense of ownership over the virtual cognitions. Moreover, by synchronizing virtual cognitions with the users'

focus of attention, we anticipate it will make the virtual experience more natural, plausible, and relatable to real world experiences.

The exposure session consisted of three scenes. In the first scene, users are sitting alone in the virtual room, hearing virtual cognitions reflecting on the upcoming appearance of the spider or snake, presenting some factual information about the animals. The reflection is accompanied by self-motivational statements. The second scene is the official start of the exposure to virtual animals. A virtual spider or snake will move out slowly from a sofa in the corner to the center of the room. Users could explore the virtual room or look at the spider/snake, while being exposed to the virtual cognitions. Finally, the spider or snake will crawl out the room and disappear from the users' sight. In the last scene, users will be again alone in the virtual room like the first scene. They will hear the virtual cognitions that reflecting the exposure they experienced in the last few minutes, their performance during the exposure and also affirmatively encouraging them in their ability of dealing with the feared animals.

3. Method

To investigate the effectiveness of such eye-gaze adaptive virtual cognitions, an empirical experiment with 24 participants, utilizing the within-subject design, will be conducted. The study was approved by university' human research ethics committee (ID: 577). A prior registration of this study can be found online.

For the head-mounted display and eye-tracking technology, we will use the FOVE 0 with resolution of 2560*1440 pixels, while the virtual environment was created in Unity3D. Virtual cognitions were written in English, Dutch or Mandarin, which match the participants' mother tongue. Participants read the scripts aloud and are recorded with a pair of In-Ear Binaural microphones. Although the system is designed for the treatment of spider or snake phobia, as the first step, participants with spider or snake phobia were not recruited in this study.

3.1 Materials and measures

To assess how plausible people thought the virtual cognitions were, a 3-item plausibility questionnaire was used. This questionnaire was an adaptation from the one used by Millevill-Pennel and Charron [8]. To investigate the sense of ownership of the virtual cognitions, a dedicated questionnaire was created that was inspired by several existing questionnaires [9,10]. We will also collect their self-efficacy of handling spiders and snakes as a secondary measurement [11].

Moreover, as a behavioral measure, the number of eye-gaze shifts participants made after hearing the instructions within virtual cognitions will be counted automatically by the system.

3.2 Procedure and apparatus

The study consists of four phases: audio recording, pre-measurement, exposure, and post-measurement. In the first phase, a consent form will be given to participants that informs them that they might see virtual spiders and snakes in a virtual environment. After signing the consent form, participants will be instructed to read out some text given in random order with the reflections on the spiders and snakes, the instructions that might trigger the eye-gaze (focus) shifting, and self-motivational statements. The reading will be audio recorded. After that, the participants will be asked to fill in an online questionnaire to collect their biographical data (e.g. age, gender, education, profession, previous virtual experience), self-efficacy and anxiety with handling spiders and snakes (Spider questionnaire (SPQ) and Snake questionnaire (SNAQ)). At least a one day interval will exist between the first two phases and the next exposure phase

In the exposure phase, a within-subject design will be used, thereby the order of conditions will be counterbalanced. Participants will randomly complete two conditions: VR exposure with eye-gaze adaptive virtual cognitions and with no eye-gaze adaptive virtual cognitions. The participants in both conditions will be required to wear the same HMD and be exposed to a virtual room with a spider or snake appearing in the middle of the room. In the non-adaptive condition, participants will hear randomly chosen virtual cognitions, while in the other condition, participants will be exposed to the virtual cognitions adapted to participants' eye gaze with aim of steering their attention to or away from the animals in the virtual world. During the exposure, the number of eye-gaze shifts participants make after hearing the instructions within virtual cognitions will be counted. After each exposure, participants are asked to complete a questionnaire about their attitude towards this virtual experience, such as the plausibility and sense of ownership of the virtual cognitions, and again their self-efficacy of handling spiders and snakes.

4. Conclusions and discussion

In conclusion, we set out to examine the effectiveness of the system that synchronizes virtual cognitions and people's focus of attention. With the aid of eye-tracking technology, the eye-gaze adaptive virtual cognitions have the potential to make the exposure experience more plausible, natural and effective. Introducing the virtual cognitions to create a pre-phase for the formal virtual reality exposure therapy might enhance people's willingness and confidence to attend the upcoming therapy.

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Looking for the Right Swipe: Gender Differences in Self-Presentation on Tinder Profiles

Gordon P. D. INGRAM^{a,1}, M. Isabela ENCISO^a, Nathalia ERASO^a,
Maria Jose GARCIA^a and Antonio OLIVERA-LA ROSA^b

^aUniversidad de los Andes, Colombia

^bUniversidad Católica Luis Amigó, Medellín, Colombia

Abstract. Tinder has become a popular online dating tool for people looking for either short- or long-term relationships. In this study we build on existing research on gender differences in the motivations of Tinder users, by analyzing gender differences in self-presentation. We predicted that women would try to attract men to right-swipe (i.e., potentially match) their profiles through largely visual means; while men would put more emphasis on showing off their skills and interests. In a sample of 300 randomly obtained Tinder profiles (150 heterosexual females and 150 heterosexual males), half from Colombia and half from the USA, we found mixed support for our hypotheses. There was no significant difference between numbers of photos uploaded by women and men, but certain types of photos were unique to one gender. Links to other social networks did not differ much between genders; however, men tended to include more textual information in their profiles.

Keywords. Gender differences, Instagram, online dating, self-presentation, selfies, Spotify, Tinder

1. Introduction and Hypotheses

Although stereotyped as the preserve of people looking for casual sex, Tinder has become a popular online dating tool for people looking for either short- or long-term relationships [1, 2, 3], with an estimated 50 million users in more than 190 countries, and 10 million daily active users. In a uses and gratifications study, [1] showed that Casual Sex was just one of several classes of motivations for using Tinder, while Love was more common; and while 46% of users had gone on a date with a Tinder match, only 19% had taken part in a one-night stand with a match. It is thus reasonable to suppose that patterns of gender differences found in other online dating apps and sites (reviewed in [4]) will also apply to Tinder. In particular, theory predicts differences in the gender mix of people who use the site for short-term and long-term mating purposes, as well as differences in the strategies that different genders use to attract a mate.

Indeed, gender differences in Tinder use are very apparent: [5] found that men tended to use Tinder for sex, travel and starting a relationship, whereas women used it more for friendship and self-validation. Similarly, [1] found that men were more likely than women to use Tinder for casual sex. This is in line with evolutionary psychological studies of online dating [4] and of gender differences in social network use [6]. In addition to cultural factors, a successful evolutionary explanation of sex differences in self-presentation generally is the sexual strategies theory of Buss and Schmitt [7]. This theory posits that due to their higher obligatory investment in offspring, women have less to gain from a short-term mating strategy and should therefore be more conservative

and less risky in their mating choices. [8] reviewed evidence suggesting that men were more likely to initiate “sexting” (exchanges of sexually explicit text messages) than women were. While this finding might be expected to generalize to the initiation of chats

¹ Corresponding Author, Gordon P. D. Ingram, Department of Psychology, Universidad de los Andes, Carrera 1 # 18A-12, Bogotá, Colombia; E-mail: gp.ingram@uniandes.edu.co.

on Tinder, this was not the hypothesis examined in the current study. Instead, we sought to examine gender differences in self-presentation on Tinder profiles.

Self-presentation, which has been defined as “the packaging and editing of the self during social interactions to create a desired impression in the audience” [9, p. 336] has long been recognized as an important motive behind the use of social networking sites [10], the Internet [11] and, indeed, behind social interactions in general [12, 13, 14]. Self-presentation theory predicts gender differences between men, who may like to present themselves as high-status risk-takers, and women, who may prefer the presentation of familial relations and emotional expressions [15]. Self-presentation on dating sites like Tinder may well differ from self-presentation on more general social networking sites like Facebook, however, because of the differences in the intended audience. Gender differences in self-presentation on dating sites are related to issues of parental investment and sexual strategies, in that self-presentation strategies may be linked to what is attractive to the opposite sex: women on dating sites may try to attract men primarily through visual means, emphasizing their value as short-term mating prospects, whereas men often try to convince women that they are reliable, low-risk, long-term mating prospects, a proposition that may involve a certain amount of verbal persuasion.

Although Tinder is primarily a visual application, both visual and verbal means of self-presentation are available to users. Interaction between users starts with one user viewing a photo of another who lives nearby, along with some very basic biographical information (their age and the university where they were educated). If the user likes the look of the photo, he/she swipes right; if not, he/she swipes left [3]. If at some other time the user in the photo sees the photo of the first user in their search results and swipes right on someone who has previously swiped right on them, a “match” occurs, and conversations between the two often begin. However, in certain cases a user is not sure from the first photo whether they will make a right or left swipe. They can therefore dig deeper into the other user’s profile and unearth more information if it is provided, including additional photos, some resumé-type biographical information, free text comments (known as the “profile description”), and sometimes links to other social media accounts, notably Instagram (for even more photos) and Spotify (for the user’s favorite music).

We therefore hypothesized that women would try to attract men to right-swipe (i.e., potentially match) their profiles through largely visual means; while men would try to do so more by showing off their skills and interests in the textual information fields and by linking to Spotify accounts. In particular, showing pictures of the whole body should be more important for females who want to demonstrate their potential suitability as short-term mates, according to a large body of work on the importance of the waist/hip ratio in female attractiveness [16]. We predicted that (H1) females would upload more photos to their Tinder profile than males; (H2) a higher proportion of photos would be of the whole body in females (including the so-called “mirror selfies” [17], in which it is easier to show the whole body than with normal selfies); (H3) females would more frequently link to their Instagram account than males, in order to provide even more photographic material for male consumers; and (H4) males would more often link to their Spotify account than females, in order to demonstrate an important non-visual aspect of their personal identity. These hypotheses represent an advance over previous studies of Tinder, in that they are based in evolutionary psychological theories about sex differences that have already been applied to social networks such as Facebook [6].

2. Method

These predictions were tested by creating one male profile and one female on Tinder, and then selecting and classifying the first 300 Tinder profiles (150 heterosexual females and 150 heterosexual males) that appeared. Half of these profiles were collected from Colombia and half from the USA, with equal numbers of females and males in each country. We coded each profile for number of photos included and whether Instagram and/or Spotify accounts were linked. We also developed a scheme for categorizing the

photos that had been uploaded, based on things that we thought *a priori* might be likely to vary between men and women, assigning each photo a value of Yes/No for each of

the following variables: selfie; mirror selfie; travel (e.g. vacation shot); with friends; showing whole body; sports-related; and with pets.

3. Results

- H1: females submitted a mean of 3.9 photos (SD = 2.0), while males submitted 4.3 (SD = 2.0), a non-significant difference ($t(299) = 1.2, p = .25$)
- H2: pictures of the whole body and mirror selfies were unique to female profiles (see Table 1 below)
- H3: 39% of females and 31% of males linked to their Instagram account, a non-significant difference ($\chi^2(1) = 2.1, p = .15$)
- H4: 35% of males but only 22% of females linked to their Spotify account, a significant difference ($\chi^2(1) = 6.5, p = .01$)

Table 1. Differing proportions of photos in each category (not exhaustive), split by gender (** significant at the 0.001 level; * significant at the 0.01 level).

| Photo category | Females (% of photos) | Males (% of photos) |
|----------------|-----------------------|---------------------|
| Selfies | 34 | 30 |
| Mirror selfies | 11*** | 0 |
| Travel | 5 | 15** |
| With friends | 5 | 5 |
| Body | 14*** | 0 |
| Sports | 0 | 6** |
| Pets | 0 | 6** |

Notable unpredicted results included that pictures of sporting activities and pets were found only for males, although proportions were low (6%) in both cases, so this difference may not be very reliable. Pictures taken while traveling (e.g., on vacation) were also significantly more common in men ($\chi^2(1) = 8.1, p = .004$). We further found that men were much more likely than women to include a verbal profile description, and to include information about their college major. Results were broadly similar in both countries. Given the relatively small samples ($n = 75$) when split by country and gender, we do not report country-specific analyses here.

4. Discussion

H1 was not supported: we found no significant difference between numbers of photos uploaded by women and men, with the trend even being in the opposite direction to the prediction. This is in contrast to studies of other social media such as Facebook in which female users typically upload many more photos than male users [4]. This discrepancy may be because Tinder initially asks users to upload a maximum of only six photos when they register with the app. While it is possible to upload more, the user interface for this is not intuitive and only 6% of our sample had done so. Future work could investigate whether the difference exists in dating apps/sites that make it easier for users to upload photos. In contrast, H2 was supported: men never uploaded mirror selfies or even other photos that showed their whole body. This suggests that rather than simple visual information such as photos in general marking a gender difference in sexual strategies, it may be certain types of visual information—such as waist-hip ratio [5]—that are important. Further research could focus on whether poses and clothing that heterosexual women use in photos on Tinder and other dating sites, compared with social networks where they are not specifically trying to attract men, serve to accentuate this ratio.

H3 was not supported, especially considering the slight female bias in Instagram's user base. Although H4 was superficially supported, correcting for the 55-45% male-female split in Spotify's user base would likely mean it was not supported either. In retrospect, we would expect much less of a gender difference in linking to other social

network accounts than in text-based profile elements such as description of university major that allow males to demonstrate their earnings potential, or

photographic elements that allow the same (such as travel pics) or demonstrate a more caring side (pictures with pets). However, these hypotheses did not occur to us before we carried out our exploratory analysis of Tinder profile elements. Since the results in these areas were not predicted, they need careful replication before firm conclusions can be drawn from them. Despite this important limitation, the current study represents an advance towards a theoretically motivated analysis of gender differences in Tinder use, which could be used to generate predictions about how these might differ from gender differences in self-presentation on social networking sites such as Facebook and Instagram that do not involve such a clear “biological market” for mates [18].

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Virtual Reality and Minimal Analgesia Attenuate Pain During Spine Surgery

José Luis MOSSO VÁZQUEZ^{a1}, Patricia CANSECO AGUILAR^b, Dejanira MOSSO LARA^c, Ian MILLER^f, Brenda K. WIEDERHOLD^{d,e,f}, Mark D. WIEDERHOLD^d

^a *Universidad Panamericana México City*

^b *Medical Center November 20, ISSSTE*

^c *Hospital Angeles México*

^d *The Virtual Reality Medical Center, San Diego CA USA*

^e *Virtual Reality Medical Institute. Brussels, Belgium*

^f *Interactive Media Institute, La Jolla, CA USA*

Abstract. We present progress with 17 cases of virtual reality (VR) therapy to reduce pain and anxiety during interventional treatment under radiology guidance on patients diagnosed with intense and chronic back pain with narrow channel syndrome and lumbar disc hernias. **Methodology.** Patients under informed consent fitted with a head mounted display (HMD), to allow them to navigate in VR scenarios, lie in a prone position. The procedure begins using minimal analgesia with an intravenous single dose with fentanyl 50 mcg without sedation. We infiltrate locally with local anesthesia (lidocaine 1%); depending on the interventional procedure involved. The interventional procedures were: discography with discolysis with ozone, caudal blockages, and foramina blocks. During the procedure, patients navigate VR scenarios created at the Virtual Reality Medical Center in San Diego (Dr. Brenda Wiederhold). At the end of the procedure, patients recover for one to two hours before leaving the Surgical Center. **Results.** No statistically significant increase in pain ratings from baseline through procedure were noted, however, a significant decrease was noted post-operatively. The attenuation of pain due to VR distraction in 17 patients allowed the procedure to be non-sedative (Midazolam was not used). **Conclusions.** Advantages of VR therapy include a high degree of patient satisfaction, minimal risk without sedatives, such as midazolam, maintenance of patient's conscious awareness, stress reduction in the patient, stress reduction in the anesthesiologist, and cooperation with the patient. The non-invasive VR equipment used is portable, reliable, and led to a better patient-physician relationship. VR therapy during pain treatment is an excellent option in the pain clinic. Chronic pain treated with anti-inflammatories administered directly to the spine and local ozone is an area in which the use of VR can significantly reduce pain. With this experience we demonstrate the cost benefit advantage that also offers satisfaction to patients while offering savings to health institutions. No complications were presented.

Key words. Pain clinic, virtual reality, Chronic Pain, Surgery.

1. Introduction.

Chronic spinal pain. (defined as daily pain for at least 3 months), including lumbar, thoracic and cervical hernias, is one of the most prevalent orthopedic disabilities [1]. Chronic pain with neuropathic characteristics is more prevalent in women than in men. Research suggests approximately 60% of subjects who report neuropathic characteristics are women. These reports are most prevalent for women aged 50–64 years [2]. Neuropathic characteristics are more than twice as prevalent in manual workers or farmers than in managers and are more prevalent in rural areas than in large urban

communities [1-3]. Additionally, research indicates that chronic pain is more prevalent in women and more senior patients. Neuropathic symptoms are most commonly located in the limbs, since it is a consequence of damage to the neurovascular bundle. There are numerous treatments for neuropathic pain, one of which is spine infiltration. Spine infiltration is an invasive treatment that requires an operating room,

¹ Corresponding author: jmosso@up.edu.mx

anesthesiologist, preoperative assessment and post-operative recovery. Traditional methods require intravenous analgesia, sedatives and local infiltration of lidocaine in the spine. Unfortunately, despite medications, pain during the procedure is high. During the procedure, patients are in a prone position and procedure times vary depending on the diagnosis. Normally pain and anxiety are elevated in the majority of the cases.

There are adjunctive treatments such as cognitive behavior therapy and behavior therapy for chronic pain in adults [3]. Randomized controlled trials provide support for the effectiveness of cognitive behavioral therapy (CBT) and behavior therapy for chronic pain in adults [3]. Additionally, virtual reality (VR) offers an alternative chronic pain treatment option [4, 5]. VR is a particularly effective tool to reduce pain and anxiety without modifying conventional intraoperative techniques. For example, Wiederhold et al. [6, 7] report applications of VR to reduce chronic pain in combination with CBT. VR is also an effective supplemental tool for the treatment of phobias, posttraumatic stress disorder (PTSD) and anxiety disorders. [8, 9], stress management in soldiers with PTSD, [10-12], and addictions [13]. VR similarly reduces pain in patients during invasive surgeries, such as colposcopies [14], upper endoscopies [15], cesarean surgeries, outpatient surgeries [16], and intensive care units without complications VR technology is progressing and enhancing patient experiences of immersion and presence in virtual worlds, thereby improving its analgesic effects. Other versions of VR, like mobile devices inserted in to Google Cardboard devices are easy to use and much less expensive than high-end systems.

2. Methodology.

A prospective observational study was performed with 17 patients aged 40 to 78 years (average = 66.7 years). Pain intensity was moderate to severe; patients reported between 1 and 3 years of pain. All patients were diagnosed with chronic back pain and treated with analgesics, such as anti-inflammatory medications (e.g. tramadol, pregabalin, paracetamol) and specific medications to treat hypertension, diabetes, or other diseases for many years. Specific diagnoses were: Lumbar or cervical radiculopathies, symptomatic lumbar hernia, narrow channel syndrome, peripheral neuropathy, stenosis of neural channel, poslaminectomy, nerve roots compression, diabetic polyneuropathy, spine damage, sacrum ileitis, coxartrosis, post herpetic neuropathy, cryoglobulinemia, poslaminectomy, bilateral sacrum ileitis and narrow lumbar channel, peripheral neuropathy T6, T7 y T8, narrow lumbar channel, and lumbar hernias L3-L4 and L4-L5. The most common disease was narrow channel syndrome (spinal stenosis) from the lumbar or cervical spine. The procedures conducted were percutaneous discolysis, sacroiliac and lumbar foramina blockage, and epidurography. All the procedures were performed in the operating room under radiological guidance.

Patients were scheduled for spine infiltration of fentanyl (50 mcg or 1-2 mg/Kg) one week before the procedure. Lumbar procedures were performed introducing ozone in the lumbar region with aseptic conditions, local anesthesia and sedation. The ozone was introduced into the lumbar disc (5 to 7 ml) in the epidural (5 to 7 ml) and periradicular spaces (5 to 7 ml) at a concentration of 27 lg. In all patients, 1500 mg of cefuroxime was administrated intravenously as a prophylactic measure.

The effectiveness of the treatment was based on patient reported pain. via the visual analog scale (VAS) before, during and after the procedure. A score of 0 on the VAS scale indicates no pain, a score of 10 indicates extreme pain. All the patients were asked about the possible adverse effects of the treatment and a survey was carried out on patient satisfaction with the technique post-surgery (0 = not satisfied, 10 = extremely satisfied).

3. Results.

Seventeen (17) patients participated (9 males (52.94 %) and 8 females (47.06 %). Fourteen of the subjects are retired, three are still employed as drivers. Medications used in the procedures included: Fentanyl 50 mcg, methylprednisolone, ozone, lidocaine, contrast medium and radiofrequency. Pain increased from baseline only slightly during

the procedure (7%) and decreased significantly after surgery to an average 1.18. After the procedure all patients recommended this technique using VR for immersion and pain attenuation. Patients' average degree of satisfaction was 9.5/10. Patients reported no adverse effects.

4. Conclusions.

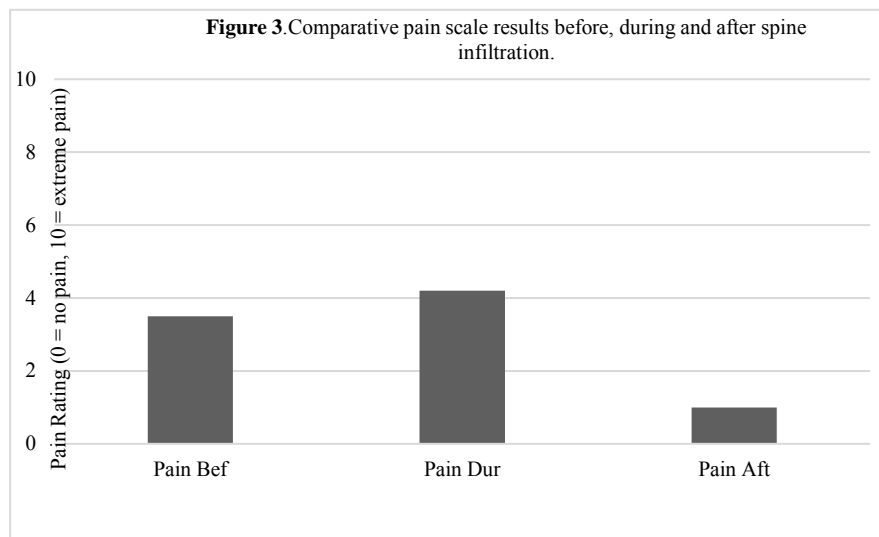
Spine surgery assisted with VR immersion is a safe and effective technique for the treatment of chronic back pain. Even with the lack of sedation, only a slight increase in self-reported pain during the procedure was noted, and despite this slight pain, patient satisfaction remained high. This research corroborates previous research that VR immersion during invasive procedures helps reduce the need for sedative medications, helping to save costs for both patients and healthcare institutions and reduce recovery time. The current VR immersion technique did not interfere with the traditional spine infiltration procedure. While no complications are reported, patient feedback suggests that VR needs additional comfort measures for extended surgical procedures. Overall, this application is acceptable and feasible for patients and efficacious for use in multidisciplinary pain clinics. Future methods of administering VR pain immersion should continue to be adapted and improved for wider distribution.



Figure 1HMD placement and back cleaning before spine infiltration. Centro Médico Nacional 20 de Noviembre, ISSSTE. Mexico City



Figure 2. Spine infiltration under fluoroscopy control



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Characteristics of Cybersecurity Victims at Clark Atlanta University

Medha TALPADE^{a1}, and Roy GEORGE^b

Shanice Blair^a, Douglas Green^a, Breonna James^a, Jamecha McKinney^a, Kenneth Ukwu^b

^a*Department of Psychology, Clark Atlanta University*

^b*Department of Cyberphysical Systems, Clark Atlanta University*

Abstract. The cybersecurity business report (2018) estimates that cybercrime damage costs will hit \$6 trillion annually by 2021 which is an upward trend from \$3 trillion in 2015. Resources are being invested in training and understanding the human factors that contribute to these crimes to help deter them. However, most of the research has focused primarily on the Caucasian population with African Americans and other minorities being overlooked. This study focused on the psychosocial characteristics of this under-represented segment of the population in cybersecurity research. The results support past research on the relationship between the demographic variables and cybersecurity victimization but shed new light on these relationships in the minority population.

Keywords. Psychosocial, minority, cybersecurity victim

1. Introduction

The cybersecurity business report (2018) estimates that cybercrime damage costs will hit \$6 trillion annually by 2021 which is an upward trend from \$3 trillion in 2015. This represents “the greatest transfer of economic wealth in history, risks the incentives for innovation and investment, and will be more profitable than the global trade of all major illegal drugs combined⁷”. Resources are being invested in training and understanding the human factors that contribute to these crimes to help deter them. For example, studies have identified the characteristics of the hacker based on the type of messages [1,2] the psychosocial factors of the cybervictim [3-8], and internet search characteristics⁵. However, most of the research has focused primarily on the Caucasian population with African Americans and other minorities being overlooked. Pew Research Center (Feb. 2018) indicates that 75% of adults in the United States (US) who own a smartphone are black and the majority (94%) who own a smartphone are 18-29 years of age. The report also indicates that reliance on smartphones for online access is especially common among younger adults, non-whites and lower-income Americans. Thus, it is important to study the psychosocial characteristics of this under-represented segment of the population in cybersecurity research. This project specifically identified, (a) the personality characteristics, (b) the technological knowledge, (c) the socioeconomic status, (d) the motivations and device of access, of an African American cybersecurity victim.

¹ Corresponding author: MTalpade@cau.edu

2. Research Questions

2.1 Central Question: What are the psychosocial characteristics of the African American cybersecurity victim?

- RQ 1: What is the relationship between personality type and becoming a cybersecurity victim?
- RQ 2: What is the effect of knowledge and familiarity with technology on becoming a cybersecurity victim?
- RQ 3: What is the effect of religiosity on becoming a cybersecurity victim?
- RQ 4: What are the demographic characteristics (age, gender, socioeconomic status, religion) of the cybersecurity victim?

2.2 Methodology

An online survey was administered to 134 students at Clark Atlanta University (CAU). The survey included: Personality type as measured by the Big Five Personality test [9]; knowledge of technology as measured by the adapted version of the Technological Familiarity Questionnaire and the Technology Cognition Questionnaire [10]; Religiosity was measured by the Revised Intrinsic/Extrinsic Religious Orientation Scale -Intrinsic, Extrinsic-Social, Extrinsic-Personal [11], and demographic characteristics assessed through self-report. The independent variables for this study are personality type as measured by the Big Five Personality test; knowledge of technology as measured by the adapted version of the Technological Familiarity Questionnaire and the Technology Cognition Questionnaire; and demographic characteristics assessed through self-report. The dependent variable included reports by participants of being a cybersecurity victim, based on their experiences and responses to 7 questions (e.g., Has your identity ever been stolen?; Has your email ever been hacked?; Has your social media ever been hacked? (Twitter, Facebook, Instagram, etc.); Has your pin or password ever been stolen?; Has your computer ever crashed? (because you clicked on email, spam, website, etc.); Have you ever fallen victim to online money scams?

2.3 Results

Significant impact of personality type, religiosity, familiarity with technology, and demographics of the minority student population, on reports of becoming a cybersecurity victim were revealed. Results of a Kruskal-Wallis and Mann-Whitney U tests indicated that high scores on conscientiousness, intellect/imagination, agreeableness, and emotional stability were associated with reports of cyber victimization (see Fig.1). The religiosity scale identifies whether the individual has an intrinsic or extrinsic religious orientation. High scores on the extrinsic religious orientation (related to how the individual experiences religiousness and perceives one's own social behavior), were associated with reports of computer crashes, whereas high scores on the intrinsic religiosity (related to personal involvement with religion) were associated with reports of compromising of pins and passwords (see Fig.2). A lower annual income (<\$15,000) was associated with significantly more reports of the pin/passwords being compromised (see Fig.3). Networking usage and expertise with technology were also significantly related to reports of being a cybersecurity victim (see Fig.4).

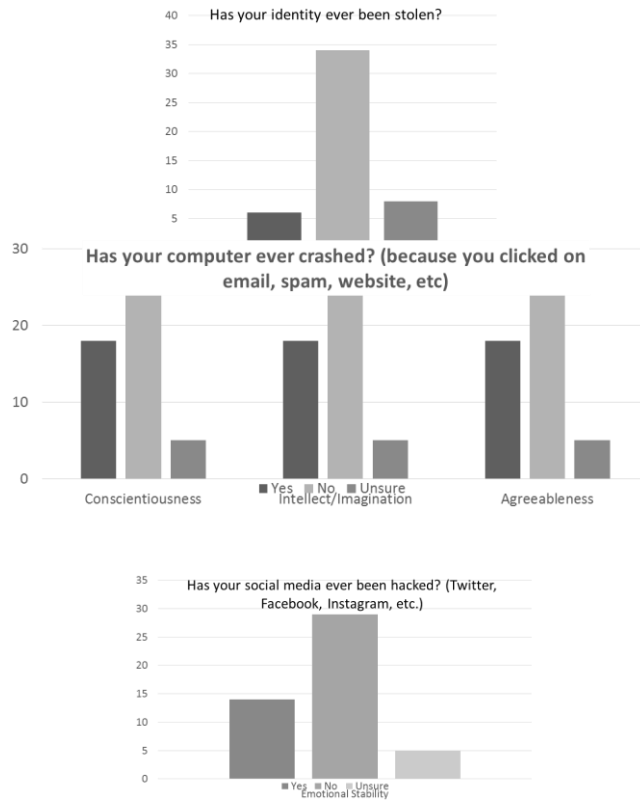


Figure 1. Type of cybersecurity victim and personality.

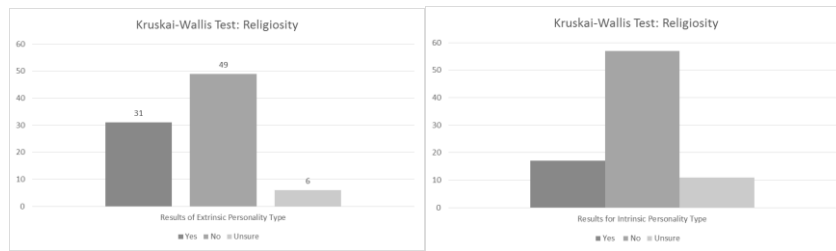


Figure 2. Cybersecurity victim and religiosity type.



Figure 3. Cybersecurity victim and income.

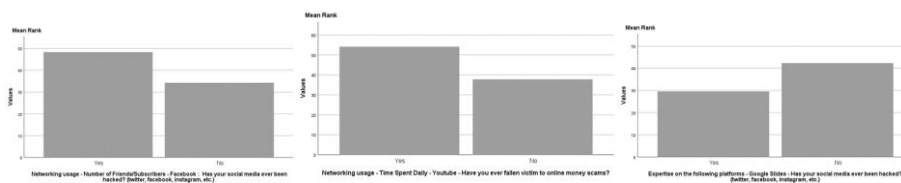


Figure 4. Cybersecurity victim and familiarity and use with technology.

3 Future Directions

Results indicated a significant impact of the psychosocial variables on reports of being a victim of cybersecurity. Past research has established a relationship between demographic variables and cybersecurity victimization. However, this study sheds a new light on these relationships in the minority population. This is a correlational study. Further studies should investigate the relationships between the psychosocial characteristics through experimental manipulation of message content. Results of this study and future results can be used for education and outreach to facilitate informed and prepared cyber-system users.

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