Volume 20, Year 2022
ISSN: 1554-8716

# Annual Review of CyberTherapy and Telemedicine

## Metaverse Creates New Opportunities in Healthcare

Editors:

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

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

http://www.arctt.info

Annual Review of CyberTherapy and Telemedicine
ISSN: 1554-8716
20

# ANNUAL REVIEW OF CYBERTHERAPY

# Annual Review of Cybertherapy and Telemedicine 2022

Metaverse Creates New Opportunities in Healthcare

Edited by

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**Annual Review of CyberTherapy and Telemedicine, Volume 20**

Annual Review of CyberTherapy and Telemedicine

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6540 Lusk Boulevard, Suite C115
San Diego, CA 92121

ISBN: 1554-8716

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Printed in the United States of America

Journal Website: http://www.arctt.info
Interactive Media Institute Website:
http://www.interactivemediainstitute.com

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Journal Web site: http://www.arctt.info

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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. 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.

Healthcare delivery systems have been evolving to rely more heavily on technology. There has been a shift in care diagnosis and treatment that 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 - 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 address 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

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# SECTION I

# EDITORIAL

This introductory text expresses the position of the editors – Brenda K. Wiederhold and Giuseppe Riva – the focus of this year's issue.

*Brenda K. Wiederhold and Giuseppe Riva*

# Metaverse Creates New Opportunities in Healthcare

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**Abstract**. The metaverse can be imagined as the immersive sequel to today's text-and-picture-based Internet where users stare at a screen, ignoring physical reality. Instead, by taking advantage of advanced technologies including artificial intelligence, AR, VR, and ever-increasing connectivity (like 5G networks), the metaverse promises online experiences that are more immersive and interactive than those of the past, a seamless merging of the physical and digital worlds. This improved relationship bodes particularly well for the role that technology can play in both physical and behavioral healthcare. Specifically, the metaverse has the potential to impact healthcare because of the convergence of three current major technological trends: (a) telepresence, (b) digital twinning, and (c) blockchain. These three concepts could come together to create entirely new means for delivering care, potentially lowering costs and vastly improving patient outcomes. Finally, while innovations in digital healthcare are to be commended for granting easier access to care for a wider range of people, it is important to consider the ethical matters that come along with them. Pervasive societal issues like discrimination, privacy violation, lack of transparency, and public safety do not disappear just because treatment has gone virtual.

**Keywords.** Metaverse, Virtual Reality, Virtual Reality Therapy, Mixed Reality, Telepresence, Mental Health, Digital Twins, Blockchain,

## 1. Introduction

When Mark Zuckerberg announced his company's name change from Facebook to Meta last year, public response varied. His proclamation was accompanied by plans to spend $10 billion over the next year on Facebook Reality Labs, which works on augmented reality (AR) and virtual reality (VR) to make "online worlds where people exist in immersive, virtual and shared spaces." [1]. His message went on to state that over the next 5 years, he intended to hire 10,000 individuals in the EU to build the metaverse [2]. What exactly was this "metaverse" he so confidently referenced? In truth, it was hard to pin down. It seemed that every article defined the term differently. But that didn't stop the word from exploding into common jargon, appearing everywhere from newspaper headlines to Instagram posts. One reason the term "metaverse" has become so omnipresent in today's lexicon is that it is a truly flexible and dynamic word that can be used to mean different things in different contexts.

The term "metaverse" first garnered notice in Neal Stephenson's 1992 cyberpunk novel *Snow Crash* [3]. Nearly thirty years later, the *Wall Street Journal* described it as "a virtual world where our digital avatars and those of people in our communities and around the globe come together to work, shop, attend classes, pursue hobbies, enjoy social gatherings and more." [4].

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The metaverse can be imagined as the immersive sequel to today's text-and-picture-based Internet where users stare at a screen, ignoring physical reality. Instead, by taking advantage of advanced technologies including artificial intelligence, AR, VR, and ever-increasing connectivity (like 5G networks), the metaverse promises online experiences that are more immersive and interactive than those of the past, a seamless merging of the physical and digital worlds [5].

The reason a solid definition of the metaverse feels so slippery is because the technology that supports it is in constant flux. When the term was coined in the early 1990s, the idea of the metaverse, then a fictional concept, borrowed heavily from existing online communities.

As the behaviors and functions of these online communities have evolved, so too has the idea of what the metaverse can be. Some imagine the metaverse as a shared, persistent digital space in which sometimes cartoon-like avatars gather in virtual rooms for meetings, commerce, and entertainment [6].

In this model the metaverse is similar to former or existing online communities like Second Life or Fortnite. Others see the metaverse as a new level added to the existing structure of the internet, allowing enhanced interaction between apps and platforms. Still others envision multiple metaverses for different purposes. In any case, it appears the only certainty about the metaverse at the moment is that its definition will change as frequently as the internet and technology change.

Because the metaverse can feel so amorphous, its success will depend in part on creating connections and communities. The group of experts surrounding the Cyberpsychology and Social Networking Conference and Journal is just such a community, one that has spent years adapting and adopting new technologies to enhance behavioral healthcare. For 25 years, the journal and the conference have given a platform for researchers to feature research at the forefront of this field.

In 2021, the conference was able to accommodate travel restrictions due to the pandemic and to pivot successfully to being a completely virtual experience, enabling participants from 22 countries to share three days of cutting-edge research that will undoubtedly contribute to shaping the metaverse and its purpose.

Regardless of the exact form the metaverse eventually takes, experts predict that, much like the introduction of the Internet or the iPhone, the metaverse will reshape most aspects of our daily lives. That includes our work, our social and romantic interactions, and even our financial transactions.

While we currently access the Internet using our smartphones and computers—devices that allow for only limited immersion—tech leaders believe that we will soon be using specialized glasses similar to the VR headsets that are currently available, but which are less bulky and more comfortable. There will also likely be a wider selection of haptic devices that allow users to actually “feel” virtual objects to help mirror the virtual world [4]. The main feature of the new metaverse, is its “interreality” [5], the fusion between the virtual world and the physical one. In practice, in the metaverse what we do in the physical world influences the experience in the virtual world and vice versa.

All of this will create an immersive online experience that is more natural allowing us to connect more effectively with our communities.

## 2. Metaverse in Health Care

Though certain elements of the metaverse already exist, current online worlds are expected to advance rapidly, expanding not only to mirror the real world, but also to permeate it. Rather than acting as a parallel to the physical world with a rigid set of rules, the metaverse will become part of the “next pattern of computing.” [7]. Experts predict that it will be more intuitive than current computing systems. A simple example: rather than sifting through drives and folders to find a document, attach it to an email, and then send it to a co-worker, a user could instead be able to flip through stacks of papers on a virtual desk, pick a document up, and hand it directly to their co-worker’s avatar for review.

Futurists also predict that devices used to access the metaverse will shift toward being worn rather than carried, and spoken to rather than typed on. Overall, they will

integrate into our physical world in ways that create users who are more present than distracted [7]. All of this instinctive and familiar interaction should help overcome the friction that currently stands in the way of digital interaction feeling natural, enhancing the relationship between human and machine.

This improved relationship bodes particularly well for the role that technology can play in both physical and behavioral healthcare. And as many of the world's largest tech companies are racing Zuckerberg to leap into the metaverse (analysts believe that between 5% and 20% of tech giants' R&D spending goes towards "frontier technologies" including the metaverse [7]), another area of exponential growth is the healthcare industry. A recent report found that due to COVID-19, health expenditures in 2020 alone grew at the fastest rate experienced in the past two decades [9].

And the association does not end with money. According to futurist Bernard Marr, the metaverse has the potential to impact healthcare because of the convergence of three current major technological trends: (a) telepresence, (b) digital twinning, and (c) blockchain [10]. These three concepts could come together to create entirely new means for delivering care, potentially lowering costs and vastly improving patient outcomes.

The attitude toward telepresence, using technology to "be together" virtually even while apart physically, has soared recently, largely because of the pandemic. More than 70% of consumers who had never tried digital and virtual programs to access healthcare before the pandemic now express willingness to use it, and consumers between the ages of 18 and 24 are now three-times as likely to use emerging virtual and digital mental health tools [9]. The pandemic has forever changed consumer perception and behavior when it comes to accessing care, creating a population that is more open to receiving their health care at home. What is more, healthcare providers have taken note of this trend, expanding their services to include virtual options. Before 2020, just 43% of healthcare facilities had the ability to provide remote treatment to patients. In early 2022, that figure skyrocketed to 95% [10]. Currently, the vast majority of healthcare providers have developed the ability to treat patients from afar.

One key technology that can be used to enhance the experience of telepresence is VR. VR can allow both patients and their providers to interact just as they would in person.

In fact, VR can be considered a transformative technology, capable of modifying what people think reality is. To achieve this goal, the technologies of the metaverse hack different key cognitive mechanisms [5]: the experience of being in a place and in a body, the processes of brain-to-brain attunement and synchrony, and the ability of experiencing and inducing emotions. In this view, the sense of presence is generated by the VR's ability to predict how the mind simulates reality and to generate digital content that is consistent with these predictions. The more correct the prediction, the more the subject will feel present in the virtual environment they are experiencing, even though they know that the environment is not real [12].

This is an exciting concept for behavioral health especially. Decades of research has shown that for many patients, lasting change happens when they are able to confront the situations that cause them distress and learn how to cope with them constructively with the help of a therapist [11]. The use of advanced technologies like VR can enhance presence, making this type of treatment especially effective and convenient.

A second tech trend, digital twinning, refers to creating "a virtual model, or simulation, of any object, process, or system, generated using real-world data, for the purpose of learning more about its real-world counterpart." [10]. Digital twins in healthcare could be a version of a patient's classroom or office, or even a visual reproduction of patients themselves. In the metaverse, there is the opportunity for healthcare providers to truly accompany patients into specific individualized environments, thus enhancing the efficacy of treatment.

Finally, the advent of blockchain ("distributed and encrypted databases that allow data to be stored and transferred securely in a way that no one except the data owner can tamper with") [10] can help with concerns about privacy, ethics, and safety as healthcare moves online. Unlike paper records, faxes, or transfer via unsecured email or online portals, blockchain would allow patients to own their medical records on a secure personal file. While blockchain is said to be unhackable, it is also simple to give

consent to any clinician anywhere in the world to review the records with the click of a button.

The metaverse, with its capabilities for immersion, customization, and security, has an important role to play in the future of healthcare. With individualized, predictive, and empathetic engagement models, technology can help provide hyper-personalized data-driven care that could lead to earlier identification of conditions and customized interventions that lead to better patient outcomes [9].

## 3. Conclusions

Of course, our voyage into the metaverse may not be completely smooth sailing. As is the case when venturing into any new frontier, there are bound to be some choppy seas. Though public attitude toward advanced technologies has definitely improved, especially due to lifestyle changes forced by the pandemic, there is still some discomfort surrounding the use of that technology, especially for older adults. A 2021 survey found that 83% of adults 55 and over own a smartphone, 66% own laptops and 58% own tablets. However, another survey over the same time period indicated that more than half of Americans over age 65 and two-thirds of adults over age 75 have little confidence in their ability to set up and use their digital devices [13].

Furthermore, because, as mentioned earlier, technology is constantly changing, even those who are comfortable with such devices often face a steep learning curve as each new model is released. As the metaverse begins to play an increasingly important role in all aspects of our lives, some familiarity with technology will be required to allow all users to successfully navigate activities of daily living. Accordingly, it will be important to develop supports for those who need them, assisting people in navigating this new frontier.

Beyond user-related issues, not all of the technology necessary to create a fully functioning metaverse is currently up to the job. For the metaverse to truly replicate the real world, there will need to be significant upgrades to existing computer systems and other technology. Though some of the necessary technologies have been around for years, other elements (such as fast wireless links, cloud computing, 5G, and AI) have only recently come into their own. Beyond that, even when sufficient tech does exist, these new advanced technologies will need to become more affordable and widely accessible in order for the metaverse to achieve its potential.

Finally, while innovations in digital healthcare are to be commended for granting easier access to care for a wider range of people, it is important to consider the ethical matters that come along with them. Pervasive societal issues like discrimination, privacy violation, lack of transparency, and public safety do not disappear just because treatment has gone virtual. In fact, in some cases, these concerns may be exacerbated as activities move online. For example, the anonymous counseling employed by some web-based platforms calls to question whether at-risk patients would properly receive emergency care should they need it. In addition, there have been several major breaches in online security and patient privacy in the past. And while the potential for home-based healthcare is promising, we must also ensure that technology continues to become more affordable, apps are adequately vetted, and providers are competently trained. As the metaverse takes shape, it will be essential for providers, users, and legislators alike to cooperate to create a virtual space that safely engages users worldwide.

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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 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, 2009*

# Where do we stand? An overview of reviews regarding the current status of virtual reality applications in alcohol use disorder

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**Abstract.** The current overview of reviews aims to evaluate the progress of VR use in AUD, emphasizing its present status in terms of assessment and treatment applications. *Methods*. The literature search was conducted using terms like "virtual reality" and "alcohol", "substance", "addiction", or "addictive" on databases such as Web of Science, Embase, PubMed, and the Cochrane Library. *Results*. Seven narrative and systematic reviews published between 2014 and 2021 were identified as targeting the use of VR in addictive behaviors including AUD. In total, 33 studies targeted the use of the VR technology in AUD, although 18 studies were duplicated in the reviews. Overall, the two main applications of VR in AUD were: 1) *assessment* (mainly using VR-based cue-exposure paradigm targeting craving elicitation during exposure to alcohol-related cues and contexts), and 2) *treatment* [generally VR-cue exposure therapy (VR-CET) to reduce responses (e.g. craving) to alcohol-related cues and contexts]. In all studies, VR was successfully implemented as an assessment or treatment approach (and outweighed control conditions). *Discussion*. The reviews emphasize that VR is an ecologically valid instrument in AUD and is a better alternative to traditional cue-exposure techniques due to its technical features. Limitations and future research directions regarding the use of VR in AUD are discussed.

**Keywords.** Virtual Reality, Alcohol Use Disorder, Overview, Reviews

## 1. Introduction

For the past two decades, Virtual Reality (VR) applications have increased exponentially in the field of mental health. Despite its wide acknowledgment in the treatment of *anxiety disorders* (e.g. phobias) *or trauma and stress-related disorders* (e.g. post-traumatic stress disorder, PTSD), there is still much research needed to determine the clinical potential of VR in alcohol use disorder (AUD) [1,2]. The current *overview of reviews* aims to evaluate the progress of VR use in AUD, emphasizing its present status in terms of clinical applications, limitations, and future research directions. This overview intends to examine the highest level of empirical evidence regarding the implementation of VR technology in the assessment and treatment of AUD.

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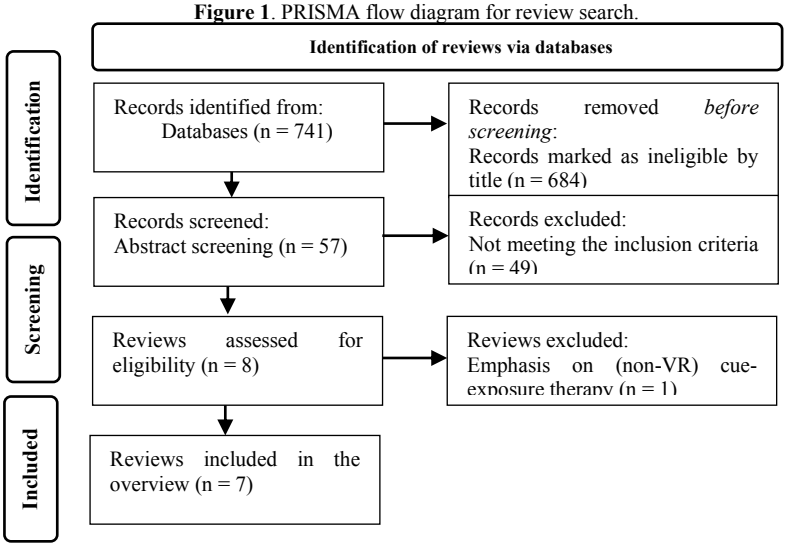
## 2. Methods

The literature search was conducted using pairing terms like "virtual reality" and "alcohol", "addiction", "substance" or "addictive" (addictive behaviors) on databases such as Web of Science, Embase, PubMed, and the Cochrane Library. Inclusion criteria consisted of publications targeting the clinical applications of VR in AUD (e.g. assessment, treatment), systematic and narrative reviews, meta-analyses, and overall syntheses reported in English.. Regardless of the target of the manuscripts (e.g. applications of VR in all substance use disorders, SUD), only studies emphasizing the use of VR in AUD were depicted in this overview. Studies from the same reviews focused on the use of VR in other alcohol-related patterns like light drinking, heavy drinking, or binge drinking were not considered in this overview. PRISMA guidelines were followed for data search and reporting (Figure 1) [3].

## 3. Results

Seven reviews (two narrative and five systematic reviews) published between 2014 and 2021 included studies targeting the applications of VR in AUD alongside other SUDs (e.g. nicotine) and behavioral addictions (e.g. gambling) [1-2,4-8]. To date, no meta-analyses have been published on this topic due to limited existing research. In addition, only one narrative review was solely focused on this topic (VR use in the treatment of AUD), although the review included studies with non-clinical and sub-clinical samples (e.g. light and heavy drinking, binge drinking, nicotine-dependent problematic drinking patterns) [4]. Of the total studies included in the seven reviews, 12 studies targeted *VR-based assessment* in AUD (of which seven studies were duplicated), and 21 studies targeted *VR-based treatment* for AUD [mainly virtual reality cue-exposure therapy, (VR-CET), of which 11 studies were duplicated]. In total, there are currently five original studies in the literature regarding the use of VR as an assessment instrument, and 10 original studies using VR as a treatment instrument in AUD. In terms of the main addressed mechanisms, *alcohol craving* was the core component of VR assessment and treatment in all AUD studies reported in the reviews. Other mechanisms like anxiety, social, personality, and behavioral features of AUD, self-efficacy and motivation for change, as well as coping skills were addressed. In the reviews [1-2,4-8], VR applications were mainly based on the principles of *cue-exposure technique*, implying exposure to virtual alcohol-related cues and contexts (e.g. alcoholic beverages, alcohol-related environments like pubs). The participants in the studies were AUD individuals (versus healthy participants) ranging from members of Alcoholics Anonymous (AA), treatment seekers, and non-treatment seekers. Regarding the clinical samples, there was inconsistent data in two systematic reviews referring to one manuscript [9], in which participants were reported as "alcohol dependent" [5] versus non-AUD individuals [2]. Nevertheless, the authors in the original manuscript reported participants as individuals "with no history of alcohol-related disease" [9]. Considering the objectives and the

**Figure 1**. PRISMA flow diagram for review search.



inclusion criteria in the current overview, the study [9] was not considered in the systematic review by Ghiţă and Gutiérrez-Maldonado as the sample consisted of non-AUD participants [2].

The VR technology implied hardware like head-mounted displays (HMDs),- interactive computer programs (based on drinking patterns in countries where the studies were conducted, e.g. South Korea, United States, Spain). In several reviews, the type of VR equipment was highlighted, whereas other reviews did not put emphasis on it (see Table 1).

Regarding the outcomes of the reviews, VR was successful in inducing significant levels of alcohol craving and assessing different AUD features (e.g. self-efficacy, personality or social factors). The data was consistent across different studies conducted in several countries with varied VR equipment. Regarding VR treatment, interventions were based on several *VR-CET sessions* (e.g. eight or 10 sessions), *training* through *games* and tasks such as *VR-based approach-avoidance programs* for AUD participants. The control conditions reported in the reviews were healthy participants (non-AUD), treatment as usual (TAU), or cognitive-behavioral therapy (CBT). The data indicated that VR-based interventions were superior to control conditions as depicted by self-reported instruments (paper-and-pencil or visual analog scales, VAS, which were embedded during the VR exposure procedures to explore momentary levels of alcohol craving for instance) and (neuro)physiological instruments (Table 1). However, despite its promising results, there are several limitations emphasized in the reviews: a) studies included small sample sizes (only one study included a large sample size), b) none of the reviews highlighted rigorously conducted randomized controlled trials following the CONSORT guidelines, and c) a lack of follow-up data of the participants (none of the reviews reported longitudinal data).

**Table 1.** Evidence of narrative and systematic reviews.

| Article (by year of publication) | Type of review | Aims (N*/N**) | Primarily addressed mechanisms | Population characteristics | VR equipment | Outcomes |
|---|---|---|---|---|---|---|
| Hone-Blanchet et al. (2014) | SR | Assessment: 3*<br>Treatment: 1* | Alcohol craving | AUD vs. healthy participants; Non-treatment seeking AUD individuals; | Interactive computer programme and HMD | VR assessment – successful elicitation of alcohol craving in alcohol-related VR environments vs. neutral VR environments; VR treatment – VR-CET outweighed CBT in AUD (a significant decrease in craving was obtained) |
| Durl et al. (2018) | SR | Assessment: 1**<br>Treatment: 1** | Alcohol craving | AUD individuals; AA members; | Interactive computer programme and HMD | *Similar outcomes as reported by Hone-Blanchet et al. (2014)* |
| Ghiţă and Gutiérrez-Maldonado (2018) | SR | Assessment: 2* + 2**<br>Treatment: 4* + 1** | Alcohol craving; social, personality and behavioral AUD; Self-efficacy and motivation for change; Coping skills | AUD vs. healthy participants; Non-treatment seeking AUD individuals; AA members | Interactive computer program and HDM | Consistent results among different studies regarding the applications of as an assessment and treatment instrument to either elicit or to decrease levels of alcohol craving as part of VR-CET [data were supported by self-reported instruments (e.g. paper-and-pencil instruments), but also other measurements (e.g. EEG and PET-CT)];<br>***Inconsistent data with the review by Hone-Blanchet et al. (2014) |
| Trahan et al. (2019) | SR | Treatment: 1** | Alcohol craving | AUD participants | N/A | VR-CET outweighed CBT; alcohol craving was significantly reduced (as recorded by EEG alpha and self-reports) |
| Segawa et al. | SR | Assessment: | Alcohol craving | AUD | HMD | *Similar outcomes with reviews* |

| | | | | | | |
|---|---|---|---|---|---|---|
| (2020) | | 1**<br>Treatment: 1** | | participants; Healthy participants | | *by Ghiţă and Gutiérrez-Maldonado (2018) and Hone-Blanchet et al. (2014)* |
| Lebiecka et al. (2021) | NR | Assessment: 2**<br>Treatment: 2* + 2** | Alcohol craving<br>Anxiety | AUD<br>N/A | N/A | Summary of existing studies as reported in previous systematic reviews (Segawa et al., 2020; Ghiţă and Gutiérrez-Maldonado, 2018 and Hone-Blanchet et al., 2014) |
| Tsamitros et al. (2021) | NR | Assessment: 1**<br>Treatment: 3* +5** | Alcohol craving | AUD participants | N/A | VR interventions (VR-CET/VR games/VR approach-avoidance training) were superior to control conditions |

AA – Alcoholics Anonymous; AUD – alcohol use disorder; EEG – electroencephalogram; HMD – head-mounted display; N/A – not available/mentioned; NR – narrative review; PET-CT - Positron Emission Tomography and Computed Tomography; SR – systematic review; VR-CET – virtual reality cue-exposure therapy; *N - AUD studies included in the reviews excepting studies targeting other substances; N** - duplicated AUD studies (studies reported in previously published reviews); ***The inconsistent data refers to the manuscript by Cho et al. (2008) [9], in which participants were reported as AUD (in Hone-Blanchet et al., 2014) [5] versus non-AUD individuals (in Ghiţă and Gutiérrez-Maldonado, 2018) [2].

## 4. Discussion

Regarding its *assets*, VR technology has been successfully implemented as an assessment and treatment instrument in AUD with an emphasis on alcohol craving, regardless of the AUD population (AA, treatment seekers vs. non-treatment seekers). The reviews underline that VR is an ecologically valid instrument in AUD and is a better alternative to traditional cue-exposure techniques due to its technical features (e.g. sensory inputs, immersion). Future larger-scale randomized controlled trials, including follow-up data of the participants, are fundamental to determine the efficacy and effectiveness of VR applications in AUD [2]. *Cybersickness*, *user experience*, the *sense of presence* during VR exposure, *perceived realism* of the VR cues and environments, and *patient-reported outcomes* are significant key aspects for further research. In addition, the added value of implementing other therapeutic approaches (e.g. coping skills training) alongside VR-CET should also be considered [1]. Another research opportunity is to examine the potential of VR-CET as a continuing care tool in AUD for relapse prevention. As technologies progress rapidly, adding other instruments (e.g. eye-tracking within HMDs or the use of wearables during the exposure protocol) may determine further insights about the AUD mechanisms. Although challenging, exploring the generalization of VR-based intervention effects in daily-life situations is essential in AUD. One common recommendation in all reviews was to accelerate research regarding the use of VR, particularly in the treatment of AUD [1-2,4-8]. Therefore, despite its promising clinical potential, it is still premature to draw solid conclusions about the efficacy and effectiveness of VR use in AUD considering the insufficient research and limitations depicted in seven reviews.

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# Biofeedback interventions using immersive virtual natural environment: A scoping review

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**Abstract.** This work presents a scoping review of psychological interventions where biofeedback is enhanced by immersive natural Virtual Reality scenarios. Our target is to describe the biofeedback implementations in which the physiological feedback to the user is embedded in the design of the virtual environment. We focus specifically on the studies leveraging natural environment scenarios, as these are proven to enhance the sense of presence in the user. After a thorough screening of search results, we selected 16 articles fulfilling these desired criteria.

**Keywords.** Biofeedback, Immersive Virtual Reality, Natural Environment, Attention Restoration Theory.

## 1. Introduction

The growth and improvement of Virtual Reality technology (VR) offers new possibilities for psychological interventions.

The VR experience needs to be felt real, giving the user a Sense of Presence (SoP): the "feeling of being in a world that exists outside of the self" [1]. According to Attention Restoration Theory, an experience, defined as restorative, typically provides a feeling of being away, triggers fascination, and is coherent with itself and the observer's end goals. A restorative experience also allows the mind to rest, improving concentration and relieving mental fatigue and stress, and is furthered by exposure to natural environments [2,3,4].

Biofeedback (BF) is the application of biosensors and electronic devices, used in healthcare since the late 1950s, to monitor and visualize physiological reaction in order to improve the perception of control over it and developing new possible ways of self-regulation.

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Its applications range from clinical rehabilitation to positive psychology [5,6,7], and it is made possible by giving the user a video/audio feedback directly linked to their internal activation. Improvement in technology also allows for increasingly complex feedback, even with the implementation of immersive VR, Here we analyze how VR can relate with Biofeedback (BF) applications, especially when immersive natural environments are implemented.

## 2. Method and Tools

We conducted a review of the literature regarding biofeedback or neurofeedback and VR available on several databases. Search strategy – We queried the PsycINFO, Web of Science, and PubMed databases with the query: biofeedback OR neurofeedback OR "neuro feedback" AND virtual reality OR tecnolog*, which yielded as of 22/02/2021, 325 hits on Web Of Science, 373 on PubMed, and 109 on PsycInfo for a total of 626 non-duplicated articles.

Screening flow – Results were screened to fit the following criteria: a) works published in English, b) using BF, and c) using psychological correlates, discarding articles about physical therapy and rehabilitation, or using physiological measures only or Brain-Computer Interface. After applying these criteria to titles and abstracts, articles were reduced to 231.

Full texts of the corpus were filtered with the same criteria, and further analysis selected studies with deep VR immersion and physiological feedback embedded in the scenario. Results - From these eligible articles, we included in this work the 16 biofeedback studies leveraging a high immersivity natural environment.

## 3. Results

Table 1 lists the articles fulfilling the requested characteristics. The use of natural environments is described in multiple modalities, both with clinical and non-clinical subjects, often with similar aims, such as the enhancement of SoP and relaxation.

Four studies are focused on healthy participants: the first analyzes the perceived restorativeness and the sense of presence of a forest environment after a stress induction [3], and the second values the effectiveness of a Heart Rate Variability (HRV) BF based on slow-paced breathing in a virtual beach scenery at sunset, following the characteristics of Attention Restoration Theory [4]. The third study incentives breathing awareness and promotes slow, diaphragmatic breathing in an abstract natural environment [8] while the fourth tests how novice users react to HRV BF in VR compared to a traditional implementation of HRV BF [2].

Five studies are part of the INTREPID Project, a clinical treatment for generalized anxiety disorder where therapists can choose among different scenarios set on an island [1,5,9,10,11]. Another tropical beach scenario is used during cognitive behavioral therapy (CBT) for guided imagery to train adolescents suffering from tension-type headaches to achieve relaxation [6] and during a short protocol against disorders related to higher arousal, such as anxiety disorders and hypertension [7].

Another article describes a treatment for chronic pain in which subjects learn to achieve a stable meditative practice while walking through a VR forest [12].

Two projects focus on stress: INTERSTRESS assesses and treats stress, having both scenarios for stress exposure and various natural environments for relaxation [13], while Stressjam trains both healthy participants and patients dealing with stress to modify their level of stress (raising or lowering it) to overcome obstacles in a complex scenario on a tropical island [14].

Finally, two articles describe VR biofeedback for impulse management: in DEEP, the aim is to reduce anxiety and destructive classroom behavior in clinical adolescents wherein subjects are in an underwater fantasy world [15], while Playermancer teaches relaxation skills, self-control, and emotional regulation in an archipelago of islands, each with different scenarios and activities [16].

**Table 1.** Articles included in the review with details of VR environment, kind of biofeedback, and aim of the study

| Article | VR environment | Biofeedback | Aim |
|---|---|---|---|
| Rockstroh et al., 2020 [3] | Forest environment with different weather conditions from clear sky, sunshine, and bird chirps to clouded sky, rain, and wind sounds | Electrodermal activity (GSR) | Analysis, after a stress induction, of the perceived restorativeness and the SoP of a forest environment where changes in weather and soundscape give the feedback of electrodermal activity (GSR) |
| Blum et al., 2019 [4] | Beach scenery at sunset designed following the Attention Restoration Theory. The sky moves from cloudy to a clear and star-spangled sky. The lamps and a campfire can be lit or not | HRV-BF based on slow-paced breathing | HRV-BF based on slow-paced breathing training for the purpose of improving relaxation, relaxation self-efficacy, focusing on the moment, conservation of attentional resources, and reduction of mind wandering |
| Blum et al., 2020 [8] | Stylized natural landscape with hills, rocks, flowers and swaying trees with some of the elements changing their color | Breathing BF (recording the respiration-induced abdominal movements through positionally tracked hand controllers) | Increasing breathing awareness and promotion of slow diaphragmatic breathing in an abstract natural environment with a less conventional breathing BF (cost-effective, easy to use, and fairly unobtrusive)<br>Some elements change their color with each exhalation |
| Rockstroh et al,, 2019 [2] | Same virtual beach sunset scenery as Blum et al., 2019 [4] | HRV-BF through deep diaphragmatic breathing | Test how novice users react to HRV-BF in VR compared to a traditional HRV-BF, to reach and maintain a heart coherence through deep diaphragmatic breathing |
| EU-funded research INTREPID: Riva et al., 2009 [1], Repetto et al., 2009 [9], Repetto et al., 2013 [10], Pallavicini et al., 2009 [5], Gorini et al., 2010 [11] | Immersive VR is used in the Inpatient Scenario<br>Different scenarios set on an island where physiological parameters control elements like waves, clouds, a campfire, and waterfall<br>It also populated the interface with clinical targets, words or objects [1, 9] | Inpatient and Scenario: GSR, heart rate (HR), Thermal and Electromyography (EMG) BF | Clinical treatment for generalized anxiety disorder developed through VR (to be used with therapist - Inpatient Scenario) and mobile application (for independent use - Outpatient Scenario) for both relaxation and controlled exposure. Therapists can pick the scenarios. Riva [1] also compared the effectiveness of interventions with/without VR, while phase-2 controlled clinical trials compare the VR + mobile applications with/without BF [10, 5, 11] |
| Fominykh et al., 2017 [6] | Sandy beach surrounded by a tropical forest, a shoreline with some rocks and waves, the sky and some clouds; the height of the waves increases with HR as the sky becomes darker and a wind sound is added | HR BF | The goal of the exercise is to make the sea as “calm” as possible, where the threshold value for a “calm” sea is adjusted/calculated individually from the baseline heart rate value. It is used with guided imagery and HR sensor BF to train adolescents suffering from tension-type headaches to relax |
| Morganti et al., 2016 [7] | A wood with a bonfire, the size of the flame is variable | Breathing frequency and HR BF | Clinical application, evaluating the efficacy of a short protocol against higher arousal-related disorders such as anxiety disorders and hypertension; the scenario of a fire (growing with the subject’s activation) in a wood is used during four BF sessions |
| Gromala et al., 2015 [12] | Patients walk through a deciduous forest with undergrowth. A light fog recedes or thickens and draws closer | GSR BF | Mindfulness-based stress reduction intervention to treat chronic pain; the subjects learn to achieve a stable meditative practice to control the physiological activation while |

| | | | |
|---|---|---|---|
| | depending on the GSR activity | | walking through a VR forest in which GSR modifies the weather and the thickness of the fog |
| INTERSTRESS project Pallavicini et al., 2013 [13] | Various relaxation environments: beach, lake, campfire, mountain summit, and desert. The scenarios for stress exposure are not natural settings but working scenarios linked to the population tested (teachers) | HR and HRV-BF | A solution for the diagnosis and the treatment of psychological stress. The treatment is based on CBT combined with VR, HR, and HRV biofeedback, presenting both scenarios for stress exposure and relaxation |
| STRESSJAM Maarsingh et al., 2019 [14] | Video game with different levels and obstacles to be overcome, set in a tropical island | HRV-BF | The user has to overcome various challenges by modifying his stress activation. This is the only study which leverages the conscious rise of stress level and not just relaxation.<br>It is tested both in healthy and in clinical populations |
| DEEP Bossenbroek et al., 2020 [15] | Video game without specific goals except for exploring an underwater fantasy world.<br>Players receive feedback about their breathing through a circle in the middle of the visual field and by elements in the environment which change in color, size, or movement | Respiratory BF through diaphragmatic breathing | VR BF for impulse management; the aim is to reduce anxiety and destructive classroom behavior and daily levels of state-anxiety in adolescents with behavioral and psychiatric problems. Moving in an underwater fantasy world becomes easier with slower and deeper breathing |
| Playermancer Fernández-Aranda et al., 2012 [16] | Islands of an archipelago; each island has different activities and objectives.<br>The face of Cronos: a climbing path up a cliff wherein player avoids obstacles produced by emotions.<br>Treasures of the sea: the player swims under water gathering artifacts and balloon fish (difficulty is related to emotions).<br>Sign of the Magupta: a constellation of stars is drawn up in relation to the relaxation level | GSR, oxygen saturation, HR, HR variation, skin temperature and breathing frequency BF, plus emotion recognition system through facial gestures and speech | 2D video game (the only one not used with a VR headset but still complex enough to be included) for patients with impulse-related disorders. Teaches relaxation skills, self-control, and emotional regulation. The scenario is an archipelago; each island has different activities, and quests get more difficult with higher undesired emotional and/or physiological reactions |

## 4. Discussion and conclusion

Our scoping review suggested that the use of BF inside an immersive VR scenario is possible, functional, and already implemented in multiple studies with varying virtual environments. Our focus on natural environments showed that they are mainly used for enhancing relaxation, but are also occasionally used for more complex interventions.

The most used physiological correlates are extracted from ECG (HR and HRV), GSR, and respiration. The context of use ranged from guided imagery therapy to autonomous use, often targeting the stimulation of heart coherence and deep diaphragmatic breathing.

The majority of the studies target clinical populations for which VR BF seems to currently be the main field of application. Nevertheless, the few implementations aimed at healthy people posit an interesting reflection about the feasibility of applications directed to improve well-being and quality of life.

In conclusion, the employment of immersive VR scenarios with embedded BF seems promising and is already in use. A decrease in production costs for both VR systems and BF machinery will likely lead to wider utilization and more complex scenarios.

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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 cy-bertherapy need to give significant attention to clinical issues, technology, ergonomics, hu-man factors, and organizational changes in the structure of the relevant health service.

*Wiederhold & Riva, 2004*

# The relationship between computer-game-type preference and personality traits, moral foundations, and self-regulation among young adults

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**Abstract.** With the growing popularity of computer games and the rapid development of this industry, it seems critical to have an up-to-date classification of computer-game types that won't grow old as quickly as the genre-typed did. This study investigates the relationship between computer-game-type preference and personality traits in the context of O. A. Popov's classification of computer games. Split into two dimensions: in having a playable character and an ability to make moral choices, young adults show numerous significant differences in levels of computer-game addiction, personality traits, self-regulation, and moralities. People preferring-existing-of-playable-character-or-characters-games appear to be more introverted, having problems with self-regulation, and having weaker moral foundations while being more open to new experiences. Preferring-to-have-moral-choices and haven't-decided-on-moral-choices show the same observation with the addition of less agreeableness and exception of moral foundations. Moreover, haven't-decided-on-moral-choices appear to be more greed-avoiding than preferring-not-to-have-moral-choices.

**Keywords.** Computer Games, Personality Traits, Early Adulthood, Moral Foundations

## 1. Introduction

Throughout the last quarter of the century, computer games have become increasingly popular, especially among young people. The rapid development of the industry makes creating a timeless classification of computer games challenging for researchers. Traditionally, computer games are split up the same way as books - by genres, for example, as is done in the classification by J. C. Wright [1]: educational, sports, sensorimotor simulators, other vehicular simulators, strategy games, and "other." However, it is acknowledged by authors [2] that nowadays the genres overlap. Also, the complexity of modern games' gameplay makes the genre assignment process arbitrary. In these conditions, the classification presented by O.A. Popov seems substantially more resistant to aging than the traditional one. This classification (loosely based on the theory of games by R. Caillois) uses two bases: the ability to make moral choices in the game and the existence of playable character(s), thus making the division of games from each other clear.

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Previous researchers claimed that personality traits significantly contribute to game preference, but most researchers focus on global personal factors such as gender and age, with accidental character traits.

Computer games are often described as young males' activity, with females preferring more gentle games. With regard to personality traits, Hungarian researchers say that schoolchildren who prefer casual games are more friendly and more organized. Also, they are more open to experience [6, 7]. American and Australian authors found some positive relations between dancing games and both extraversion and agreeableness, while MMOGs and strategy games show negative correlations. But other results are controversial: while there are negative relations to be found between conscientiousness and preferring first-person shooters among young adults, others say that fighting games are positively related to this character trait. Also, the relations of openness to experience to personality traits is questionable [8, 9].

Our study aims to investigate relationships between personality traits and computer-game-type preferences in the context of the unwonted classification.

## 2. Methods

For collecting data, we have put numerous ads in different groups of social networks and computer-game-related resources. In ads, we asked people to volunteer as participants in return for getting individual results and recommendations. Participants filled out a questionnaire in a specially written Internet form. The test battery included the Chen Internet Addiction Scale, a modified version of the computer-game engagement questionnaire for teens by A.V. Grishina, the HEXACO-60, the MFQ30, the self-regulation aptitude questionnaire by N.M. Pejsahov, as well as custom-made questions about gaming activity that included questions about preferred games, time spent playing, and frequency of game sessions.

Since the internet and computer-games addictions are overlapping concepts, we used both The Chen Internet Addiction Scale (as a sign of addiction to MMOGs as well as non-gaming activities) and the computer-game engagement questionnaire for teens by A.V. Grishina which we modified for use on adults to see whether there is a difference in levels of addiction. Both of these tests have proven to have high data consistency. CIAS measures addiction through compulsive symptoms, tolerance symptoms, withdrawal symptoms, interpersonal and health problems, and time management problems. Grishina's test follows a similar design with scales including the force of attraction, self-regulation, fervor, concern of ambiance, and preferred type of communication.

The game-type-preference questions were ranking GIF images that showed crucial points of gameplay. We strived to minimize possible distortions of choosing. In order to do so, we made the color schemes inside of each question the same, and the order of presentation for game types differed from question to question. We set the preferred type as the one that gained the highest rank in the sum of all questions.

The other tests were for investigating personality traits.

HEXACO-60 is a questionnaire for dimensions of personality. Having almost the same structure model as the Big Five Personality Inventory, HEXACO-60 provides the 6th dimension called Honesty-Humility. Honesty-Humility measures individual differences in people’s sincerity, fairness, greed avoidance, and modesty. In the context of Povov's classification, the capacity to track down morality seemed to be critical. For that reason, we also used MFQ30 (Moral Foundations Questionnaire), designed to assess the degree to which people prioritize five foundational domains in moral decision-making: care, fairness, loyalty, authority, and purity. And the last one is the self-regulation aptitude questionnaire by N.M. Pejsahov that measures eight scales of self-regulation: analysis of contradictions, prognostics, goal definition, planning, criteria for assessing the quality, decision-making, self-control, and correction.

## 3. Results

The sample consisted of 112 young adults (51 males and 61 females), between 18 and 30 years of age (M = 25, 4). All respondents confirmed that they have playing-computer-games experience.

In general, respondents show no signs of Internet or game addictions – the levels are moderate with M = 49, 7 for CIAS scores and M = 15, 7 for Grishina's test scores, being closer to the border of no-addiction than severe addiction, while spending around 3 hours per day on computer games. 14.3% of them had severe symptoms of Internet addiction and 12.5% of computer game one.

Gamers were split twice according to two dimensions of classification: preferring-existing-of-playable-character-or-characters-games (n = 71) or preferring-not-existing (n = 36), and preferring-not-to-have-moral-choices (n = 30), haven't-decided (n = 16), or preferring-not-to-have-moral-choices (n = 15).

### *3.1. Existing-of-playable-character(s) dimension*

ANOVA has shown the impact of game-type preference on scores of different scales. In the general sample, people preferring existing-of-playable-character(s)-games show more signs of addictions. They have more time management problems (M = 9,68, M = 8,08, p <0,01), and they are more engaged in computer games in general (M = 13,0, M = 17,1, p <0,01) as well as on numerous sub-levels: the force of attraction (M = 12,2, M = 9,56, p <0,01), self-regulation (M = 25,6, M = 19,59, p <0,01), the concern of ambiance (M = 3,08, M = 2,67, p <0,01), and fervor (M = 10,44, M = 7,89, p <0,01). The distribution of the "fervor" scale wasn't normal, so we used the Mann–Whitney U-test to verify the differences and the results were the same (U = 807, p <0,01).

In terms of personality traits, people preferring games with existing-of-playable-character(s) are more open to new experiences (M = 3,25, M = 3,61, p <0,01), with scales of aesthetic appreciation (M = 3,04, M = 3,65, p <0,01) and creativity (M = 3,17, M = 3,67, p <0,01) providing this result. They are less extraverted (M = 2,97, M = 2,59, p <0,05) with sociability (M = 3,15, M = 2,52, p <0,01) and liveliness (M = 3,14, M = 2,62, p <0,05) scales making the contribution. They're more fearful (M = 2,75, M = 3,11, p <0,05) and less forgiving (M = 3,08, M = 2,64, p <0,05). They also have weaker in-group/loyalty (M = 14,13, M = 16,9, p <0,01), purity/sanctity (M = 13,74, M = 15,67, p <0,01), and authority/respect (M = 13,3 M = 15,39, p <0,05) moral foundations, and have struggles with self-regulation when it comes to the ability to collect data about implementing plans in substantial communication (M = 3,52, M = 4,14, p <0,05).

For females, the results are quite the same with those preferring existing-of-playable-character-or-characters-games being more emotionally attracted to computer games (M = 8,4, M = 12,8, p <0,01), having issues with self-regulation (M = 16,9, M = 26,0, p <0,01) and having more fervor towards computer games (M = 6,2, M = 10,7, p <0,01) as well as a higher total level of computer game addiction (M = 11,1, M = 17,4, p <0,01). The level of addiction is moderate for both groups. Preferring existing-of-playable-character-or-characters-games women were less social (M = 3,3, M = 2,49, p <0,01) and had a lower sense of optimism (M = 3,30, M = 2,44, p <0,01), thus being more introverted (M = 3,05, M = 2,4, p <0,01). They are less forgiving (M = 3,35, M = 2,51, p <0,01) and more fearful (M = 2,8, M = 3,48, p <0,01), but more open to experience (M = 3,23, M = 3,7, p <0,01) while having a better appreciation of various art forms (M = 3,2, M = 3,85, p <0,05) and being more creative (M = 3,03, M = 3,86, p <0,01). Also, women preferring existing-of-playable-character-or-characters-games show fewer signs of perfectionism (M = 3,77, M = 3,33, p <0,05), while having less capability to change behavior in-process (M = 2,63, M= 3,75, p <0,01) and less self-control (M = 4,0, M = 3,2, p <0,05).

Males have no statistical differences except for preferring existing-of-playable-character-or-characters-games, being more stubborn (M = 2,98, M = 2,46, p <0,05), but having more tendency to accept the unusual (M = 2,9, M = 3,42, p <0,01) and fewer scores on the in-group/loyalty scale (M = 17,06, M = 13,9, p <0,05).

### *3.2. Existing-of-moral-choice dimension*

The second dimension, according to the classification, is existing-of-moral-choice. The significant skewness of preferences among males (almost all preferred to have moral choices) was the reason why we investigated only females. There are numerous differences between preferring-to-have-moral-choices, haven't-decided, and preferring-not-to-have-moral-choices females (Scheffe-adjusted). Both preferring-to-have-moral-choices and haven't-decided have lower self-regulation levels (M = 25,87, M = 24,33, M = 16,56) (p <0,01) and more fervor (M = 10,37, M = 10,27, M = 6,25) (p <0,01, p <0,05) than preferring-not-to-have-moral-choices.

Preferring-not-to-have-moral-choices are more extraverted than haven't-decided (p <0,05), and preferring-to-have-moral-choices (p <0,05) (M = 3,14, M = 2,42, M = 2,44) ,more scores on liveliness (p <0,01, ns), sociability (ns, p <0,05) and social boldness scales (ns, p <0,01). They are less open to experience than haven't-decided (p <0,01) and preferring-to-have-moral-choices (p <0,01) (M = 3,11, M = 3,73, M = 3,7) with impart of aesthetic appreciation (ns, p <0,01), creativity (p <0,01), and inquisitiveness (p <0,05, ns). They are more forgiving than preferring-not-to-have-moral-choices (p <0,05) and haven't-decided (p <0,01) (M = 3,69, M = 2,6, M = 2,45) and less fearful than preferring-not-to-have-moral-choices (p <0,05) and haven't-decided (p <0,01) (M = 2,69, M = 3,64, M = 3,39).

Furthermore, preferring-to-have-moral-choice individuals show more tendency to display wealth and privilege than haven’t-decided (M = 3,43, M = 2,50) (p <0,05) and they are less lenient in judging others than preferring-not-to-have-moral-choices (M = 3,29, M = 2,83) (p <0,05).

## 4. Conclusion

This study established differences between people preferring different types of computer games. It is important to understand that our research was not designed to establish causality between personality traits and computer games addiction. However, the result allows us to make an inference that having-moral-choice and having-playable-character-or-characters games tend to be more addictive and attract people with troubles by their "world of remediable errors." On the other hand, despite extensive use of computer games (that is, around half of one’s average free time [10]), gamers can't be classified as addicted neither to the Internet nor to games themselves according to the tests. This is consistent with studies declaring the prevalence of computer game addiction being between 10-17% [11].

Games having moral choices and playable characters (role-playing games), which have been described as the most addictive types [12], are more attractive to people showing more introversive signs and weaker morality. Those people, often portrayed as shy, lonely, and quiet, usually have a less extensive social network and thus may try to compensate for the gaps by playing computer games. Self-regulation issues, shown through different aspects, are also related to the preference of games having playable characters and moral choices. At the same time, the more realistic-like worlds of those games seem to be more alluring for people that are more tolerant towards ideas that may seem radical or unconventional. Taking into account the fact that games provide, for example, the ability to kill NPC (non-playing characters), these relations seem to represent the exploratory nature of gamers.

## 5. Acknowledgments

The reported study was funded by RFBR, project number 20-313-90039

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# Inspiring awe in high school teachers: Design and preliminary test of a virtual training on AltspaceVR

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**Abstract.** The emotion of awe, arising when the human being confronts himself with something vast, able to overwhelm current mental structures and to turn into a potentially transformative experience, has been recently introduced into the learning domain as a driver of knowledge-seeking behavior as well as an authentic trigger of interest towards science. However, to date, an awe-inspiring training for workers into the domain of science – specifically of STEM or STEAM – has not been designed and tested yet. In this study, we implemented recent scientific evidence concerning how to elicit intense instances of awe into an awe-inspiring training delivered through a social virtual reality (VR) platform - AltspaceVR. High-school teachers attended this novel awe-inducing training consisting of an autobiographical recall of awe as well as the exposure to awe-inspiring virtual environments (VREs). Their level of awe, presence, and affect were measured before and at the end of the training. Moreover, at the end of the experience, participants were involved in a focus group on the overall experience. Participants reported a profound sense of awe along with other related emotions, as well as a continuous sense of presence in the VRE. In conclusion, this training could pave the way for a multitude of applications, enhancing the individual involvement towards science and technology at any age.

**Keywords.** Awe, Education, Training, STEM, Virtual Reality, Presence

## 1. Introduction

Awe is a complex emotion dealing with complexity [4] and transformation [1; 3], which can inspire people to learn, especially in the scientific domain [2; 5]. Currently, psychology operationalized it as the resultant of two main cognitive appraisals: the perception of vastness and the need for accommodation [6]. Despite intense moments of awe being rare in life, Virtual Reality (VR) along with autobiographical recall have been shown as effective awe-inspiring techniques, able not only to resemble but to even strengthen complex emotional experiences. Here, we designed and pilot-tested an awe-inspiring training in a social virtual reality (VR) platform – AltspaceVR. The training was designed for high school teachers of STEM disciplines. Quantitative reports of their experience were collected before and at the end of the training. A focus group was carried out at the end of the training. This study featured an innovative awe-inspiring training using an ad hoc set of VR scenarios designed for eliciting awe in AltspaceVR by focusing on tools, design guidelines, and methods from the psychological domain of emotion elicitation.

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## 2. Method and procedure

10 subjects (7 females; sample's mean age = 52.5; *SD* = 6.19) were involved. Their level of awe (Brief Awe Scale [7]), affect (Self-Assessment Manikin- SAM [12]), and sense of presence (single item) were measured through the Qualtrics platform (www.qualtrics.com). At the end of the training, subjects took part in a focus group exploring their affect, emotions, and their desire to repeat the experience, as well as being asking for concrete feedback for improving the design of the training. Quantitative analyses were carried out using Jamovi (Version 1.1.9.0In this training, using the *AltspaceVR* platform and its embedded world-editor, three immersive VREs in which participants could move freely while listening to the experimenters and two ad hoc validated awe-inspiring narratives were designed. Some objects such as the ExperienceLab logo were created from scratch using the software Unity (version 2021.1.17) and were imported into the platform since objects present in Altspace's world creator were still limited to a number of pre-existing packages. Studies on awe have shown that natural and vast landscapes produced intense states of awe [11]. For this reason, we chose to build two main awe-inspiring environments: "forest", which features a big space immersed in water surrounded by immense trees and with a huge waterfall, and "deep space", representing a general outer space with planets, asteroids, and a reproduction of the Solar SystemThe third scenario was a hall in which we conducted the first part of the training: a meeting room with a web projector in it (useful to project the training slides) filled with peculiar additions, like looking out into space and having a big vessel coming in throughwindows at regular intervals.

**Table 1.** Phases and activities of the training.

| Phases | Activities |
|---|---|
| Warm up and welcome | Brief introduction to the training and basic rules of *AltspaceVR*. |
| Pre-training assessment | Measurement of awe, presence, and affect. |
| Presentation about AWE | Exposure to awe-inspiring images + scientific explanation. |
| Entry into "awe" virtual worlds | Autobiographical recall/narrative of awe-related personal experiences. |
| Focus group and discussion | Exposure to multisensory VR experiences ("Forest" and "Deep Space"). |
| Post-training assessment | Measurement of awe, presence, and affect. |

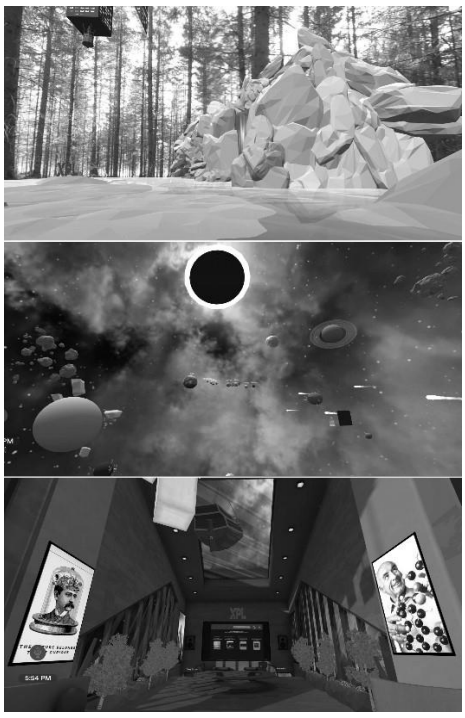

**Figure 1.** The three virtual environments: "forest", "deep space" and XPL meeting room.

After an initial phase of warm up and welcome to the platform, participants were instructed on the main dynamics of the virtual world and the commands to perform operations such as moving or requesting speech. The first part of the training consisted of a presentation on the theoretical frame of awe using the virtual laboratory's web projector. Immediately afterwards, an autobiographical recall task was proposed, focusing on recollecting personal awe experiences. After this task, participants were divided into two groups and led by two researchers to the two different virtual spaces through the portals located in the meeting room, with the instruction to keep in mind the feelings and memories just evoked. Groups were assigned randomly to either the Forest or the Deep Space scenario in a counterbalanced order. Additionally, during both VRE scenarios an ad hoc, awe-inducing recorded narrative along with background music was played within each group as an auditory cue to intensify awe. After experiencing both VREs, groups were led back to the meeting room where the final session on the collective experience of awe took place. Finally, they completed post-assessment measures and participated in the final focus group.

## 3. Results

At the qualitative level, participants reported to be satisfied with the experience, to have appreciated the whole design of the environments, and to have understood the meaning of the training. Additionally, they reported to have been felt immersed in the experience, resulting in a continuous sense of presence.
These are some of the comments that came out during the focus group, regarding the possibility of inspiring awe in schools (Authors translated participants' feedback from Italian):
"*Include in every educational action an element of novelty with respect to what is known to the learner; novelty stimulates curiosity, produces motivation, and incites to operate and to want to know more*".
"*Increase curiosity, which is a strong engine. Because there is an aspect that is strongly related to the specific disciplinary content and specific skills, having a scenario as a basis and activating their curiosity with respect to the topic and not the*

*tool, is important*".
"*Teach students not to be afraid of change. Teachers need to learn this, too. Teaching the attitude to change, teaching tools for change can add value to facilitate the learning process. Change involves readjusting the person, which is not always easy, but fostering change by helping them understand its value and strengths brings positive added value. In our society, it is critical to help students cope with change*."

At the quantitative level, the descriptive analyses showed a little difference between sense of presence pre- ($M$ = 3.27; S.D = 0.388) and post-training ($M$ = 3.35 $SD$ = 0.457), a potential result also supporting the qualitative data on the maintenance of the sense of presence during the whole training. The general perceived sense of awe, instead, showed an increase in the post-training results ($M$ = 8.45; $SD$ = 1.81) compared to the pre-training ones (*mean* = 7.46; $SD$ .= 1.66) confirmed by a paired samples t-test (*p-value* = 0.062). This increase may support the effectiveness of training in eliciting feelings of awe. Descriptive of SAM were as follows: Valence pre ($M$ = 7.30, S.D. = 1.42) post ($M$ = 7.20, $SD$ = 2.57), arousal pre ($M$ = 5.30, $SD$ .= 2.06) post (mean = 6.90, $SD$ . = 1.29) and dominance ($M$ = 5.80, $SD$ . = 1.23) post ($M$ = 6.20, $SD$ . = 2.30) remained stable.

Finally, *AltspaceVr* was shown to be a simple tool to create engaging virtual scenarios, linking people all around the world and conveying a high sense of presence. On the other hand, at the time of the experiment, this platform was not fully supported and optimized for Mac users whose experience was different from Windows users regarding the objects displayed on screen (e.g., some of them were not visible for Mac users). Thus, the platform was regarded as not highly user-friendly since it required a medium level of VR- related skills to be used.

## 4. Conclusion

In this pilot study, we designed and tested (through a mixed method approach) the design and user experience of a VR-based awe-inspiring training created for high school teachers with an expertise in the domain of STEM. A strong interest towards the content of the training emerged. Additionally, this training resulted in a potential controlled remote procedure to elicit feelings of awe reliably. In the future, the sample needs to be extended. Future research in this regard should explore the interaction's effects between the levels of awe preceding and following training, as well as the possibility of generating different trainings related to the improvement or treatment of emotional correlates of human experience. It would also be interesting to measure the long-term effectiveness of the training in a future study to test how well the emotion of awe can be elicited and maintained over time through ad hoc training.

**Acknowledgments**: The project has been supported by Fondazione Cariplo, grant: "Promoting Education of Scientific and Technological Societal Issues Through Sublime (PROMETHEUS)" n°: 2019-3536

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# Positive technology for emotion regulation: a virtual self-help intervention

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**Abstract.** Emotions and stress experienced in the academic environment are known to be related to important outcomes such as health and well-being together with other comorbidities such as decreased academic performance, increased college dropouts, and increase of problematic online and offline behaviors. Today, the situation appears even more critical in relation to the COVID-19 pandemic. Drawing on positive technology framework, this study aims to promote well-being in university students who are facing the challenging period of graduation by increasing their ability to emotionally regulate. Emotion regulation is defined as the initiation, maintenance, and modification of the occurrence, intensity, and duration of feeling states. Forty-two university students voluntarily participated in a self-administered modular intervention of 6 sessions spread over three weeks that involves virtual scenarios (used in 2D). Students were randomly allocated to an experimental group and to a waiting list group that started the intervention after 3 weeks. The virtual scenarios consisted of narrative metaphors aimed at encouraging students to be aware of their emotions, and positive resources to cope with difficult situations and develop strategies to regulate their affective states. Before and after the six sessions, participants completed an assessment by filling in online questionnaires. The results showed a significant increase both in emotional well-being and psychological well-being in the experimental group compared to the waiting list group.

**Keywords.** Emotion Regulation, Self-Help, Well-Being, Positive Technology

## 1. Introduction

The university years are an essential phase of a student's life in which significant shifts in individual experience led to transformations in lifestyle and social relationships which can prove to be a stressful experience [1]. Several studies documented that student before the age of 24 report higher levels of mental health problems than the general population and that stress, anxiety, and affective disorders are the most prevalent problems [2]. The etiology of affective problems in students is complex, including stressors such as financial problems, academic pressure, adjusting to new social and geographical environments, relationships, life-stage transitions, and time management. Those stressors are linked to a general deterioration of various life-domains and reduced academic achievement [3]. Today, the situation appears as even more critical in relation to the COVID-19 pandemic [4, 5] Very recent works indicate an alarming increase of COVID-19 pandemic-related mental health problems among university students [6].

Within this context, the ability to adequately regulate emotions is essential for the psychophysical well-being of university students who often find themselves facing completely new stressful situations and stimuli. Emotion regulation is the ability to recognize and manage the intensity and the duration of an emotional experience [7, 8]

. This ability involves the use of different cognitive and behavioral strategies which provide an enriching, functional, and balanced emotional experience with respect to both positive and negative emotions. Drawing on positive technology framework [9], we present a self-administered modular intervention based upon virtual scenarios (used in 2D) that aim to improve emotion-regulation and general well-being in university students during the COVID-19 pandemic.

## 2. Methods

### *2.1. Participants*

Forty-two university students (76.2% females) enrolled in the third year of the bachelor's degree and in the second year of the master's degree participated in this study. Recruitment took place through different channels and modalities to ensure a heterogeneity of the sample. Some individuals were invited to participate in the research through the publication of a notice on the BlackBoard platform of the Catholic University; other students were contacted through social media posts and through the snowball sampling method. Participants were randomly allocated to an experimental group (21 participants, mean age = 23.67, SD = 1,62) which immediately started the intervention, and to a waiting list group (21 participants, mean age = 24.10, SD = 1.54), that started the intervention after 3 weeks. Exclusion criteria were visual and hearing disabilities. The study was approved by the local ethical committee of the Department of Psychology of Università Cattolica del Sacro Cuore of Milan.

### *2.2. Measures*

An assessment battery was administered pre- and post- the six-session of ER-focused intervention. Specifically, Italian Mental Health Continuum – Short Form (IMH) [10] as a positive mental health assessment, and the Emotion Regulation Questionnaire (ERQ) [11] to measure the tendency to regulate emotions.

### *2.3. Self-help intervention*

This VR-ER-intervention consisted of six 15-minute sessions that took place over three weeks. The first two scenarios, the secret garden and the waterfall in the prairie, aimed to induce relaxation. Each scenario began with an attention-focusing exercise followed by the VR scenario visualization and the identification of the safe place. To focus attention, participants listened to an audio designed to induce them to focus on the present moment and bodily sensations. This exercise was followed by the VR experience which guided participants to implement mindfulness-based strategies to explore landscapes while identifying internal states. Afterwards, participants identified a safe place by recalling the virtual experience and identifying a moment in which they experienced pleasant emotions. The following four scenarios, The Desert and the Oasis, The Boat and The Sea, The Mountain and the Backpack, and The Hero and The Dragon, contain longitudinal transformative narrations that aim to increase participants' confidence in their emotion regulation abilities. Each of these sessions began with an attention-focusing session in audio-format, then the presentation of the virtual scenarios, and it ended with an audio recording designed to elicit emotions felt during the video, specifically to amplify positive emotions. At the end of each session, participants were asked to repeat the virtual experience every day before breakfast using an mp3 audio version of the experience and the relevant real-life objects.

### *2.4. Procedure*

The intervention consisted of six sessions over a period of three weeks. The intervention was carried out in self-help mode, thus participants carried out the proposed experiences independently. Once recruitment of the sample was completed and the signed informed consent was collected, the subjects of the experimental group were sent via email a link to a folder that contained a psycho-education video with an

explanation of the activities of the following weeks and a Qualtrics link with the questionnaires to be completed before the start of the intervention. The waiting list group received just an email with the Qualtrics link to complete the baseline questionnaire assessment. Subsequently, every week for three weeks, participants received two emails (Monday and Thursday) containing a link to a specific 2D video (duration of about 10 minutes) and three audio files (one for the focus of attention, one inviting reflection on the video, and one with the original audio of the 2D video) to be listened to every day. Finally, after the sixth session, the post-intervention evaluation was administered through a Qualtrics link using questionnaires. At this point, the waiting list group started the same three-week protocol with pre- and post-evaluation assessment.

## 3. Results

The repeated measures ANOVA was carried out for a pre-post treatment evaluation of the measures (Table 1). Results showed a significant increase in emotional well-being (Fig.1) and psychological well-being (Fig.2) in the experimental group compared to the waiting list group. Furthermore, the experimental group showed an increase in positive attitude about the future (Fig 3) that decreased in the waiting list group.

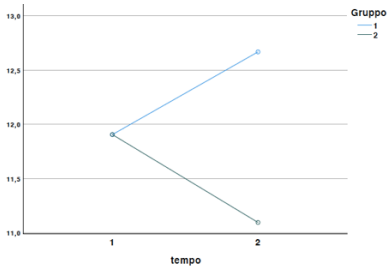


**Figure.1** Emotional well-being (IMH) (time*group interaction effect)

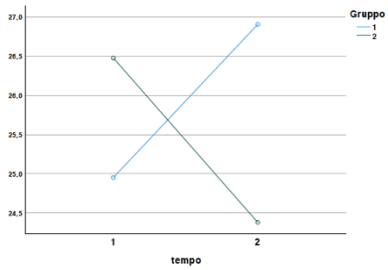


**Figure 2** Psychological well-being (IMH) (time*group interaction effect)

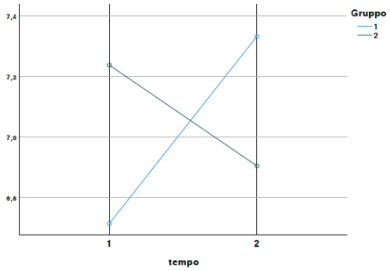


**Figure 3** Positive attitudes toward future (time*group interaction effect)

**Table 1**. Pre-post evaluation treatment

| | **Experimental group** | | | | **Waiting list group** | | | | **ANOVA** | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Pre | | Post | | Pre | | Post | | Time | | (group*time) | |
| **Measures** | M | SD | M | SD | M | SD | M | SD | F | Sig | F | Sig |
| IMH_EW | 11.90 | 2.96 | 12.67 | 2.28 | 11.90 | 3.75 | 11.10 | 2.73 | .00 | .94 | 5.10 | .029* |
| IMH_PW | 24.95 | 6.02 | 26.90 | 5.22 | 26.48 | 5.66 | 24.38 | 5.30 | .01 | .91 | 8.85 | .005* |
| ERQ- CR | 4.84 | 0.73 | 5.21 | 0.61 | 5.01 | 1.01 | 4.98 | 0.92 | 2.06 | .15 | 2.90 | .096 |
| ERQ-ES | 3.33 | 1.24 | 3.23 | 1.18 | 3.22 | 0.98 | 3.26 | 1.17 | .04 | .83 | .21 | .646 |

## 4. Conclusion

The present intervention is located within the scientific approach of Positive Technology which aims to use technology to modify the characteristics of personal experience in order to improve its quality and increase well-being in individuals [12]. Our results showed that participants had a positive response to the intervention as indicated by shifts in pre/post scores on the questionnaires. Specifically, participants showed a higher level of emotional and psychological well-being. The present study showed that this novel virtual intervention might be an effective tool for improving well-being in students that are facing a hard time in university.

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# Technology as a daily resource for Italian college students during the lockdown period. A qualitative study

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**Abstract.** The restrictions imposed during the COVID-19 pandemic have challenged human daily activities and habits worldwide. In this novel scenario, technology proved to be a resource for individuals and communities. A qualitative study explored the typologies of services primarily used by Italian university students in Spring 2020 during the first lockdown period. Technology emerged as a major resource, facilitating daily tasks such as learning activities, relationships, and leisure.

**Keywords.** COVID-19, Technology Use, University Students

## 1. Introduction

Between March and June 2020, Italian citizens experienced a strict lockdown period caused by the first COVID-19 outbreak. The fast worldwide spreading of the pandemic, with related compulsory isolation and social distancing, led to an increasingly intensive use of technologies by individuals, families and communities [1,2]. Daily tasks in any life domain were transformed by technology. This sudden change entailed both challenges and opportunities; in particular, it forced individuals to find different social interaction patterns and to develop new daily habits. Like any other category of citizens, students experienced a drastic reduction in personal and social freedom that pushed them to spend more time online [3]. Digital services emerged as a major resource to cope with the lockdown phase, allowing them to perform learning tasks, keep in touch with family and friends, and engage in leisure activities.

The aim of this study is to provide an exploratory overview of the technological resources perceived as useful by a group of Italian university students during such an unprecedented situation.

## 2. Materials & Methods

### *2.1 Participants*

This study relies on data collected among 741 students attending courses in healthcare professions, humanities, and political science at the University of Milano. Overall, 274 participants (36.9%; see table 1 for demographic features) answered to an optional open-ended question investigating useful services, and were thus included in the analyses.

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### *2.2 Materials and Procedures*

After approval from the Ethical Committee of the Università degli Studi di Milano, students attending different bachelor's and master's degree courses were invited to participate in an online survey. Participants' informed consent was obtained, and anonymity was granted throughout all study phases. Data were collected between April 17 and May 18, 2020, covering two different phases of the lockdown period: phase 1, from March 12 to May 3 was characterized by very strong restrictive measures; during phase 2, from May 4 to May 18, there was a partial reopening of core productive activities, with social distancing measures still in place. Participants completed an online questionnaire including a demographic section, scales measuring psychological processes, and an optional interview based on open-ended questions. They were free to conclude their participation at any time during the study. Based on the study aims, analyses were focused on a specific open-ended question included in the interview: *Which institutions or services are most helpful to you in your daily activities? For each of them, can you specify how are they helping you?*

### *2.3 Coding Procedure*

Answers to the open-ended questions were coded by two independent raters; discrepancies were solved through the involvement of a third expert researcher. Students provided complex answers, leading to the identification of multiple semantic units. Units were transformed into numeric items, organized into broader functional categories, based on a validated coding system already applied in previous studies [4] and corresponding to the purpose/objective of technology use. The coding procedure for each answer unit comprised firstly of the identification of the related category of purpose, and then the specific numerical item to be attributed to the unit. For answer units not fitting any available item, a new item was added to the category. Up to four answer units were retained for each participant.

### *2.4 Statistical Analysis*

The data analysis was aimed at identifying which technological services were primarily used by the students and for which purposes. Considering that each participant could provide more than one answer unit for each question, Chi-square tests were used to compare the percentages of students providing at least one answer in each category, grouped according to demographic features: type of curriculum, gender, and lockdown phase.

## 3. Results

The 274 participants who answered the question referring to technological services did not differ in demographic features (age, gender, marital status, university degree, and lockdown phase) either from those who did not complete the optional answer, or from those who referred to other typologies of services. Out of a total of 500 answer units, 393 (78.2%) referred to technological services. They were grouped into five categories based on the purposes of use: utility services, study/work, socialization, leisure, and civic engagement. Overall, 42.0% of the participants quoted technology in relation to utility services, 35.8% to study/work, 26.7% to socialization, 18.6% to leisure, and 5.1% to civic engagement. No significant differences emerged in the percentage distribution of participants referring at least one time to each of the five categories across curricula, and by gender or lockdown phase.

## 4.Discussion

Mobility and social restrictions imposed by governments during the COVID-19 pandemic made technologies essential to perform daily activities and preserve human interactions, radically transforming citizens' lives across all daily domains.

Starting from these premises, this study investigated which technological services were adopted by university students to deal with this situation and for what purposes (see Table 2 for exemplary answers by categories). Results showed that technologies were primarily useful for satisfying practical needs. Internet services allowed citizens to purchase basic goods and access services from home. Almost half of the participants in our study referred to internet-based services such as online shopping and consequent home delivery of food, music, and books. Notably, data were collected in the early stage of the lockdown in which "panic buying" was taking place [5,6]. In those days, various products including protective equipment such as gloves and masks were bought massively, along with flour and yeast. Universities engaged in remarkable efforts to move to virtual platforms for all teaching activities and services including classes, supervision sessions, exams, and access to library resources. Although students had to adjust to a different learning experience, the opportunity to perform all the routine academic activities provided them with a sort of "normality", helping them structure their daily time and pursue their academic goals in a period of uncertainty.

At the relational level, the imposition of social distancing to prevent the spread of the contagion negatively impacted young citizens' relational life [6,7]. Nevertheless, the availability of social networks and real time communication platforms allowed individuals to maintain connections and interactions with family and friends, as highlighted by our participants [8]. These resources were especially relevant to off-site students who experienced a stronger sense of isolation from the family, further enhanced by the impossibility of travel and by worries about family health conditions. Technological tools also allowed students to preserve and cultivate other types of relationships including participation in community activities and religious rituals.

Finally, technology offered a variety of leisure experiences. The students involved in the present study reported engagement in a variety of entertainment activities, with access to movies, documentaries, and news. They reported gaming online with friends, or watching the same movie together and exchanging comments about it in a live chat [9,10]. In line with European data, some participants also reported watching TV as a source of updated daily news and interesting, pleasant broadcasts [11].

Performing physical activity in a period of restrictions required high creativity; in this domain, technology was again helpful in transposing sport training programs to virtual platforms. The students reported exercising at home, but preferably in the open air whenever a terrace or garden was available to them.

It is worth noticing that participants' answers were consistent with findings obtained from other studies. Social confinement promotes new ways of socializing and connecting with others [12]. In particular, web-conferencing systems such as Zoom, Teams, or Google Meet were used for organizing synchronous social events, participating in prayer, and cultural or reading meetings.

### *4.1 Limitations*

This study has several limitations. Data were collected in a single University. Rrecruitment of participants, as well as completion of the open-ended question on the use of technology were voluntary, thus implying self-selection. Random sampling procedures were not conducted, thus reducing the generalization of the results.

### *4.2 Conclusion*

For the participants in this study, technology represented an effective resource to cope with the lockdown-related restrictions across life domains. It is however worth noticing that over one-third of the students deemed technological services as useful to grant continuity to their academic pathway, while less than 20% referred to leisure.

This finding confirms the relevance of e-learning strategies to help students preserve their daily schedule, suggesting that technological resources, even though massively introduced to counterbalance the restrictions imposed by the pandemic, could be fruitfully integrated in the academic practice, together with face-to-face activities.

**Table 1.** Demographic characteristics of participants

| | **PARTICIPANTS N. 274** |
|---|---|
| **AGE MEAN (SD)** | 23.82 (6.98) |
| **AGE RANGE** | 19-63 |
| **GENDER (% FEMALE)** | 72.2 |
| **WORKERS (%)** | 28.8 |
| **MARITAL STATUS – SINGLE (%)** | 91.2 |
| **DEGREE** | |
| **HEALTHCARE (%)** | 36.1 |
| **HUMANITIES (%)** | 32.5 |
| **POLITICAL SCIENCE (%)** | 31.4 |
| **LOCKDOWN PHASE[1]:** | |
| **1 (%)** | 177 (64.6) |
| **2 (%)** | 97 (35.4) |

(1) Phase 1 = complete lockdown; Phase 2 = partial reopening.

**Table. 2**. Exemplary answers in the main categories

| **Purpose of Use** | **Participants' answers [1]** |
|---|---|
| **Utility Services** | P39: "***Home delivery services*** *are absolutely useful in everyday life, as they allow us not to leave the house."*<br>P56: "*The* ***home shopping service*** *or the service of pickup up from the shop ...The home delivery of books and study materials …".*<br>P142: "*Definitely* ***all kinds of online services****, especially sales services (such as amazon, or other online shops), allowing me to receive everything without leaving the house.*<br>*P60: "****Online shops*** *that allow you to buy books, otherwise I would have no way to study.* |
| **Study/Work** | P8*: "The* ***University*** *- especially professors … - is certainly helping me a lot. I feel supported as a student but also as a person in my university career.* "<br>P74: *"…****university activities*** *help me give regularity to my days* "<br>P138: "*…****services offered by the university****, even if not perfect, are indispensable in order not to feel lost*".<br>P109: "**The computer, internet**. They allow connection with people, working, and studying." |
| **Socialization** | P58: "I *use* ***Zoom*** *to see my friends, to chat, to play and study together, and to follow Holy Mass every day.* ***WhatsApp*** *is useful for video calls with one friend at a time or with my boyfriend*."<br>*P60: "…****Systems*** *that allow you to make video calls and social networking, to keep in touch with people I love, colleagues and professors."*<br>*P114: "Definitely* ***instant messaging and video calling services****, with which it is easier to study with my classmates or contact my friends."* |
| **Leisure** | P30: "**Online services** for reading and watching films or documentaries."<br>P49*: "****…YouTube and Instagram*** *for exercising."*<br>*P92: "…The* ***radio*** *keeps me company and films on* ***TV*** *are big time killers* |
| **Civic Engagement** | P180: "*...the parish with the* ***streaming service*** *allow us to feel like a community even at this time."*<br>*P220: "It is helping me* ***promoting culture and reading from a distance****. A community has been spontaneously created and it makes us feel joined."* |

(1) Question: Which institutions or services are most helpful to you in your daily activities? For each of them, can you specify how are they helping you?

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# Usability and Users' Experience of EXecutive-functions Innovative Tool (EXIT 360°)

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**Abstract.** Executive dysfunction represents a health problem due to its high impact on everyday life. Thus, the early assessment of these impairments is crucial. The ecological limitations of traditional neuropsychological batteries and difficulties in administering tests in real-life scenarios have led to the use of technological tools to assess executive functions in real life. Over the last decades, several studies have shown the feasibility, acceptability, and efficacy of VR-based tools in the early evaluation of executive dysfunctions in different clinical populations. This work wanted to test usability and users' experience of EXecutive-functions Innovative Tool (360°), a 360°-based tool for assessing executive dysfunctions in a pilot evaluation study involving 23 healthy young subjects. This evaluation consisted of 1) usability assessment using the System Usability Scale and, 2) user experience evaluation by the User Experience Questionnaire and ICT-Sense of Presence. Results showed encouraging and interesting data regarding usability, user experience, and engagement of EXIT 360°. Overall, EXIT 360° appeared to be a usable, easy-to-learn, engaging, creative, and challenging tool with good spatial presence, excellent ecological validity, and few and irrelevant adverse effects. Further studies will have to be conducted to evaluate all these aspects in healthy adults and elderly subjects and a clinical population.

**Keywords.** Executive Function, 360° Environment, Assessment, Virtual Reality, Usability, Users Experience

## 1. Introduction

Executive dysfunction represents an important health issue in several neurological and psychiatric populations due to its significant negative impact on daily functioning and quality of life. Therefore, identifying early strategies for the ecological evaluation of Executive Functions (EFs) must be a priority [1].

The ecological limitations of traditional standardized neuropsychological tests and problems in administering tests in real-life contexts have led to the use of Virtual Reality (VR-e.g. 360° environments) to assess EFs in real life [2]. Different studies have shown the feasibility, acceptability, and efficacy of VR-based instruments in the early evaluation of executive dysfunction in different clinical conditions [3]–[5].

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For this reason, we developed an original 360°-based tool for a multicomponent evaluation of EFs: EXecutive-functions Innovative Tool 360° (EXIT 360°) [6]. EXIT 360° was designed to provide an ecologically valid assessment of several executive functioning components, involving participants in a "game for health," in which they have to perform everyday subtasks in 360° domestic environments delivered via a comfortable, mobile-powered VR headset.
Previous studies have shown the critical role of usability assessment and user experience in the development of VR-based tools [7] to understand any problems that could affect subjects' performance (effectiveness) [8], [9]. Firstly, the usability assessment aims to understand the "degree to which a subject is able to use a system to achieve specific goals effectively, efficiently, and satisfactorily within a well-defined context of use" [10]. Secondly, several studies showed the importance of focusing on the user experience in the development of digital content by working on "sense of presence and realism", "engagement", "enjoyment," and the presence of adverse effects (e.g., dizziness and nausea) [11], [12]. The feeling of cybersickness can lead to unpleasant experiences for the users, influencing their performance and greatly diminishing the validity of test results. Moreover, a high level of engagement that allows participants a first-person experience "like in real-life" combined with a high enjoyment can increase the motivation and participation of users and decrease typical anxiety of neuropsychological evaluation [13].

Therefore, we have conducted a pilot study to evaluate these aspects in healthy control subjects utilizing EXIT 360°.

## 2. Method

Twenty-three healthy young adults were consecutively recruited according to the following inclusion criteria: a) Aged between 18 and 35 years, b) education ≥5, c) absence of hearing or visual impairments, d) absence of systemic, psychiatric, or neurological illnesses or overt visual hallucinations or vertigo.
All participants underwent a one-session evaluation with EXIT 360°. EXIT 360° consists of a specific task for assessing EFs delivered via a smartphone inserted in a comfortable, mobile-powered headset [6], [14].

Before starting evaluation with EXIT 360°, participants were assessed with the Montreal Cognitive Assessment test [15], [16], a neuropsychological screening test for dementia, to exclude the presence of cognitive dysfunction in the whole sample.

After this preliminary screening, the neuropsychologist invited the participant to sit on a chair and wear the mobile-powered headset. Before starting the real task, participants performed a familiarization phase that lasted one minute, aimed at familiarizing participants with the technology and observing potential side effects (e.g., dizziness, nausea) [14]. Participants were immersed in a neutral 360° environment in which they explored the environments freely to find specific objects (e.g., plants, pictures). After completing the familiarization phase, participants were asked to indicate the presence of adverse effects. No participants showed side effects.

After that, participants started the real task and were immersed in a living room in which they received a global instruction: "*You are to enter a house. Your goal is to get out of this house in the shortest time possible. To exit, you will have to overcome several subtasks*".

During EXIT 360°, the subjects were immersed in domestic 360° environments where they had to perform seven everyday tasks of increasing complexity, evaluating different components of EFs. Interestingly, during the task, participants explored the 360° environments freely, simply by the movement of the head, as in real situations.

In each subtask, the subjects responded by choosing between three or more "alternatives", according to the task's request. They saw a small white dot in the headset, a "pointer" that followed their gaze. They had to respond by just moving their head and position the dot over the answer for a few seconds, and the response was selected automatically. Thus, participants did not have to learn to use complex tools. Participants had to perform all seven subtasks, obtaining one point for a wrong answer or two for a correct one.

After EXIT 360°, participants underwent an evaluation that involved assessing usability and quality of user experience. Regarding usability assessment, we used the System Usability Scale (SUS), a short questionnaire composed of 10 items on a 5-point scale, often used to evaluate the usability of technological instruments [17]–[19]. Regarding user experience, subjects completed two questionnaires: the User Experience Questionnaire (UEQ), a 26 item-scale divided into six different domains (attractiveness, perspicuity, efficiency, dependability, novelty, and stimulation) [20], [21] and ICT- Sense of Presence Inventory (ICT-SOPI), a 44 item-scale divided into four dimensions (spatial presence, engagement, ecological validity, and side effects) [22].

## 3. Results

The sample (N=23) was predominantly female (7 males and 16 females), with a mean age of 28.7±3.47 and mean years of education from 16.6±2.30. All patients included in the study showed an absence of cognitive impairment (MoCA correct score=25.44±3).

The mean SUS score was 79.6±11.6, indicating a satisfactory level of usability according to the scale's score acceptability range (cut off=68). Figure 1 shows that our mean score falls between "good" and "excellent".

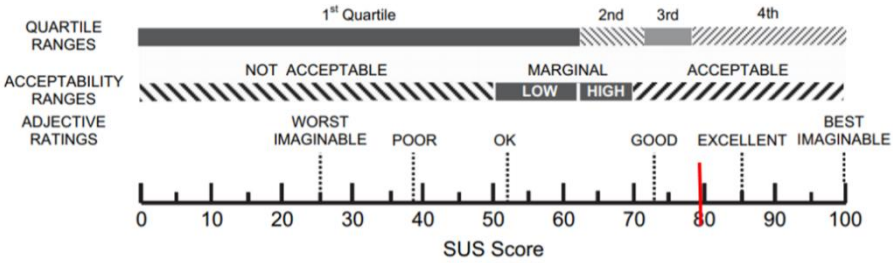


**Figure 1.** A graphic representation of the SUS' score. The figure is modified by the original version [19]

Specifically, 43.5% evaluated EXIT 360° as "good", 26.1% as "excellent," and 30.4% "best imaginable." Interestingly, participants provided good scores to two main aspects that could affect the user experience: "Usability" (mean=3.11) and "Learnability" (mean=3.35).

The UEQ showed positive evaluation (>.8) in all six domains and three dimensions (Figure 2).

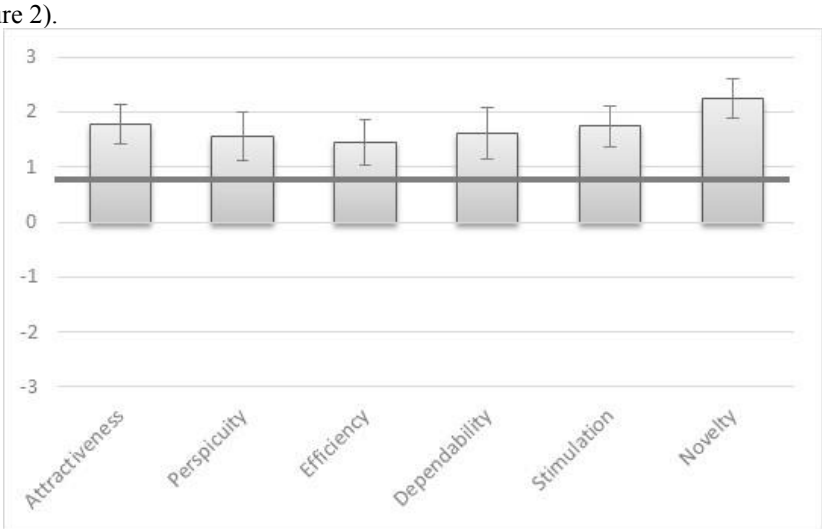


**Figure 2.** Scores of UEQ's all six scales

Table 1 showed in detail the mean scores of all scales with their respective high values of internal consistency (Alpha-coefficient >.7) [23].

**Table 1.** Scores of the six UEQ's scales. SD= Standard Deviation

| | Mean | SD | Alpha-Coefficient |
|---|---|---|---|
| **Attractiveness** | 1.783 | 0.79 | 0.85 |
| **Perspicuity** | 1.554 | 1.11 | 0.82 |
| **Efficiency** | 1.446 | 1.01 | 0.80 |
| **Dependability** | 1.609 | 1.29 | 0.82 |
| **Stimulation** | 1.739 | 0.84 | 0.81 |
| **Novelty** | 2.250 | 0.74 | 0.89 |

Finally, UEQ's scales can be grouped into three dimensions: attractiveness, pragmatic quality (involving perspicuity, efficiency, dependability), and hedonic quality (non-task-related quality aspects – stimulation and originality). Specifically, EXIT 360° obtained a good score in Pragmatic (Mean=1.54) and Hedonic (Mean=1.99) Quality.

The ICT-SOPI showed interesting results in all four dimensions (Table 2).

**Table 2.** Scores of ICT-SOPI's four dimensions

| | Spatial Presence | Engagement | Ecological Validity | Negative Effect |
|---|---|---|---|---|
| Mean (SD) | 3.07 (0.60) | 3.54 (0.53) | 4.12 (0.57) | 2.18 (1.05) |

Specifically, only two participants showed adverse effects such as dizziness and nausea. However, all participants were able to complete the whole task. Furthermore, more than half of the sample showed good scores in the spatial presence domain, for example, "*I felt I could interact with the environment shown*".

In addition, about 82% of participants said they felt involved and immersed in the virtual environments, affirming to be sorry that their experience was finished (e.g., "*I would have liked the experience to continue*"). Finally, data provided excellent results in the ecological validity domain with more than 95% of subjects supporting a perception of the virtual environments as real (e.g., "*I would have liked the experience to continue*").

## 4. Conclusion

The results reported are very encouraging and interesting in terms of usability, user experience, and engagement of EXIT 360°. Firstly, EXIT 360° showed good scores in usability and learnability (i.e., "users can easily learn how to use EXIT 360°"). Therefore, it is possible to posit that potential subjects' low performance does not depend on technological problems. Moreover, subjects had an overall positive impression of the product, evaluating it as enjoyable, attractive, activating, friendly, and not boring. Secondly, EXIT 360° showed good pragmatic quality as it appeared: 1) efficient, fast, and organized (Efficiency) – indeed EXIT 360° lasted about 10 minutes, 2) understandable, easy to learn, and clear (perspicuity), and 3) supportive and secure (irrelevant side effects, Dependability). Moreover, EXIT 360° showed excellent hedonic quality in terms of stimulation (exciting, interesting, and motivating) and novelty (creative, innovative). Finally, EXIT 360° can be considered an engaging and challenging tool with high spatial presence, excellent ecological validity, and few and irrelevant adverse effects.

Further studies will have to be conducted for evaluating all these aspects in healthy adults and elderly subjects and clinical populations. Moreover, to date, EXIT 360° is an initial prototype that requires further validation to become a valid and standardized instrument for assessing EFs. Therefore, it will be necessary to evaluate the convergent validity of EXIT 360° and its effectiveness in discriminating between healthy subjects and patients with executive dysfunctions.

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# Venturing through storm and stress. A virtual reality app for the assessment of Emotional Sensitivity

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**Abstract.** Research has shown that emotion (dys)regulation is a central feature in adolescence, resulting from the mutual interactions between neurobiological and temperamental features. Indeed, a lack in the ability to regulate affective states is related to a wide range of pathological outcomes and behavioral problems. Emotional sensitivity (ES) is a dispositional feature that drives individuals to perceive more negative emotions in response to a broad range of stimuli and has been shown to foster maladaptive emotion regulation strategies both in clinical and non-clinical populations. Nevertheless, ES has not been uniquely operationalized and studied. This contribution's main objective is to suggest the development of a Virtual Reality (VR) app for assessing ES through different custom-made scenarios. A group of adolescents and a group of young adults will participate in 20-minute evaluations using a new technological app to assess ES via a head-tracked Head Mounted Display (HMD). Each subject might be inside an emotionally neutral, positive, or negative social environment. The subject must try to recognize different emotions in specific characters (happiness, sadness, anger, fear, disgust, and surprise) and then rate his/her emotional experience after every task. A validated device will record Heart Rate Variability as a further measure of emotion regulation. This innovative app allows us to explore ES in an ecological and valid environment, providing useful information on it as a result of the multilevel associations between self-reported and physiological levels of emotional activation, emotion recognition, and cognitive reappraisal. The ES app will provide reliable information for clinical use and research.

**Keywords.** Assessment, Emotion regulation, Virtual Reality (VR)

## 1. Introduction

The traditional conceptualization of the "storm and stress" phenotype is mainly emphasized in adolescence where individuals seek to maintain "a stable balance in a state of instability" while having the (complex) task of developing and consolidating their identity. Indeed, adolescents experience age-related challenges and numerous changes that involve both body and neurophysiological development [1]. Therefore, regulating emotions is an essential feature resulting from the mutual interactions between neurobiological and temperamental features**.** Interestingly, research has shown that emotion regulation does not develop linearly, and age-related differences have been found [2, 3]. Overall, research has shown that a lack of the ability to regulate affective states is related to a wide range of pathological outcomes and behavioral problems in adolescence and early adulthood [4, 5, 6].

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Most of the studies that have investigated emotion regulation encompass cognitive aspects related to maladaptive strategies. For example, Naragon-Gainey and colleagues (2017) [7] highlighted in their meta-analysis that emotional regulation is studied considering different regulation strategies. However, these are often explored not in association with each other but separately (i.e., reappraisal, expressive suppression, rumination, problem-solving), making it difficult to formulate a solid and comprehensive theoretical framework for (mal)adaptive strategies of emotion regulation.

Moreover, a construct that often clinicians (and patients) have highlighted is "emotional sensitivity" (ES). Indeed, a constitutional tendency to experience negative emotions in more situations than other people seems to lay at the bottom of maladaptive emotion regulation strategies in individuals. This tendency, which frequently occurs over time, means that individuals are more likely to engage in pathological strategies of emotion regulation [8, 9]. Thus, further investigating this dispositional trait might contribute to a more in-depth understanding of the mechanisms that foster difficulties in regulating emotions.

However, in line with the emotion regulation literature, the construct of ES is still vaguely formulated and does not have a unique and standardized measurement technique [10]. Nock and colleagues (2008) [11], in developing the Emotion Reactivity Scale (ERS), acknowledged the broader construct of emotional reactivity. Emotion reactivity accounts for the degree at which an individual experiences an emotion; that includes ES as a response to a wide array of stimuli, emotion intensity (EI) as the degree of the emotion experienced, and emotion persistence (EP) as the duration of the emotion before getting back to a baseline state. Functional magnetic resonance imaging (fMRI) studies have investigated EI and persistence (EP) of emotional response to facial stimuli, although with disputed results [12]. Other studies assessed emotional attention biases and the accuracy and identification of emotion perception in face-morph tasks [13]. Overall, a recent study by Ripper and colleagues (2018) [14] confirmed that ES (in that contribution defined as "emotional reactivity") accounts for an independent dimension of trait affect, emphasizing the need for future studies to explore thresholds and sub-thresholds of emotional vulnerability.

Recognizing the lack of a precise definition of this construct, the qualitative study by Wall and colleagues (2018) [9] investigated ES in a sample of people who described themselves as "emotionally sensitive." Overall, the study suggested that ES may be considered a part of the process leading to emotional dysregulation. ES appears to be characterized by a fundamental tendency of the individual to experience more easily negative emotions in reaction to external stimuli, even low-intensity ones. Interestingly, ES was considered a negative trait only by the subjects with a higher level of personality pathology. This last result, although qualitative, might suggest that individuals can perceive ES as a factor that predisposes them to more significant psychological distress only when the personality structure is already impaired. This condition allows for the possibility that ES, although the individual does not identify a factor that fosters maladaptive emotion regulation strategies until it is "too late," meaning when the personality structure is maladaptive, such as in borderline conditions [15,16].

These considerations emphasize the need for further research to be able to detect ES in advance, acknowledging individual and age-related differences [17].

In this scenario, Virtual Reality (VR, experienced through a head-tracked Head Mounted Display; HMD) has proven to be an engaging and immersive way to promote the first-person experience and eliciting genuine emotional reactions [18]. Indeed, VR allows for an ecological and realistic assessment [19, 20, 21].

This contribution hypothesizes that ES is a complex construct that ought to be gathered through combining different components of the emotional experience, i.e., the level of emotional activation (emotional intensity and emotional persistence), the ability to recognize emotions (emotion recognition), and emotion regulation strategies (expressive suppression, cognitive reappraisal).

Indeed, the main objective is to illustrate the initial development of a VR app, providing an ecological assessment of ES through different custom-made scenarios. More specifically, we aim to test the associations between different components of ES

within specific scenarios (positive, negative, and neutral): (1) emotional activation (EI and EP), (2) recognition of emotions (ER) and, (3) cognitive reappraisal (CR).

## 2. Methods

Participants will be a group of adolescents from 14 to 18 years old recruited in high schools, and young adults ranging from 21 to 25 years old recruited via social media adverts.

*Measures*

*Positive and Negative Affect Schedule* (PANAS; Watson et al., 1988b) is a brief 20-item self-report scale to assess positive (i.e., active, alert, attentive, determined, enthusiastic, excited, inspired, interested, proud, and strong) and negative affect (i.e., afraid, ashamed, distressed, guilty, hostile, irritated, jittery, nervous, scared, and upset).
*Emotion Regulation Questionnaire* (ERQ; Gross & John, 2003) is a 10-item self-report measure widely used to assess two emotion regulation strategies (*cognitive reappraisal* and *expressive suppression*).
*Head Mounted Display Oculus Go©* will be used to explore the virtual environments.
Physiological signal will be collected by means of a *Procomp Infinity* device from Thought Technology, and *Biograph Infinity 5.0.2* software will be used to record them.

*Procedure*

Before starting the VR evaluation, participants will carry out a phase of "familiarization" with the HMD and wear the validated device to record HRV. Subjects will be free to explore an emotionally neutral environment (i.e., a waiting room) and ask the examiner questions about the procedure. After this initial phase, designed to prevent the following results from being contaminated by external causes (i.e., dizziness), the examiner will explain the procedure. Afterward, subjects participate in 20-minute evaluations. Each subject is immersed inside a neutral virtual room as a recorded voiceover introduces the specific setting and guides the subject inside the environment.

*Baseline*

First, we will gather data on EI and EP via physiological assessment (HRV) as well as the administration of the PANAS.

*Task*

The subject opens a door and enters an environment that might be emotionally neutral (e.g., a waiting room), negative (e.g., a hospital ward during an emergency), or positive (e.g., a sunny day on a countryside hill). The subject will be guided for five minutes alongside free immersive observation of the virtual scenario guided by the recorded voiceover: in the neutral environment, no voiceover will be heard; in the negative environment, the voiceover will describe the scenario of a pandemic emergency related to the surge of a new deadly variant of COVID-19; in the positive environment, a soothing voice will describe the naturalistic environment in a meditation-like situation.

Then, as a virtual screen appears in the scenario, the subject must recognize facial emotions (anger, happiness, disgust, sadness, fear, surprise). This part of the task will be an adaptation of Jovev's experiment [13].

*Follow-up*

Afterward, the subject is taken to a new neutral environment and rates his emotional experience via the PANAS. Individual differences in reappraisal and maladaptive emotion regulation strategies will be assessed with the ERQ. HRV data will provide an assessment at baseline before starting the task, after having experienced the room, during the emotion recognition task, and again after the experience. Every subject will experience the neutral environment first, then, in random order, a positive or a negative setting (see Fig.1 for an overview of the experiment).

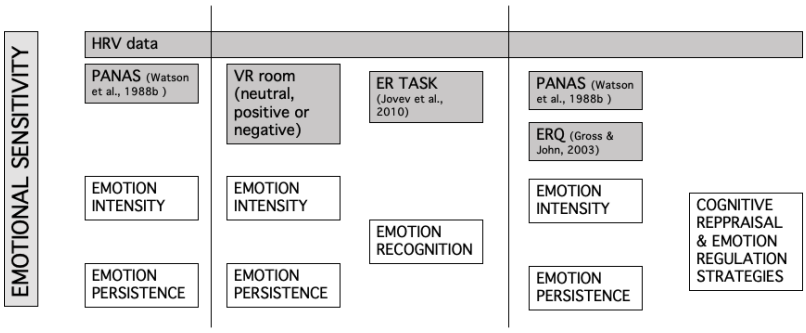


**Figure 1** A comprehensive framework to assess individual differences in Emotional Sensitivity.

## 3. Discussion

The expected benefits of this VR assessment are two-fold. First, the app will allow for the gathering of data on individual differences in emotional sensitivity as a result of the multilevel associations between self-reported and physiological levels of emotional activation, emotion recognition, and cognitive reappraisal, offering useful insights on age-related specificities in different non-clinical populations (adolescents and young adults). Highlighting specific patterns of associations accounting for individual-related and context-related is crucial during both adolescence and early adulthood, as literature shows [i.e., 22, 23, 24]. Second, it will assess different thresholds of recognition of emotions inside emotionally charged (or not) scenarios (emotion recognition), the level of emotional activation before, during, and after the task (via HRV device) (emotion intensity), and the tendency to elaborate the emotional experience positively, neutrally, or negatively (cognitive reappraisal), thus operationalizing a multi-layered construct that has significant clinical impact [9].

Also, the initial study will assess the overall user experience and possible problems. All in all, the ES app will provide reliable information for clinical use and research.

## 4. Conclusions

The ES app allows us to:
1) provide an ecological evaluation of the emotional experience, accounting for possible environmental factors
2) assess individual differences in Emotional Sensitivity, accounting for different components (reaction to stimuli, emotional activation and cognitive reappraisal)
3) provide a methodologically sound operationalization of a complex construct that has substantial clinical evidence. Further studies will have to be conducted to evaluate these aspects in different clinical samples such as those with personality disorders and mood disorders.

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# Training Mentalizing Skills In Virtual Reality: An Experimental Treatment For Children

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**Abstract.** Mentalization is the ability to understand behaviors as underlying mental states such as thoughts, emotions, and motivations. Mentalization development is considered complete between 8 to 12 years old. The possibility to work on this competence may have a substantial role in preventing or intervening in child psychopathology. Mentalizing Skills (MS) are activated in a relational context. This contribution's main objective is to suggest developing a Virtual Reality (VR) tool to assess socio-emotional abilities in children and train mentalization skills (MS) in an immersive environment. More specifically, we aim to test longitudinal variations (before and after intervention) of (1) socio-emotional problems and (2) emotion regulation strategies (expressive suppression and cognitive reappraisal). Participants will be assessed with the Roberts-2 test using a VR app to assess MS using a head-tracked Head Mounted Display (HMD). The new app will assess the participants' ability to make inferential thoughts about others' states of mind, and a validated device will record Heart Rate Variability as a measure of emotion regulation. This new protocol will provide a reliable and engaging way to assess and train MS in an ecological environment via an agile technology-based approach, offering clinicians valuable insights into the children's skills/deficiencies, useful for prevention and clinical intervention.

**Keywords:** Assessment, Middle Childhood, Mentalization, Socio-emotional development, Virtual Reality (VR)

## 1. Introduction

Mentalization is a mental function that allows us to implicitly and explicitly understand self-related and interpersonal-related actions as intentional mental states such as personal desires, needs, reasons, beliefs, and feelings [1].

The latter is even more critical as mentalizing skills (MS) grow in the context of attachment relationships. Indeed, it is the primary caregiver that simultaneously communicates an empathic understanding of the child's mental states and facilitates the symbolization of emotional phenomena [2]. From a developmental perspective, the ability to mentalize peaks between 7 and 12 years old, when most children can think of themselves and others more as individual personal qualities and mental states [3].

Allen and Fonagy [4] described mentalization as a "pause" button that we use to regulate emotional reactions; indeed, understanding emotions is not enough if we cannot make sense of them in a self/interpersonal context.

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When we can ascribe meaning to others' behaviors (and our own), the interpersonal world becomes more predictable, safe, and meaningful. However, when we misinterpret the intentions of others or struggle to make sense of our inner states, this can lead to confusion, misunderstanding, and problems in interpersonal relationships, contributing to increased conflict or inner anger and fear. The interpretation we give to the underlying reasons for specific behaviors of others has a significant impact on the way we think and act. Indeed, adequate mentalization is essential to the ability to regulate emotions and the development of a coherent self-narrative. On the other hand, deficits in this capacity have been hypothesized to create a vulnerability to psychopathology [2]. Interestingly, difficulties in MS can be more clearly associated with a breakdown of mentalizing that is either temporary and context-specific or more chronic. On the one hand, a temporary, context-related breakdown may take the form of a switch away from more controlled, explicit mentalizing, usually in the context of heightened emotional states of stress or arousal. On the other, a more chronic deficit in MS, i.e., in some children referred to child mental health services, may manifest as limited ability to mentalize about themselves or others. This condition manifests as an inability to understand their feelings and failure to use reflection to facilitate self- and affect regulation [5, 6]. Impairments in MS in childhood are related to a wide array of cognitive and socioemotional problems such as in attentional control, effortful control, academic achievement, emotion regulation, and internalizing and externalizing problems [7]. Indeed, Baron-Cohen talks about "mental blindness" in children with ASD [8]; deficits in mentalization are often found in children with anxiety disorders [9], and mentalization is inversely correlated with depressive disorders in children [10]. Finally, research shows strong evidence of the relationship between quality of attachment and MS [11;12].

Thus, adequate MS are considered a protective factor in psychopathological outcomes (i.e., in trauma-exposed children and adolescents) [13;14]. Moreover, recent literature converges in identifying mentalization as a common factor of psychotherapeutic change [1;15]. Currently, the Mentalization Based Treatment for Children (MBT-C) is the only systematic and transdiagnostic treatment available to promote the child's ability to regulate emotions and to mentalize about self and others [5]. Indeed, from this perspective, the therapist's task is to encourage a mentalizing process in the therapeutic interaction. This aim in children's mentalization-based treatment goes together with developing the capacity to recognize, endure, and regulate emotions. This capacity is enormously helpful in becoming more attuned to others, understanding complex social situations, and experiencing self-control, a sense of self, and agency. Indeed, children from clinical populations are often underregulated or overregulated, thus showing ineffective use of the "volume control" of emotions [5].

The aim of the present study is to provide reliable and engaging instruments to assess and train MS in clinical settings when MBT-C is not available or suitable.

Thus, as the promising advances in integrating new technologies in the clinical settings is proving beneficial [16] and allows for an ecological and realistic assessment [17;18], this contribution's main objective is to suggest developing a VR tool to assess socio-emotional abilities in children and train mentalizing skills (MS), focusing on emotion regulation in an immersive environment that might also foster therapeutic alliance [19]. More specifically, we aim at testing longitudinal variations (before and after intervention) of (1) socio-emotional problems and (2) emotion regulation strategies (expressive suppression and cognitive reappraisal).

## 2. Methods

Participants will be children ranging from 8 to 12 years old, recruited in mental health services for children and adolescents. The research includes patients with internalizing and externalizing problems, certified by clinical services.

*Measures*

*The strengths and difficulties questionnaire* (SDQ; Muris et al., 2003) consists of 25 items describing positive and negative attributes of children and adolescents that can be

allocated to 5 subscales of 5 items each: the emotional symptoms subscale, the conduct problems subscale, the hyperactivity-inattention subscale, the peer problems subscale, and the prosocial behaviour subscale.
*Emotion Regulation Questionnaire for Children and Adolescents* (ERQ–CA; Gross & John, 2003) comprises 10 items assessing the ER strategies of Cognitive Reappraisal (6 items) and Expressive Suppression (4 items).
*Roberts-2* (Roberts & Gruber, 2005) is a narrative test for children and adolescents from 6 to 18 years old. Roberts–2 aims to measure two main psychological issues: the developmental function, which includes the cognitive, affective, and relational changes that occur as children grow older, and the clinical functioning, which involves the possible inclusion of unusual and atypical elements within the comprehension of social situations.
*Head Mounted Display Oculus Go©* will be used to explore the virtual environments.
Physiological signal will be collected by means of a *Procomp Infinity* device from Thought Technology, and *Biograph Infinity 5.0.2* software will be used to record them.

*Baseline*

Demographics will be collected in this phase. Parents will compile the SDQ questionnaire while children are assessed with the ERQ–CA.

*Assessment*

Participants will wear a HRV monitor and the HMD headset. Subjects are entirely immersed in a neutral environment that they can freely explore (i.e., a living room).
After familiarization, the examiner asks them to look for a screen on one of the virtual walls and then signals that it is where the stimuli will appear.

Participants will see a selection of 5 cards from the Roberts-2 test that allows for exploration of an individual's models of cognition and representations of self and others by analyzing personality characteristics, cognitive functioning, and relational dynamics via a narrative task [20]. Every card depicts a problematic relational situation within the familial or peer context (i.e., rule breaking, bullying, siblings' rivalry, health problems that affect significant others). A voice-over asks questions ("What is happening here? What do they think and feel? What happened before and what is going to happen after?") while the Roberts-2 cards appear on the blank screen in the VR scenario. The examiner tape-records all verbal responses as well as HRV data. To evaluate the socio-emotional competences (or lack of) of the children (i.e., to recognize and "solve" those problematic situations), subjects are asked to tell a story about each situation, evaluating the characters' thoughts, emotions, and motivations as the story plot unfolds. To evaluate emotional regulation both on an implicit and explicit level, children will be assessed both via HRV data and by asking them to rate their "emotional volume" on a virtual dial numbered from 1 to 10, signaling no emotional activation, calm ("low volume"), to high emotional activation, agitation ("high volume") before and after every card.

*Intervention*

The assessment phase will detect socio-emotional themes to focus on in five intervention sessions in VR, highlighting detailed difficulties as well as strengths, and the patient's implicit and explicit emotional reactions. During these sessions, the therapist and the patient will join the virtual room together and face a socio-emotional theme, using it to train MS according to the eight polarities of the mentalization framework, i.e., allowing the patient to develop significant narratives that include self and other-related perspectives, explicit and implicit motivations, and clear evaluation of affect and cognition. Practically, the therapist has to "stop and rewind" the narrative process to the point where the child lacks mentalization or suggests thinking of a different narrative for the same situation. Again, children will be asked to move their "volume" dial starting from the one they previously indicated (assessment phase). This will allow for a focus on finding different regulatory strategies associated with problematic socio-emotional themes.

*Follow-up*
At the end of the intervention, parents compile the SDQ questionnaire while children are assessed with ERQ–CA. Six months later, parents compile the SDQ questionnaire while children are tested again with the ERQ–CA and the VR app.

## 3. Expected results

The new app will provide an ecological assessment of the participants' ability to create an elaborate story that includes emotions, resources, thoughts, and characters' states of mind, and develops a positive conclusion, highlighting specific abilities/deficiencies in making assumptions about others' behaviors, emotions, and motivations. Moreover, it will assess socio-emotional abilities in children in a reliable way able to match the verbal and nonverbal (physiological) behaviors. Additionally, the VR environment will provide an engaging and suitable condition to train children to recognize, find, and modulate emotions to train/develop MS.

All in all, we expect to find significant variations in the levels of socio-emotional problems and emotion regulation strategies after the intervention. Finally, the initial pilot study will assess overall user experience and possible difficulties such as video-length fatigue.

## 4. Conclusion

The present experimental treatment will provide a time-limited approach to provide an advancement in MS to prevent or treat trans-diagnostical developmental psychopathology.
This original project allows us to:

1) Obtain specific information about different areas of socio-emotional development to tailor clinical intervention
2) Promote the ability “to make sense” of interpersonal dynamics by collecting data on thoughts, emotions, and motivations
3) Train children in understanding mentalization breakdowns and control the “volume” of their emotion in order to re-establish mentalization abilities
4) Train children in developing self-agency and self-efficacy in managing difficulties with socio-emotional functioning
5) Prevent or intervene in complex and developmentally crucial functions of daily life in an enjoyable way

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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 offers greater interactivity and better tailoring of information to individual needs.

*Wiederhold & Riva, 2004*

# Covid-19 Lockdown in Italy as a Potential Transformative Experience: A Pilot Study

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**Abstract.** Transformation can be deemed as a process composed of specific emotional (e.g., awe) and cognitive components (worldview and mental schema) interacting together to trigger impactful experiences of transformation (TE). Several theories posited that one trigger of transformation can be something able to violate people's current worldview. In Italy, the lockdown – requested by the Government to limit the consequences of pandemic - represented an unprecedented experience for Italian citizens. Although COVID-19 home confinement significantly impacted psychosocial wellbeing and encouraged the adoption of new communication technologies to overcome lockdown loneliness, no difference emerged in relation to lockdown intensity. However, the potential transformative impact of this event has not been tested yet. In this study, we measured fluctuations of nine healthy Italian people's cognitive worldview and personality traits, as well as their disposition to live the complex emotion of awe in three timeframes (i.e., at the beginning of Italian Lockdown period, at the end, and one month after the end of the lockdown). No significant changes emerged from data analyses, thus suggesting that, despite the potential impact of this worldwide event, people's stable worldview, personality factors, and complex emotion dispositions persisted, at least, immediately after the first lockdown period.

**Keywords.** Transformative Experience, Worldview, Complex Emotions, Lockdown

## 1. Introduction

Transformation has been deemed as a sudden and unexpected change involving people's accustomed worldview, certainties, and dispositions that would be not reversible. Particularly, what differentiates a transformative experience, in this sense, from a simple change during the life of a human being is that the former represents a sudden and long-lasting transformation that encompasses a person's beliefs, identity, and attitude towards others [1], while the latter is described by the psychological literature as a linear, stepwise, and continuous process. In other words, a transformation produces a *trait*, intended as a long-lasting, stable restructuration in one or more personal dimensions, be it an attitude, performance, or any other inner characteristics. The unprecedented changes that came on so quickly due to the spread of COVID-19 on the entire population, and whose worst limitations consisted of the stay-at-home confinement to accomplish social distancing and mitigate risk for infection, pose many challenges. These include compromised health, well-being, and sleep as a consequence

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of disruption of the daily life routine, anxiety, worry, isolation, greater family and work stress, and excessive screen time [2].

On the other hand, social distancing, domestic isolation, and working from home could have also presented some aspects of opportunity, in the sense that this new situation has reshaped the boundaries of each human being's existence in terms of priorities and necessities. Possible criteria for identifying the occurrence of the lockdown period as a transformative experience may include the features identified from related studies [3] that define, in these terms, a transformative experience:

- The experience should be subjectively different from ordinary processes of change.
- The experience should entail something insightful for the individual.
- The experience should involve moments of deep insight and awe.
- The experience should concern a wide range of behaviors and beliefs that infuses almost to the level of personality (e.g., the individual may say, "I became a different person.").
- The experience should include more than a singular behavioral modification (e.g., stopping smoking).
- The experience should involve positive changes although transformative experience can be also negative [4].

Additionally, in 1962, Maslow observed how the mechanism behind a transformative experience can be characterized by moments of unexpected acceleration in personal development. He defined these moments "peak experience", describing them as powerful, self-transforming events characterized by a sense of inspiration, well-being, and transcendence. According to Maslow, positive, long-term effects of a peak experience include a more positive view of the self, other people, and the world, as well as renewed meaning in life [5].In virtue of this, the lockdown, requested by the Italian Government to limit the consequences of the pandemic, could have represented a transformative experience itself, falling within the criteria and long-term effects identified by the literature.

To test this hypothesis, we ran a study in which we monitored fluctuations in terms of relatively stable dimensions: general worldview [6], personality factors [7], and dispositions to live awe [8] in nine Italian participants across the initial pandemic period (from February 2021 to July 2021) in Italy [9]. Three timeframes were considered in relation to the first lockdown period: (i) the beginning, (ii) the end, and (iii) a 1-month follow up.

## 2. Methods

9 participants (6 females; sample's mean age = 23.9; S.D. = 1.9) were involved. Participants reported no symptoms associated to COVID-19, nor other symptoms. They were all healthy and did not have close relatives affected by COVID-19 or other clinical pathological conditions at the time of the study. An online survey (www.qualtrics.com) consisting of the Italian version of the World Assumption Scale (WAS), the Italian Big-Five Inventory (BFI-44), and the Italian Dispositional Positive Emotions Scale (DPES) was administered to participants. The World Assumption Scale (WAS) [10] is a frequently used measure in trauma research. The 32 items of the WAS are intended to represent eight assumptions about the benevolence of the world, the meaningfulness of events, and the worthiness of the self. The items theoretically form eight subscales that consist of four items each. Answers are given on a 6-point scale ranging from 1 (*strongly disagree)* to 6 (*strongly agree)*. The Italian version of the Big Five Inventory (BFI) [11] is a 44-item self-administered tool designed to measure the Big Five factors of personality.The DPES [12] measures the general disposition to experience seven distinct positive emotions (i.e. joy, contentment, pride, love, compassion, amusement, and awe). The DPES consists of 36 items rated on a 7-point

scale ranging from 1 (strongly disagree) to 7 (strongly agree). The minimum score that can be obtained by submitting to the final version of the 36-item scale is 0, while the maximum score obtained by adding the participant's answers is 252.

All the participants were subjected to the three questionnaires in at least two out of three different timeframes considered – i) at the beginning of Italian Lockdown period or ii) at the end of the Italian Lockdown period. However, data from BFI-44 and WAS scale for the third timeframe - the follow-up stage about one month after the end of the lockdown – were collected from 7 out of 9 participants. For this reason, data analysis was conducted considering 7 participants out of 9.

## 3. Results and discussion

Repeated measure ANOVAs did not show significant differences across the three timeframes regarding the target variables. However, Pearson's correlations among key variables showed an initial high significant positive correlation between the disposition to experience awe and the belief of the world as a controllable place ($r = .851$; $p = .004$) and the people as benevolent ( $r = .763$; $p = .017$), which diminished in the second phase (controllability: $r = .684$; $p = .042$) and became nonsignificant in the last phase. Conversely, in the follow up, a significant high positive correlation between the Extroversion personality factor and the beliefs that people are benevolent emerged ($r = .701$; $p = .036$).

The absence of any significant differences in the target variables across the three different timeframes in which the Questionnaires (WAS, Italian Big Five Questionnaire, DPES) were assessed means that no significant mutation in one's beliefs, personality, attitude toward others and the world, was detected. This could be interpreted as a non-potential identification of the lockdown period as a transformative experience.

However, the Pearson's correlation between the disposition to experience awe and the belief of the world as a controllable place was found to be positive and significant in the first timeframe, diminished in the second one and was absent after one month to the end of the lockdown. This could be indicative of a lower disposition to experience positive emotions, caused by a political and social distrust toward the institutions and the world itself, and triggered by the after-effects of the home confinement together with all the limitations, especially caused by the second period of lockdown, and more visible one month after the end of the isolation. This can be easily explained by previous Italian studies conducted after the lockdown [13,14,15] in which lower rates of anxiety, depression, and perceived stress were found out during the three weeks of confinement, but increased rates in the same mental disorders such as depression symptoms and anxiety symptoms together with PTSD symptoms, were detected after the end of the lockdown, in a period between 1 to 3 months.

Despite this, a significant high positive correlation between the Extroversion personality factor and the beliefs that people are benevolent was found out among participants in the follow-up stage of the study. This correlation indicates a possible desire in those who are more prone to new social situations and whose personality is characterized by breadth of activities, urgency from external activity/situations, and energy creation from external means to recover earlier from the lockdown's after effect, along with a new tendency to trust people and the world outside.

## 4. Conclusion

In this pilot study, we tested the potential transformative impact of the lockdown in Italy. Despite all these variables remaining stable, some significant internal correlations emerged between awe proneness and worldview, meaning that given the results of this study, we could not identify the lockdown period as an actual transformative experience. The administration of the WAS, Italian Big Five Questionnaire, and DPES assessed some changes that need further investigations. Finally, this study relied on a

very small sample of participants, thus it is plausible that the power was too low to detect significant changes across the three timeframes. However, this remains the first empirical study that proposes and implements an operationalization and assessment of TEs in a naturalistic context.

**Acknowledgments**: this project was supported by Fondazione Cariplo, grant: "Promoting Education of Scientific and Technological Societal Issues Through Sublime (PROMETHEUS)" n°: 2019-3536

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# Cyberintervention on plant workforce's mental activity for safety

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**Abstract.** Stress is recognized as an important health and safety indicator in work environments as it can both endanger workers and hinder companies' workflow. HRV is recognized as a good psychophysiological indicator of personal stress and can also be detected with innovative wearable electrocardiogram (ECG) bands which allow us to obtain recordings in real-life situations. This work proposes an innovative procedure for the assessment and a subsequent intervention against stress, using an AI approach for the detection of unhealthy stress status followed by a VR heart rate variability biofeedback treatment to address it. The procedure consists of assessing personal data and stress and tiredness levels of workers, and then collecting their ECG data through the cardio band Zephyr BioHarness during a standard workday. Researchers will shadow the participants without interfering, labeling each activity according to a predefined scale in clusters of homogeneous behaviors. After preliminary analysis, the data will populate a database to be used to train an AI with the goal to detect patterns related to stress and find out which HRV components are best at predicting stress. To compare our on-field recordings, we will also use data from open-source databases, with physiological registration of stressful situations. This procedure was tested on 11 plant workers during a standard job day.

**Keywords.** Mental Activity, Stress, ECG, HRV, Company Productivity

## 1. Introduction

Chronic stress can lead to cognitive dysfunctions, cardiovascular diseases, depression, and death, and it is related to injuries and accidents [1–3]. Apart from health and safety issues, in work environments, stress causes performance reductions [3] that hinder workflow and reduce companies' productivity and profitability.

Many studies correlate stress to changes in Heart Rate Variability (HRV) values, detected by ECG; in detail, in the frequency domain, the decrease in the High Frequency (HF) values and the increase in the ratio between Low and High Frequency (LF / HF) were proven to be significantly related to stress levels [2,3].

Wearable wireless devices for health monitoring are becoming increasingly accurate and reliable, and therefore a popular prevention tool used in healthcare. This is also due to their low-cost availability and the possibility to be used outdoor and in motion [1].

Thanks to the reliability of recent smart devices, we decided to exploit this kind of technology in a novel approach: we measured psychophysiological ECG data of a group of plant workers along with recording the type of activity they simultaneously carried out during their day job.

Our general objective is to investigate potential correlation between ECG activation, psychological status, and type of activity performed.

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For this purpose, we put in relation psychophysiological data obtained in a real-world context with changes of environment and activity in the daily workflow and the workers' psychological condition to assess their status during their day job.

Our ultimate aim is to create a useful tool for workers that could improve health and safety, and help people avoid dangerous mental states such as extreme stress or tiredness.

In the present study, we propose a procedure for the simultaneous assessment of ECG activation, psychological status, and type of activity. To test the feasibility of such an investigation, we have carried out a preliminary registration in a real-life condition with a sample of 13 plant workers.

## 2. Method and Tools

Our proposed procedure includes a 15-minute meeting in which we explain the aim of the study to the subjects, collect the minimal significant set of their personal data, along with information about their stress and tiredness levels in brief questionnaires in accordance with data protection and privacy regulations.

The questionnaires consist of 7 items administered before and after the recordings using a Likert scale from 1 to 10, and 4 yes/no questions about personal situations that could raise stress levels:

- How physically tired do you feel right now?
- How mentally tired do you feel right now?
- Right now, how much do you need to sleep or rest?
- Right now, how is your energy level?
- Right now, how physically nervous do you feel?
- Right now, how tense are your muscles?
- Right now, how stressed do you feel?/During your job, how stressed have you felt?
- Did you have any physical discomfort today?
- Have you experienced a non-ordinary and potentially stressful situation in the last month?
- Do you often have difficulty sleeping?
- Have you felt stressed or unable to manage daily events/unforeseen events?

The Zephyr BioHarness BH3 band [4,5] is a gold standard tool for multiparametric monitoring of ECG, HRV, and respiration signals, designed for sport activity and therefore suitable for data collection in a work environment. Participants are asked to wear it and, after the beginning of data collection, have a 2-minute baseline recording while resting.

Data need to be collected over at least two and half hours, depending on the duration of the shift and the subject's activities that day. Data are collected on the field while workers are carrying out their standard and planned activities. Meanwhile, researchers observe the work of those involved without impacting normal workflow, and register which activities are performed by each worker and at what time. At the end of their activities, involved workers repeat the 2-minute baseline recording and the stress and tiredness questionnaire.

Recorded ECG data are automatically saved and time referenced in the local memory of the Zephyr BioHarness. All the collected data are anonymized in compliance with all labor and governmental laws and regulations.

Thirteen plant workers took part of a preliminary test of our procedure aimed to investigate the feasibility of the procedure.

## 3. Data processing and preliminary results

Recorded workers' activities needed to be successively labeled in terms of predefined homogeneous behaviours as identified in Table 1, with one indicator for the

category of activity (mental, physical, stand-by, rest) and one for the activity's relevance (strategic, operational, stand-by, rest).

**Table 1.** Activities are described in terms of type of activity (physical or mental) and relevance (strategic or operational). Stand-by activity 3/7 and Rest break/Coffee break 4/8 always coincide.

| Code | Type of activity | Description |
|---|---|---|
| 1 | Predominantly mental activity | Activities of control, supervision, and all those activities that involve reasoning in order to make a decision |
| 2 | Predominantly physical activity | All the operational activities that can be included in an "automatic" decision which is neither reasoning nor decision-making. (e.g. walking, lifting weights) |
| 3 | Stand-by activity | Not a break from work, but a temporary lack of activity during the performance of one's duties |
| 4 | Rest break / Coffee break | An effective break from work activities (e.g., coffee break) |
| **Code** | **Type of activity** | **Description** |
| 5 | Strategic activity of significant importance | Activities that involve decision-making by a person who plays a key role in the company, not easily replaceable |
| 6 | Operational activity | Non-strategic operational activities carried out by a person holding a non-strategic role |
| 7 | Stand by activity | Non-strategic operational activities carried out by a person holding a non-strategic role |
| 8 | Rest break / Coffee break | An effective break from work activities (e.g., coffee break) |

ECG data are retrieved from the Zephyr's internal memory and examined through Matlab, digital signal processing modules, and SinusCore.

Each labelled epoch will be synchronised and linked to the psychophysiological recordings and to the results of questionnaires; this data will be used to populate a multimodal database. It will be important to precisely define which variables would be included in the single dataset and to choose which variables will be included in the minimum dataset in order to sufficiently obtain precise predictions with the lowest computational cost of the models used.

## 4. Discussion

Our experience suggests that this procedure is feasible and could lead to interesting evaluations of workers' stress conditions.

Moreover, some pre-analysis were performed: data was analyzed in terms of key statistical indicators over time (average, variance, correlation) with different preliminary hypotheses, and some qualitative evidence has arisen during the meetings with the workers.

The main difficulties were found in the following of the subjects by the experimenters: the routes in the plants were complicated and partially dangerous. Consequently, the subjects often talked to us, explaining the functioning of the instruments around and of the job. This could also be linked to the novelty of the experience for them.

We believe that the realistic working conditions are sufficiently maintained, especially during the core activities. However, different kinds of activity tracking methods could be considered (e.g., video equipment, automatic geospatial tracking,…) to minimize bias due to the researcher's presence.

Another important point is that the shift of the single subject needs to provide different kinds of activities with different levels and kinds of engagement and stress.

Future steps will focus on the data analysis and will proceed in the following way: recorded physiological data, divided in epoch and linked to the labels of worker's activity and level of stress, will populate a database which will be used to set up an AI/ML approach.

To increase the amount of data, we will request access to 3 open-source multimodal databases in which researchers link psychophysiological recording to activities categorized by arousal and valence [6] (stress is described as a high arousal and negative valence status). These are:

- MAHNOB HCI-TAGGING (recording data from eye tracker, ECG, 32-channels EEG, skin conductance, respiration, and skin temperature) [7]
- DEAP (recording data from 32-channels EEG, skin conductance, Blood Volume Pulse, ECG, respiration, skin temperature, electrooculogram, and electromyography of the zygomatic and trapezius muscles) [8]
- DECAF (recording data from magnetoencephalography, electrooculogram, ECG, trapezius electromyography, and infrared facial videos) [9]

The integration between our recording and the open-source database will follow three methodological logics:

- Machine learning on the open-source database then application of the best performer algorithm to our on-field recording database
- Machine learning on our on-field recording database then application of the best performer algorithm to the open-source database
- Mixing the open-source database with our on-field recording database, dividing it in two homogeneous groups – one for machine learning and one for evaluation

Machine learning will start with a preliminary estimate of maximum accuracy and will therefore take place as suggested by Orrù et al. [10] through supervised black box regression models – more accurate but not easily interpretable, such as, for example, Tree Ensembles (Random Forest, Gradient Boosted Trees) and Deep Neural Networks.

Secondly, we will implement a training through supervised white box regression models (i.e., Linear Regression, Decision Trees, GAMs) performed directly through stratified 10-fold cross validation (removing 20% of the data for the next test and performing fold and training on the remaining 80%) in order to ensure maximum replicability of the study. The results of the various models will then be compared and evaluated to determine which ones show greater precision. The implementation of this phase will take place via Azure Machine Learning or equivalent systems.

A further step would be to collect a wider dataset spanning over different organizations, seniority tiers, and assigned tasks. This will be used to improve the AI capability to recognise unhealthy stress statuses.

A proposed step is the design of a user-friendly smartphone application collecting physiological data, analysed through a remote processing service, giving real time feedback. With this application, we will also provide a virtual reality immersion experience to train people who find themselves in stressful situations.

As in Blum et al., [11] we will use a virtual nature environment to administer immersive HRV biofeedback based on slow-paced breathing as it has shown good results in terms of relaxation, relaxation self-efficacy, decrease of mind wandering, and conservation of attentional resources (making it suitable for work environments).

## 5. Conclusion

The procedure suggested and carried out appears feasible and could lead to implementations which could improve workers' health and safety and could boost productivity and profitability in plants. Additionally, we suggest that this kind of procedure be tested and applied in different fields and conditions.

Main innovations are the use of real-life recording for creating the AI dataset and the early detection of dangerous stress levels. More studies will lead to the definition of the minimum time series needed to understand the stress level and give real time feedback to the user.

Furthermore, the use of wearable ECG sets and smartphone-based VR represent an innovative but viable and cost-effective solution for a small-medium enterprise.

Similar systems would be also applied to other mental states such as boredom, sleepiness, or flow performance.

## Acknowledgment

Special thanks: We would like to thank Buzzi Unicem Italia and Iplom spa as well as all their workers, for supporting our research and hosting us in their plants.

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# 360° immersive photos and videos, an ecological approach to memory assessment: the ObReco-2

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**Abstract.** In recent years, the efficacy of psychometric tests in evaluating life-like abilities has become one of the central topics in the neuropsychological assessment field. Considering that many of the classic available tools show low to moderate levels of ecological validity, researchers emphasize the need to collect data that are more similar to what is observed in realistic settings. Virtual reality emerges as a promising instrument to provide life-like experiences in a controlled and safe way that might enhance the ecological assessment compared to standard paper-and-pencil tests. Particularly, an innovative trend in virtual reality technologies are 360° spherical photos and videos which allow for keeping high levels of graphical realism and immersivity. These features appear to be crucial elements to solve the issue of validity. In this scenario, we present a protocol exploiting a 360° technology for the neuropsychological assessment of memory. Retracing the structure of the Rivermead Behavior Memory Test, the ecological device ObReco-2 recreates a daily environment. During the task, patients will be immersed in a house and asked to memorize some objects that need to be moved for a relocation.

**Keywords.** Memory, Assessment, 360° video, Object recognition, Virtual reality

## 1. Introduction

One crucial debate in the neuropsychological field is how to best measure cognitive functions in a reliable and valid way. The controversy revolves around the concept of ecological validity, which defines how much patients' test scores predict real-life functioning, i.e., the relationship between neuropsychological tests and real-life activities [1]. Classically, neuropsychological assessment is provided in the paper-and-pencil modality. However, over the past decade, there is an ongoing debate about the effectiveness of many of the available tests in assessing life-like abilities; indeed, patients couldn't present problems in the clinical setting but showed difficulties in daily situations [2]. This problem stems from a test construction technique that begins with a solid theoretical paradigm evaluating abstract constructs with no reference to real-life performance or behaviour. Thus, academics emphasize the importance of moving from a construct-based to a function-based approach which originates from the direct observation of performance in everyday life contexts to create more ecological assessment procedures [3; 4; 5]. The most well-known example of this approach in the memory assessment domain is the Rivermead Behavioural Memory Test (RBMT) [6],

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which covers a series of daily-life tasks such as locating personal objects, remembering an appointment, etc.

ecently, new suitable technologies emerged to develop function-led tools for neuropsychological assessment such as virtual reality (VR). Thanks to its capability to simulate realistic environments, VR can be used to create complex stimuli for examining individuals' cognitive abilities in a more ecological setting [5], allowing researchers and clinicians to collect measures very similar to those observed in naturalistic environments, thus obtaining better prognostic indexes of real-life functioning in a safe and controlled situation.

Several authors have already employed VR to develop technological tools for the neuropsychological assessment of memory, creating virtual 3D environments (e.g. office and supermarket) in which patients could navigate the virtual space while learning and then recalling some objects in the environment [7; 8]. The results showed that these tasks are valid tools for measuring memory functioning in an ecological context.

In this regard, an emerging declination of VR technology offering promising results are the 360° immersive photos and videos [5]. They are spherical videos or photos recorded by a camera with omnidirectional lenses, able to collect images from all around the space. This approach offers more advantages than graphic-based VR. As mentioned, 360° images capture the real-world, offering a high level of visual realism that can further boost participant engagement Moreover, this technology does not require a high level of professional expertise to be managed, and the equipment required is less expensive [9]. Further, due to the user-friendly design of the environments and hardware, 360° technologies are especially ideal for the assessment of patients with mild to severe impairments [5; 10] who may have difficulty interacting with more sophisticated devices.

Considering this, we aim to present our neuropsychological assessment protocol based on 360° technology. Starting from the evidence obtained in an earlier pilot study [11], we will implement a novel tool, ObReco-2, considering limitations regarding the design of the experiences. Specifically, we will look for tasks that resemble the challenges of daily life, working around the interactivity limitations that characterize this technology.

## 2. Method and Tools

### *2.1. The ObReco-2*

ObReco-2 (Object Recognition-version number two) is a 360° task based on the Picture Recognitions sub-test of the RMBT-3. The aim is to create a task to assess memory in a situation as realistic as possible, simulating a real-life circumstance in a daily setting. As a result, the task occurs in a living room in which we request participants to encode and then recall some target objects. The context is briefly explained during the initial phase: Marco, who is living with other roommates, has to relocate and thus he has to collect all his objects and put a label with his name on them.

The virtual interactive experience consists of a series of different phases:

(i) Familiarization: patients will wear the headset, finding themselves immersed in a 360° natural landscape. Four icons numbered from 1 to 4 are placed in the four cardinal points and patients will be asked to look for all the numbers in order (Figure 1). When selected, each number will show a message indicating to continue to the following number, up to number 4, which will show the test instructions. This phase aims to make the patient familiar with the technology and to detect possible side effects (i.e. cybersickness).


**Figure 1.** The figure shows the naturalistic scenario, explorable during the familiarization phase.

(ii) Encoding: a 360° black space appears showing the instructions along with a file audio and two interactive icons. The one on the left allows participants to listen to the instructions again while the right one allows them to continue with the test (Figure 2).

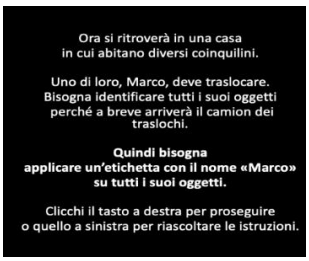


**Figure 2.** The figure shows the instructions that participants could both read or listen to.

Participants will be then immersed in a domestic environment (i.e., a living room) in which they can navigate from a first-person perspective, which is the one of the experimenter. This one walks around the room and points attention to the 15 target objects for 3 seconds each, putting a tag with the name 'Marco' on them (Figure 3). In the room, there are also 15 other objects as distractors. In this phase, participants are instructed to label all the target objects.

**Figure 3.** A screenshot showing the daily environment presented during the encoding phase.

(iii) Interference: after having labelled all the target items, participants will be invited to remove the headset and they are then engaged in non-verbal tasks for 15 minutes.

(iv) Free recall: they will be asked to recall as many objects as possible from the encoding phase.

(v) Recognition: in this last part, participants will be asked to wear the headset again. They will be immersed in the previous living room (Figure 5) and the instructions are to find and label the target objects among all the previous objects and a new set of 15 ones as a distractors. Then, a final black screen will appear representing the conclusion of the test session.

**Figure 5.** The panoramic photo of the room in which 15 targets are mixed with distractors.

### *2.2. Participants*

Participants will be 10 volunteers aged 60 or over (without maximum age limitation) of both sexes, and all participants will have normal or corrected-to-normal vision. Exclusion criteria will be invalidating internist, psychiatric or neurological conditions, or cognitive difficulties certifiable by a score of the Mini-Mental State Examination (MMSE) [12] lower than 24 points.

The study will involve randomized within-subject data collection. To examine the concurrent validity, each participant will perform a recognition task in two different conditions in a counterbalanced fashion: paper and pencil, including the Picture Recognition sub-test of the RBMT-3 Italian Version [4], and the 360° version.

### *2.3. Materials*

Files were recorded in a real environment using an omnidirectional video camera, the Insta 360 ONE X, which can record spherical photos and videos with a resolution of 608 x 3040 and 5.760 x 2.880 pixel, respectively. We combined all the photos and videos into a single interactive experience using the InstaVR software. The result consists of an interactive application that may be experienced using a Head-Mounted Display. In particular, we will use the Oculus© Go headset (64 GB) which allows participants to navigate and interact within this immersive 360° scenario thanks to a wireless controller.

### *2.4. Measures*

The task requires participants to encode 15 objects, recall, and recognize them after 15 minutes. Therefore, two measures of accuracy will be provided: the number of objects correctly recalled and recognized during the two recovery phases.

### *2.5. Data Analysis*

All of the data will be organized in a Windows Excel sheet. We will use two paired sample t-tests to evaluate the scores of free recall and recognition tasks in two conditions: paper and pencil test and 360° mode, to examine if the variations in performance are statistically significant. Finally, we will perform a second analysis to see whether there are any significant correlations between the considered activities. Jamovi will be used for all of the analyses (Version 2.0.0).

## 3. Future Directions

Based on the literature, the presented protocol seems to be promising in assessing memory function. However, further studies will analyze the usability and the clinical efficacy of ObReco-2. A future goal consists of exploring the validity of the instrument in comparison to standard paper and pencil tests and examining correlations of the data obtained in these two assessments. Additionally, it will be useful to survey participants' perceptions related to the used technology.

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# Gesture based word (re)acquisition with a virtual agent in augmented reality: A preliminary study

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**Abstract.** From an evolutionary perspective, language and gesture belong together as a system, serving communication on both an abstract and a physical level. In aphasia, when language is impaired, patients make use of gestures. Laboratory research has provided evidence that gesture can support aphasia rehabilitation, or more specifically, anomia rehabilitation. Here, we test an anomia gesture-based rehabilitation scenario with a virtual trainer (VT) in augmented reality (AR) as a therapy simulation. Thirty German-speaking participants were trained on 27 bi- and three-syllabic words of Vimmi, an artificial language. Each Vimmi word was paired to a function word in German. The participants were divided into two Groups of 15 and 15 persons. Group A learned word pairs by observing the gestures performed by the VT and additionally imitating them. Group B learned 27 word-pairs by observing the VT standing still and listening to them. Participants were trained singularly for 3 days, alternating one day of training with one day of rest for memory consolidation. Word retention was assessed immediately after each training session by means of free and cued recall tests administered electronically. Group A and Group B did not differ in word retention. When subdividing participants in high and low performers, interactions showed that high performers benefitted more from gesture-based training than low performers. The data in this preliminary study do not speak in favour of VTs as possible tools in gesture-based AR language rehabilitation. Technology might have, in this case, detrimental effects on word learning.

**Keywords.** Language; Gestures; Aphasia; Rehabilitation, Embodiment, Virtual Training

## 1. Introduction

Language and gesture are two sides of the same coin [1]. When spoken language is impaired, gestures come into play. Patients with anomia (PWA) failing to retrieve single words when naming objects or concepts may substitute the words with non-specific words (empty speech), or may provide circumlocutions or gestures [2]. It is conceivable that patients pantomime in order to substitute the words they cannot retrieve. At the same time, patients might unconsciously try to reactivate neural representations linking words and gestures, being as both systems are processed by a common neural system [3]. Traditionally, anomia treatment is administered by picture naming through flash cards [4]. In recent years, anomia has also been treated with gestures, thus supporting what patients spontaneously do [5]. This approach finds an early study [6] in which non-fluent aphasics found facilitation in naming objects when performing representative gestures. Despite its potential relevance [7], only a few therapy studies have been conducted on gesture-based rehabilitation [8]. In the last few years, digital technologies have paved a new way towards language rehabilitation [9]: with a computer or a tablet, patients can administer themselves as much therapy as they want or need, at any time of the day, ubiquitously [10].

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First steps in this direction prove that anomia rehabilitation takes benefit of digital therapy [11]. This option has been tested for naming tasks, with images appearing on the screen. However, digital therapy can be extended to rehabilitation with gestures performed by a virtual trainer in AR.

### *1.2 The present study*

With the present study, we aim to pursue the idea of anomia rehabilitation with gestures by means of a virtual trainer (VT) in augmented reality (AR). We will start the project with an experiment on healthy subjects considering that PWA have perception and motion impairments related to their pathology. Here, we hypothesize that imitating the gestures of the avatar is more efficient than hearing and reading the words and watching a VT that performs no gestures.

## 2. Methods

### *2.1 Participants*

Thirty German-speaking students from the University of Graz (14 F, 16 M; age ranging from 21 to 30; M = 26.1, SD = 2.88) participated in this study. The study was approved by the local ethics committee.

### 2.2 *Stimuli*

The stimuli consisted of 27 items of the artificial corpus "Vimmi" [12]. They were paired with German function words and divided in three counterbalanced learning blocks. For each word, audio-files were recorded. We modelled the AR-Avatar VARA as a woman aged of approximately 40 wearing casual clothes with the editor of game development platform UNITY5 (www.unity.com). The VARA's skeleton was animated with videos of a human previously recorded by Microsoft Kinect V2, further processed with iPi Studio (http://ipisoft.com/), Brekel ProBody 2 (https://brekel.com/brekel-pro-body-v2), and Asus Xtion. The avatar performed symbolic gestures that were arbitrarily paired to the words to be memorized. The stimuli consisted therefore of 27 items in Vimmi, 27 audio-files, and 27 modelled gestures performed by the avatar. Additionally, a no-gesture sequence in which the avatar stood still was realized.

### *2.3 Procedure*

In a between-subjects design, participants of Group A learned 27 artificial words watching the avatar. The avatar performed a gesture for the word. Simultaneously, an audio file was played, and the written word appeared on the screen. Thereafter, participants were asked to imitate the avatar's gesture and to repeat the word aloud (Condition GESTURE / G). In Group B, participants performed the same procedure with the exception of the gesture. The avatar that remained still performed no gestures and so did participants while sitting in their chairs (Condition AUDIOVISUAL / AV). Every word was presented 12 times. After each word block, there was a 5-minute break. The training lasted three days for approximately one hour daily.

The avatar and the audio files were downloaded into a smartphone (Galaxy S6; Samsung) mounted display on a Google Cardboard (Google) (HMD).

### *2.4 Tests*

After each training, participants completed 5 different retention tests on a standard PC by means of Google Forms in order to determine their learning progress: (1) Free recall of German words, (2) Free recall of Vimmi-words, (3) Free recall of German-Vimmi word pairs, (4) Cued recall from German into Vimmi, and (5) cued recall from Vimmi into German. Thirty days after the last training, participants were sent a link via email in order to assess their long-term memory performance (Follow-up - FU) with the same tests.

## 3. Results

Correct answers were given a score of 1, and wrong answers were given a score of 0. The score was 0.5 if the answers were not perfect but still recognizable. The scores ranged from 0 to 27 for each test.

The average retrieval performance over all tests over all time points was a mean value of 11.71 (SD=3.78). According to the approach used by Macedonia and colleagues [13], we further split the Groups in high vs low performers using the median intra-Group as the reference value (Group A: median=11.82; Group B: median=12). Table 1 reports descriptive data for all the Groups in all the tests and assessment time-points.

We investigated the influence of gestures on memory performance by running five repeated measures (one for each memory test) ANOVAs with the variable TIME (day 1, day 2, day 3, FU) as the within-subject factor, and GROUP (A vs B) as the between-subject factor. In addition, we considered the two Groups (A and B) separately, and we ran five repeated measures (one for each memory test) ANOVAs adding the factor Performance (high vs low) as the between-subjects variable in order to understand whether the learning curve differed for high and low performers belonging to the same encoding condition.

In the ***first set of analyses***, the factor Time was always significant [Free German: $F(3,81)= 95.23$; $p<0.001$; $\eta^2=0.78$; Free Vimmi: $F(3,81)= 92.39$; $p<0.001$; $\eta^2=0.77$; Paired recall: $F(3,81)= 85.74$; $p<0.001$; $\eta^2=0.76$; German to Vimmi: $F(3,81)= 87.49$; $p<0.001$; $\eta^2=0.76$; Vimmi to German: $F(3,36)= 68.43$; $p<0.001$; $\eta^2=0.71$]; repeated contrasts indicated differences from T1 and T2, from T2 and T3, and from T3 and T4 in all the tests (with Bonferroni correction for multiple comparisons all p(s) <0.05). The factor Group was significant only in the German to Vimmi Test ($F(1,27)= 4.59$; $p=0.04$; $\eta^2=0.14$], indicating that participants in Group B learned more than those in Group A (mean A= 8.97; mean B= 12). None of the interactions of Time X Group were significant. Therefore, we conclude that the gestures did not affect the learning curve differently from the still condition.

In the ***second set of analyses***, we considered Group A and B separately. For Group A, the factor Time was significant in all the memory tests [Free German: $F(3,39)= 47.87$; $p<0.001$; $\eta^2=0.79$; Free Vimmi: $F(3,39)= 46.64$; $p<0.001$; $\eta^2=0.78$; Paired recall: $F(3,39)= 47.75$; $p<0.001$; $\eta^2=0.79$; German to Vimmi: $F(3,39)= 46.38$; $p<0.001$; $\eta^2=0.78$; Vimmi to German: $F(3,39)= 37.78$; $p<0.001$; $\eta^2=0.74$]; repeated contrasts indicated differences from T1 and T2, from T2 and T3, and from T3 and T4 in all the tests (with Bonferroni correction for multiple comparisons all p(s) <0.05).

Not surprisingly, high performers in general learned more than low performers [Free German: $F(1,13)= 24.26$; $p<0.001$; $\eta^2=0.65$; Free Vimmi: $F(1.13)= 17.01$; $p<0.001$; $\eta^2=0.57$; Paired recall: $F(1,13)= 29.78$; $p<0.001$; $\eta^2=0.7$; German to Vimmi: $F(1,13)= 24.22$; $p<0.001$; $\eta^2=0.65$; Vimmi to German: $F(1,13)= 14.97$; $p=0.02$; $\eta^2=0.53$]. More interestingly, the interaction of Time X Performance was significant only in the Paired recall [$F(3,39)= 5.55$; $p=0.03$; $\eta^2=0.3$] and in the German to Vimmi test [$F(3,39)= 3.4$; $p=0.03$; $\eta^2=0.21$]. A closer look at the differences among the levels of the interaction evidenced that in the Paired recall, the high performers learned more than the low performers in T2 compared to T1 [$F(1,13)= 8.63$; $p<0.05$; $\eta^2=0.4$] but their performance also decreased more than that of the low performers from T3 to T4 [$F(1,13)= 12.94$; $p<0.05$; $\eta^2=0.5$]. In the German to Vimmi test, high performers lost more of the acquired words than low performers from T3 to T4 [$F(1,13)= 7.9$; $p<0.05$; $\eta^2=0.38$] (all the comparisons were corrected with Bonferroni correction for multiple comparisons). Figure 2 illustrates these interaction effects. For Group B, both main effects of Time [Free German: $F(3,36)= 44.12$; $p<0.001$; $\eta^2=0.79$; Free Vimmi: $F(3,36)=50.67$; $p<0.001$; $\eta^2=0.81$; Paired recall: $F(3,36)= 52.77$; $p<0.001$; $\eta^2=0.82$; German to Vimmi: $F(3,36)= 51.84$; $p<0.001$; $\eta^2=0.81$; Vimmi to German: $F(3,36)= 31.6$; $p<0.001$; $\eta^2=0.73$] and Performance [Free German: $F(1,12)= 7.82$; $p<0.001$; $\eta^2=0.97$; Free Vimmi: $F(1,12)= 7.14$; $p=0.02$; $\eta^2=0.37$; Paired recall: $F(1,12)= 1664$; $p=0.02$; $\eta^2=0.58$; German to Vimmi: $F(1,12)= 14.28$; $p=0.03$; $\eta^2=0.54$; Vimmi to German: $F(1,12)= 14.97$; $p=0.02$; $\eta^2=0.55$] were found. Repeated contrasts on the different levels of Time underlined differences statistically significant ($p<0.05$) from T1 to T2, from T2 to T3, and from T3 to T4 (with Bonferroni correction). However,

none of the interactions of Time X Performance reached significance, indicating that the learning curve did not differ between high and low performers who learned words in the still condition.

## 4. Discussion

In this preliminary study, we tested a rehabilitation scenario with healthy subjects in order to assess for the feasibility of embodied learning by means of a VT in AR. Briefly, gestural training compared to audio-visual training showed no memory enhancement for words. When splitting the two training groups in high and low performers, in Group A, high performers benefitted more from gestures than low performers in the recall test from German into Vimmi and in the cued paired recall.

The overall results do not match the hypothesis, i.e., gesture training is more effective than audio-visual training. The reasons leading to this poor result can be multiple. First, a between-subject design is a limitation: subjects might display different cognitive capacities in both groups. Second, the duration of the training may not have been sufficient. Third, these results may be attributed to the use of technology.

Considering the interactions between level of performance and training, the present data do not match the results of another study conducted with the same vocabulary items and similar gestures [14]. The present study rather provides evidence for the Theory of Cognitive Load (TCL). It describes the limits of our cognitive processing capacities with focus on our working memory. Thereafter, multimodal input would enhance mental workload and thus penalize low performers in memory tasks [15]. We conclude that, for the moment, PWA should not take on the burden of training conducted with a VT in AR.

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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 in a variety of healthcare situations including treatment of anxiety disorders and phobias, treatment of eating and body dysmorphic disorders, neuropsychological assessment and rehabilitation, and for 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 Inter-net worlds are swiftly demonstrating their usefulness in cybertherapy applications.

*Wiederhold & Wiederhold, 2004*

# An innovative solution for an integrated evaluation of Executive Dysfunctions

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**Abstract.** In recent years, the traditional neuropsychological assessment of executive functioning has been enriched by introducing VR-based tools and identifying non-verbal physiological measures obtained with different devices such as the Eye Tracker (ET) and electroencephalogram (EEG). We propose an innovative protocol for a multidimensional and multicomponent assessment of Executive Functions (EFs). Through the use of the EXecutive-functions Innovative Tool (EXIT 360°), an original task for EFs is delivered via this innovative technological device: a comfortable, mobile-powered VR headset, combined with ET and EEG sensors. EXIT 360° can be considered an innovative solution for evaluating executive dysfunctions, through which participants are involved in a "game for health", where they must perform everyday subtasks in 360° domestic environments. Integrating this VR-based tool with physiological devices will allow us to quickly obtain more information about executive dysfunctions. Overall, this innovative assessment wants to go beyond the effectiveness of VR-based tools or ET and EEG studies by combining different data for a multidimensional and multicomponent evaluation of executive functioning with high clinical usability and ecological validity.

**Keywords.** Executive Function, 360° Environment, Assessment, Virtual Reality, Eye tracker, Electroencephalogram

## 1. Introduction

Several studies have shown the feasibility and acceptability of Virtual Reality (VR) in assessing Executive Functions (EFs) in different clinical populations, allowing for an ecologically valid evaluation in controlled environments [1], [2]. Deficits in EFs, known as executive dysfunctions (ED), affect several neurological and psychiatric populations, with high negative impacts on everyday life due to the crucial role of EFs in several daily life activities such as shopping, cooking, managing money, and working [3], [4]. The VR-based tool allows for an ecologically valid evaluation of executive dysfunction because it enables realistic spatial and temporal scenarios that reproduce daily life [5]–[8], ensuring rigorous control over key variables [5]. Specifically, virtual environments allow for 1) better control of the environment, 2) more precise presentation of the stimulus, 3) greater applicability, and 4) data acquisition and performance analysis in real-time.

Over the years, executive functioning has been further explored by identifying non-verbal physiological indices obtained with the Eye Tracker (ET) and electroencephalogram (EEG). Specifically, many studies have shown that saccadic/antisaccadic movements, pupil dilation, fixations, and gaze direction can be considered reliable indicators of ED both in elderly subjects and in neurological/psychiatric disorders [9]–[13].

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Previous studies, which have adopted a multimodal approach (virtual environments and ET), have shown differences between patients with compromised EF and healthy control subjects [9]. EEG allows for the estimation of the complexity of executive dysfunctions in several clinical populations by detecting functional anomalies in the prefrontal cortex, responsible for EFs [14]–[17]. However, several studies showed difficulties in executive functioning associated with injury in different areas due to several connections of the prefrontal lobe and cortico-subcortical circuits (i.e., basal ganglia and thalamus) [14]. To date, very few studies have successfully integrated these two physiological devices, focusing mainly on executive dysfunctions in developmental age [18], [19]. The integration of VR-based tools and their advantages with ET and EEG could have the potential to innovatively and simultaneously evaluate many components of executive functioning in a real-life setting.

## 2. Objective

This research protocol proposes a new solution for a multidimensional and multicomponent assessment of EFs through the EXecutive-functions Innovative tool (EXIT360°) [20], with an original task for EFs delivered via this innovative technological device: a comfortable, mobile-powered VR headset combined with ET and EEG sensors.

## 3. Methods

EXIT 360° was designed to provide an ecologically valid assessment of several components of executive functioning quickly and simultaneously, involving participants in a "game for health" delivered via smartphones in which they must perform everyday subtasks in 360° environments that reproduce different real-life contexts [21]. This innovative tool was based on five critical dimensions: ecological validity, multicomponent and multidimensional assessment, integration, and clinical usability [20].

### *3.1 Ecological validity and multicomponent assessment*

We have chosen 360° settings, as they appeared in previous studies a promising solution to provide an ecological evaluation of EFs [1], allowing for the reproduction of real situations that participants can explore from a first-person perspective. In EXIT 360° environments, participants have to overcome seven subtasks of increasing complexity that represent everyday situations (Figure 1).

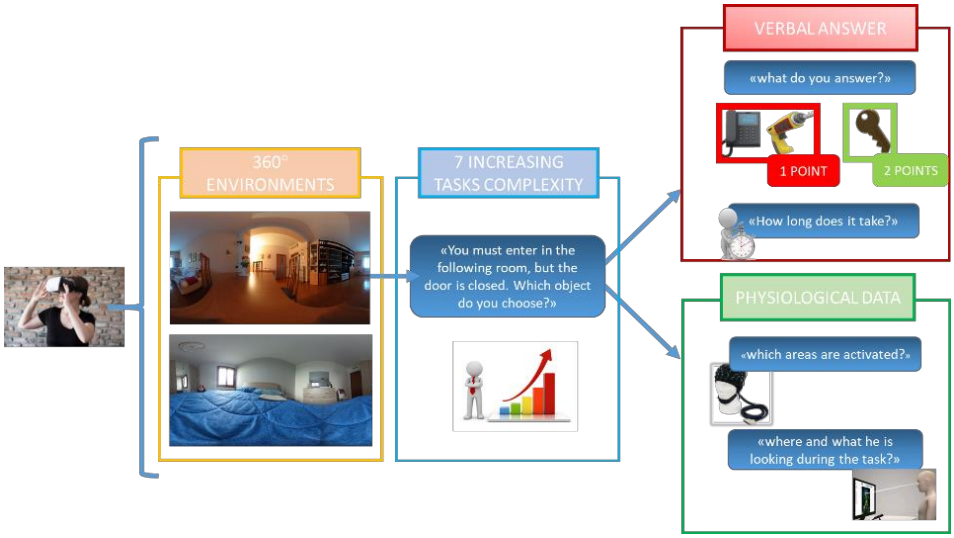

**Figure 1**: Architecture of EXIT 360°: an example of a task

These tasks were developed to tap and evaluate several components of executive functioning in a short time (about 10 minutes) including attention, planning, problem-solving, decision making, visual searching, and working memory. The complexity of the tasks changes according to the cognitive load and the presence of confounding variables. According to the task's request, the subject has to respond by choosing between three or more alternatives in each subtask.

Overall, EXIT 360° was developed using a common camera, free apps, and the InstaVR software, which allows for organizing both virtual environments and seven everyday tasks in a single experience.

### *3.2 Multidimensional assessment and data integration*

EXIT 360° is delivered via a smartphone that can be inserted into the mobile-powered headset. This technological device allows participants to experience the situation "Like in real life". Interestingly, the recent headset can be integrable with other devices such as ET and EEG that allow us to obtain physiological data in addition to verbal answer, including reaction times. As shown in Figure 1, for each task, the examiner collects response time and verbal answer by assigning one point for a wrong answer or two for a correct one.

The proposed protocol plans to use a technological device that integrates the VR headset with ET and an EEG mask with dry electrodes, allowing for a time-synchronized and automatic acquisition of eye and brain data during an immersive VR experience. These data will be transmitted in real-time from headsets to a desktop application, executable on any computer via a USB connection, and exportable as raw data for further analysis.

In particular, in the present protocol, ET will track and record any physiological deficits in eye gaze direction, saccadic/antisaccadic movements, and fixations [9]. Firstly, it will calculate the subject's gaze in the virtual environment (VE), observing where the subject is looking during the session. Furthermore, ET will define regions of interest in 3D space and fixation time of each area, allowing clinicians to detect problems in focusing on critical components for a correct interpretation of the scene, a specific deficit in patients with ED. Finally, ET will allow participants to respond by focusing on the answer within the VE for a few seconds, overcoming possible verbal difficulties and without learning to use a complex tool (e.g., joystick).

Regarding EEG signals, the EEG mask will consist of a forehead foam pad with built-in flexible printed circuit board electrodes. Recent technological advances allowed for the development of portable, inexpensive, and easy-to-use EEG headsets with few channels and dry electrodes that could be interesting for evaluating EFs outside the laboratory. For example, we will use a common EEG mask that involves nine EEG electrodes [on frontal cortex] based on a 10–20 system and acquire 6-channel, 24-bit EEG data (1 kHz). The EEG will monitor the electrical activity and any anomalies affecting the prefrontal cortex and some cortico-subcortical circuits [14]. Moreover, it will allow for recording the raw signal for future analysis both for groups or specific subjects, with a view of longitudinal monitoring. In addition, it will be possible to obtain a neurophysiological correlation of observed behavior. Finally, having both physiological data will allow for obtainment of a mutual correction of the data.

Finally, in this protocol, we support the introduction of machine learning algorithms that will manage the large quantity of information received by subjects' verbal answers and from the eye tracker and EEG, allowing constant and real-time integration among verbal and non-verbal data.

### *3.3 Clinical usability: an example*

A concrete example of the application of this innovative protocol could involve patients with Parkinson's disease (PD), in which the executive dysfunction represents the most common cognitive impairment in early-stage, non-demented PD [22], [23].

An increasing number of longitudinal studies suggest early executive dysfunction is predictive of following the development of PD dementia [24], [25]. Several studies have shown the effectiveness of the use of VR-based tools with Patients with PD in assessing executive impairments in planning, set-shifting, problem-solving, and visual searching [1], [2]. Interestingly, several studies showed the absence of clinical issues (e.g. vertigo and nausea) due to the use of 360° environments in neurological patients [1]. Moreover, a recent study conducted by Ouerfelli-Ethier and co-workers have demonstrated the suitability of the antisaccades test (AST) as a cognitive marker of EFs in PD populations [12]. AST performance was a good predictor of decision-making and visual-memory abilities for both older adults and PD patients, while it predicted visual search performance to a larger extent in PD patients. Regarding electrical anomalies, Teramoto and colleagues showed that a decreasing resting-state functional connectivity between the frontal and parietal cortex, above all in the left side, was related to executive dysfunction in PD [14]

Therefore, an integrated solution could help in the early identification of executive impairments, detecting individuals with PD at risk of developing dementia, and providing the opportunity for early neurorehabilitation interventions.

## 4. Discussion and conclusion

Our protocol wants to provide an innovative, integrated solution for evaluating executive dysfunctions by combining verbal response, reaction time, and non-verbal data by ET and EEG. Specifically, we expect five promising main results due to this innovative protocol. Firstly, we expect to collect, quickly and simultaneously, more information about executive functioning and related impairments. Secondly, we wait to obtain a quicker diagnosis of executive dysfunction. Moreover, we hope to distinguish the patients from healthy control and according to the clinical group. In addition, all these integrated data will allow us to tailor the rehabilitation to the individual needs and provide participants feedback.

Overall, this innovative assessment will go beyond the effectiveness of VR-based tools or ET and EEG studies by combining data for a multidimensional and multicomponent evaluation of executive functioning with high clinical usability and ecological validity. Further studies will be conducted to evaluate the usability and efficacy of this integrated protocol with healthy control subjects and several neurological and psychiatric populations.

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# Parent-child dysfunctional communication about sexting:

# The role of parental characteristics and parental mediation

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**Abstract.** Sexting (sending and receiving sexual messages) could entail risk for adolescent users. Hence, it is important that parents are able to address their children's sexuality and mediate to them the implications of sexting. The goal of the current study was to identify parental factors that lead to dysfunctional communication about sexting among 427 parents of Israeli adolescents (ages 10–18) and to determine whether parents' perceived severity of sexting and perceived susceptibility of sexting function as mediating factors. Parents completed a set of online questionnaires. Findings indicated that of the parenting styles examined, the authoritarian and permissive styles were positively associated with dysfunctional parent-child communication. The authoritative style was inversely related to dysfunctional communication and was mediated by positive attitudes regarding sex education. Additionally, authoritative parents were capable of assessing the severity and susceptibility of their children's sexting activities. It appears that the quality of the discussion initiated by authoritative parents enabled them to be aware of adolescent behaviors and phenomena and modulate their communication regarding the implied risks accordingly. Moreover, ethnic differences emerged between Arab and Jewish parents with regard to the quality of parent-child communication about sexting. Specifically, Arab parents tended more toward dysfunctional communication about sexting than did Jewish parents. Findings suggest that perceiving the implications of sexting as too risky diminishes parents' ability to conduct a high-quality discussion. In conclusion, parents need to mediate and conduct constructive discussions with their children regarding this topic.

**Keywords:** Sexting, Parent-Child Communication, Parenting Style, Parental Mediation, Adolescents, Sex Education

## 1. Introduction

Israel is a multicultural society made up of two main religious and ethnic groups: Jews and Arabs [1]. Jewish society is modern and Western [2] while Arab society is still primarily collectivist, conservative, and traditional, and the division of roles between mothers and fathers is clearly defined [3, 4]. Children's education is important in both sectors with mothers tending to take a more active role in their children's education than fathers [5].

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Parenting style refers to the way parents conduct themselves with their child. Baumrind [6] defined three basic parenting styles differentiated by the degree to which a parent sets boundaries, explains and justifies demands and expectations, uses control and power, and provides acceptance and emotional support [7,8]. Parenting styles serve as a basis for parental behavior and affect how parents raise their children. Similarly, they generate the emotional climate in which parent-child communication takes place [9]. The family's parenting style has a differential effect on children from different cultures, and we usually assume that in patriarchal cultures the authoritarian parenting style is more common. The research literature offers different outlooks on the parenting style used in Arab society in Israel [10, 11].

The term sexting refers to sending and receiving text messages of sexual content, accompanied by nude or semi-nude photos, to convey a sexual message [12]. Sexting is often used during the developmental stage, in which adolescents begin to experiment with their sexuality [13, 14]. A study conducted among Israeli adolescents found that 30% of the participants in 7$^{th}$ to 12$^{th}$ grades sent sexts to others. Of these, half sent sexual messages to a boyfriend or girlfriend, and 32% reported being asked by someone else to send them a nude picture. Of these, 45% of those asking for the nude picture were strangers. Nonetheless, the majority did not admit to sexting, and of those that did share this information, only 2% indicated having told a responsible adult such as a counselor, teacher, or parent about this [15]. This finding is problematic, as sexting is liable to point to a variety of risk-related behaviors [16, 17, 18].

Sexual expression can easily be stored and shared with unintended recipients, thus exposing the photographed subject to bullying, harassment, revenge porn, and/or sextortion [19, 20]. Given the declining trend of school-based sex-education programs [21], the family plays an increasingly important role in the sexual socialization of youths, conveying implicit and explicit information that can affect the younger generation's sexual attitudes, decisions, and behaviors [22].

In contrast to Jewish society, which tends to be more liberal [3], Arab society sees sexual relations as legitimate only if they are part of a personal relationship. Yet, despite this, Arab teens in Israel report that they engage in various forms of sexual activity, both physical and online [23].

The goal of this study was to examine the relationships between various aspects of parenting (ethnic, gender, parenting styles, parent self-efficacy, and attitudes towards sexuality) and the quality of parent-child communication on the subject of sexting, which could have negative implications. This examination takes place within the cultural context of Israeli society through a comparison of the Jewish and Arab sectors. It is important to examine the obstacles that prevent parents from establishing effective communication with their children on the subject of sexuality.

## 2. Method

### *2.1. Participants and Procedure*

Participants in this study included 427 Israeli parents of adolescent children, recruited through social media, specifically in a post seeking Israeli parents of children between the ages of 10 and 18 to participate in an academic study on the ways parents mediate sexuality to their adolescent children. The announcement included a link to online surveys.

Approximately half of the participants were Jews (N = 242, 56.7%) and half Arabs (N = 185, 43.3%). Both mothers (78%) and fathers (21.3%) completed the online questionnaires (Demographics, Parents' sense of competence, Parental authority, Attitudes regarding sex education, Perceived susceptibility and severity of sexting, Parent-adolescent communication regarding sexting scale, Parental mediation of sexting).

## 3. Results

Study findings demonstrated that mothers scored significantly higher than fathers on parental mediation of sexting, attitudes about sex education, parent self-efficacy, and parent authoritative style, whereas fathers scored higher than mothers on dysfunctional communication about sexting and perceived severity of sexting. Jewish parents scored higher than Arab parents on attitudes regarding sex education and parent self-efficacy, while Arab parents scored higher than Jewish parents on dysfunctional communication regarding sexting, as well as on each of the three parenting styles. The results of the study indicate deficient communication between parents and children regarding sexting (Table 1). Of the three parenting styles examined, only the authoritative style did not lead directly to deficient communication. Moreover, the multiple hierarchical regression conducted for dysfunctional communication regarding sexting demonstrated that this relationship was mediated by positive attitudes regarding sex education. An authoritative parenting style was also associated with a high perception of susceptibility and severity related to sexting.

**Table 1.** Means, standard deviations, and t values for differences in the study variables by ethnicity and gender (N = 427)

| | **Jewish (n = 242) M (SD)** | **Arab (n = 185) M (SD)** | **Fathers (n = 91) M (SD)** | **Mothers (n = 336) M (SD)** | **$F_{ethnicity}$ (1, 422) ($\eta^2$)** | **$F_{gender}$ (1 422) ($\eta^2$)** | **$F_{ethnicity\ by\ gender}$ (1, 422) ($\eta^2$)** |
|---|---|---|---|---|---|---|---|
| Dysfunctional communication regarding sexting (1-5) | 2.27 (0.56) | 2.69 (0.61) | 2.64 (0.59) | 2.40 (0.61) | 31.87*** (.071) | 15.47*** (.036) | 0.02 (.001) |
| Perceived susceptibility to sexting (1-5) | 4.37 (0.81) | 4.39 (0.74) | 4.25 (0.89) | 4.42 (0.75) | 0.01 (.001) | 0.96 (.002) | 2.25 (.005) |
| Perceived severity of sexting (1-5) | 3.65 (1.02) | 3.73 (1.08) | 3.90 (0.90) | 3.63 (1.08) | 0.96 (.002) | 5.43* (.013) | 0.47 (.001) |
| Parent self-efficacy (1-6) | 4.37 (0.58) | 4.05 (0.54) | 4.11 (0.65) | 4.26 (0.56) | 18.69*** (.043) | 6.92** (.016) | 0.06 (.001) |
| Authoritative parenting style (1-5) | 3.87 (0.38) | 4.00 (0.41) | 3.80 (0.43) | 3.96 (0.38) | 3.73 (.009) | 9.25** (.022) | 0.01 (.001) |
| Authoritarian parenting style (1-5) | 2.79 (0.55) | 3.16 (0.55) | 3.03 (0.59) | 2.93 (0.58) | 21.14*** (.048) | 2.31 (.005) | 0.23 (.001) |
| Permissive parenting style (1-5) | 2.72 (0.47) | 3.06 (0.44) | 2.86 (0.53) | 2.87 (0.48) | 39.20*** (.085) | 0.04 (.001) | 0.01 (.001) |
| Attitudes regarding sex education (1-5) | 4.57 (0.49) | 3.60 (0.81) | 4.04 (0.79) | 4.18 (0.81) | 120.01*** (.223) | 5.93* (.014) | 3.33 (.008) |

*$p < .05$, **$p < .01$, ***$p < .001$

Presumably, the degree of authoritative parents' involvement with their children, through listening and discussions, enabled them to be aware of the behaviors characteristic of this age group and the risks they entail. At the same time, perceiving the potential threat inherent in sexting can lead parents to function less than optimally when discussing the sexting issue with their children.

## 4. Conclusions

The findings of the current study point to variance in how sexting is handled in Arab society and Jewish society in Israel. The relationship found in the current study between parent-related variables, such as parenting styles and parent self-competence and dysfunctional communication regarding sexting, demonstrated that authoritative parenting was the only style related to positive parent-child communication regarding sexting. By contrast, both permissive and authoritarian parenting styles seemed to be related to dysfunctional communication regarding sexting because they do not promote significant and enabling discussions [24]. Another finding was that a strong parental sense of competence was related to positive discussions of sexting, as these parents presumably felt that they were capable of handling the topic. By contrast, permissive and authoritarian parenting styles were shown to be related to dysfunctional communication regarding sexting, presumably because they do not promote open discussions. Thus, it seems that, given the diminishing role of school-based sex-education programs and the understanding that sex education provided by parents has an important effect [21], the current study underscores the importance of understanding the effects of parent-related variables, particularly those leading to dysfunctional communication regarding sexting. It appears that in order to convey to their children the potentially adverse effects of sexting behaviors, parents need to understand and recognize that this phenomenon demands that they exercise effective mediation skills and have the ability to conduct meaningful discussions with their children.

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# Investigating Virtual Reality technology acceptance by patients: preliminary results from a TAM-based model

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**Abstract.** In this work, a tool for evaluating technology acceptance is proposed, addressing the acceptance of the Virtual Reality (VR) technology used in rehabilitation programs for frail elderly. The proposed tool is able to identify the factors that determine the intention to use (*determinants*) of users (*patients*). The tool is derived from the Technology Acceptance Model (TAM) which, based on psycho-sociological behavioral theories, is a statistical model, predictive of the users' intention to use the technology. Other TAM-based models were subsequently developed (e.g., UTAUT, UTAUT2). To investigate the acceptance of "user patient" towards the use of the VR technology, questionnaires were administered to patients with physical and cognitive impairments, based on the UTAUT2 model.

**Keywords.** Technology In Healthcare; Users 'Acceptance; Technology Acceptance Model; Virtual Reality

## 1. Introduction

Different behavioral theories of psycho-sociological derivation were used to evaluate technology acceptance, each one based on identifying the "motivational variables" that could *predict* the "intention to use" a new technology and, among them, the Technology Acceptance Model (TAM) [1] is one of the most used theories. In this model, the author postulated the following hypotheses: the motivational variables "Perceived Usefulness" and the "Perceived Ease of Use" directly affect the "Attitude Toward Using", and the latter directly affects the "Behavioral Intention to Use" (BI) a technological system. In turn, the BI directly affects the "Actual System Use" of the system. Other models have been proposed, based on the TAM, with the addition of other predictive motivational variables also moderators, in particular the UTAUT (Unified Theory of Acceptance and Use of Technology) and the UTAUT2 [2] models. To measure the motivational variables (also named *constructs*), multi-item measurement scales for each variable are used. The measurement items are formulated as questions or statements in questionnaires about a specific technological system and responses to measurement items are measured using Likert-type ("agree-disagree") rating formats, expressing the level of agreement with each it

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These models have been applied in many fields of healthcare technologies [3, 4]. A model of technology acceptance, based on the UTAUT2 model (figure 1), was proposed to investigate the acceptance of the VR technology used in rehabilitation programs for frail elderly (Figure 2) in the framework of the Italian funded research project "High-end and Low-End Virtual Reality Systems for the Rehabilitation of Frailty in the Elderly", directed by the Istituto Auxologico Italiano (Milano, Italy).

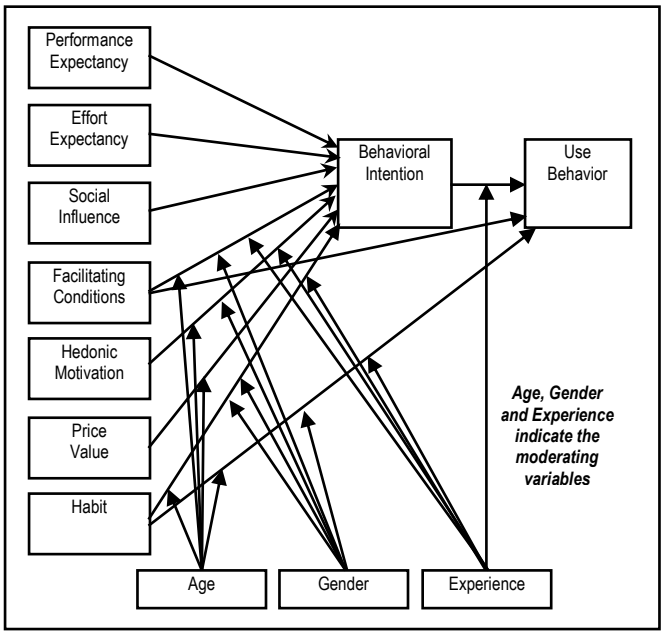


**Figure 1.** Model of technology acceptance UTAUT2 (Venkatesh et al., 2012 [2])

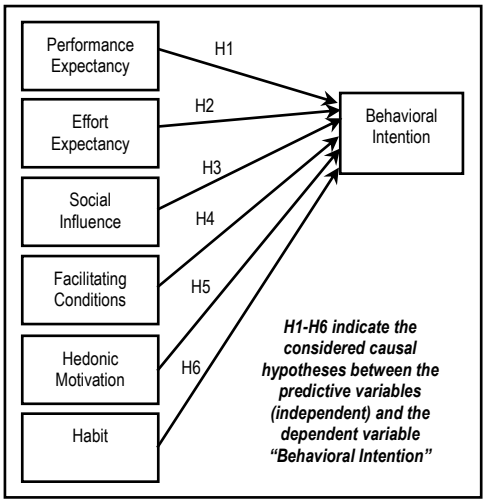


**Figure 2.** The proposed VR-TAM derived from the UTAUT2 model

## 2. Method and Tools

### 2.1. Study Design

For each construct of the VR-TAM model, multiple items were formulated in statement form (Table 1), describing the construct. The resulting questionnaires had 7 constructs and 25 items. E.g., items for "Performance Expectancy" were: "PE1. I find the VR system useful in managing my health", "PE2. Using the VR system helps me to accomplish my rehabilitation process more quickly", "PE3. Using the VR system increases my effectiveness in managing my rehabilitation", and "PE4. If I use the system, I will increase my chances of improving the quality of my life (my health status)". For "Behavioral Intention", the items were: "BI1. I intend to continue using the VR system in the future", "BI2. I will always try to use the VR system in my rehabilitation program", and "BI3. I plan to continue to use the VR system (if needed)". Questionnaires were administered to frail elderly patients with physical and cognitive impairments undergoing rehabilitation programs with the VR technology. Specifically, two VR technologies were applied for both physical and cognitive impairments: a high-end VR system consisting of an immersive virtual reality environment called CAVE (Cave Automatic Virtual Environment), and a low-end VR system called LE-TABLET (a tablet and suitable biosensors for physical rehabilitation and a 360° viewer reproducing a virtual environment on the tablet for cognitive rehabilitation).

### 2.2. Measures

Questionnaires were administered at two time points: before the VR rehabilitation program (baseline) and after the VR program (endpoint). Questionnaires contained sociodemographic and health information (first part) and questions for the different constructs investigated (measurement items) using a 5-point Likert scale ranging from (1) "strongly disagree" to (5) "strongly agree" (second part).

## 3. Preliminary results

We computed Cronbach's alpha value for all constructs, both at baseline and endpoint, to assess the internal consistency reliability of the measurement constructs (a value higher than 0.7 was considered acceptable [5]). For the CAVE, at baseline, all constructs showed values greater than 0.9, denoting a good internal consistency of the measurement scales. At the endpoint, the construct "Facilitating Conditions" and "Habit" showed a Cronbach's alpha value lower than 0.7 (0.486 and 0.549 respectively), indicating that these scales were perhaps not the most suitable to investigate with the first scale in regard to the user's perception of the resources and support available for using the CAVE, and the second on the perception that using the CAVE can become a habit. Table 1 shows the means and SD of constructs, and results of paired samples Wilcoxon test was applied to compare scores of the construct scales (for evaluating differences between pre- and post-usage of the VR technologies applied). Statistical significance was defined as $p < 0.05$.

About patients' perceptions of acceptance, we can see from Table 1, that in all rehabilitation types, both with the physical one with the CAVE and physical one with the LE-TABLET, the intention of using the VR technology ("Behavioral Intention") significantly increased from the baseline to the endpoint at the end of the rehabilitation program, ranging from a moderate value (mean 3.063, SD 1.181 for the CAVE; mean 3.095, SD 0.659 for the LE-TABLET) to a high value (mean 4.083, SD 0.590 for the CAVE; mean 3.810, SD 0.325 for the LE-TABLET). All other constructs also increased significantly, with the exception of "Social Influence" for the LE-TABLET.

**Table 1.** Means and standard deviations of the constructs and Wilcoxon test results

| | **CAVE** (16 patients: 7 women and 9 men; age: mean 78.31 and SD 6.14 | | | | **LE-TABLET** (7 patients: 5 women and 2 men; age: mean 78.71 and SD 6.18) | | | |
|---|---|---|---|---|---|---|---|---|
| | **Baseline** | **Endpoint** | **Wilcoxon test** | | **Baseline** | **Endpoint** | **Wilcoxon test** | |
| **Construct or scale** | **Mean (SD)** | **Mean (SD)** | **Z** | **p-value** | **Mean (SD)** | **Mean (SD)** | **Z** | **p-value** |
| **Performance Expectancy (PE)** *4 items* | 3.266 (1.063) | 4.047 (0.485) | –3.084 | 0.002 | 3.000 (0.577) | 3.929 (0.122) | –2.232 | 0.026 |
| **Effort Expectancy (EE)** *4 items* | 3.125 (1.072) | 3.969 (0.651) | –3.051 | 0.002 | 2.714 (0.713) | 3.643 (0.378) | –2.207 | 0.027 |
| **Social Influence (SI)** *3 items* | 3.062 (1.194) | 3.917 (0.725) | –2.807 | 0.005 | 3.143 (0.690) | 3.714 (0.405) | –1.633 | 0.102 (**NS**) |
| **Facilitating Conditions (FC)** *4 items* | 3.172 (0.965) | 3.969 (0.455) | –2.834 | 0.005 | 3.000 (0.629) | 3.786 (0.443) | –2.388 | 0.017 |
| **Hedonic Motivation (HM)** *3 items* | 3.167 (1.068) | 4.354 (0.479) | –3.190 | 0.001 | 2.905 (0.630) | 4.048 (0.126) | –2.264 | 0.024 |
| **Habit (HT)** *4 items* | 2.938 (1.167) | 3.984 (0.478) | –3.066 | 0.002 | 2.857 (0.720) | 3.821 (0.238) | –2.207 | 0.027 |
| **Behavioral Intention (BI)** *3 items* | 3.063 (1.181) | 4.083 (0.590) | –3.192 | 0.001 | 3.095 (0.659) | 3.810 (0.325) | –2.207 | 0.027 |

SD: Standard Deviation; NS: Not significant; $P < 0.05$: statistically significant; $Z_{0.05}=1.960$

Another paired Wilcoxon test was applied to examine if there were any differences between the two VR technologies (CAVE and LE-TABLET), as far as the subjective assessment expressed by the items relative to each construct is concerned. The two questionnaires were delivered to patients treated with both VR technologies. There was no statistically significant difference on all factors (constructs), indicating that these patients have similar opinion in considering these two technologies (Table 2). We underline that the questionnaires were built in a general, technology-agnostic approach. Thus, the responder's attention was not directed to the technical differences between the two VR approaches, which are evidently not negligible. Nevertheless, it is interesting to note that the subjective experience, as measured by the Wilcoxon test, was similar for HE and LE VR techniques in the patients' subgroup that experienced both. Of course, given the limited sample size, this result needs to be confirmed with broader studies. It is encouraging, though, that the LE approach was not felt as significantly different from the more costly and cumbersome high-end rehabilitation.

**Table 2.** Means and standard deviations of the constructs and Wilcoxon test results for comparison between CAVE and LE-TABLET

| **CAVE vs LE-TABLET** (5 patients) | **Baseline** | | | | **Endpoint** | | | |
|---|---|---|---|---|---|---|---|---|
| | | | **Wilcoxon test (paired samples)** | | | | **Wilcoxon test (paired samples)** | |
| **CONSTRUCT OR SCALE** | **CAVE Mean (SD)** | **LE-TABLET Mean (SD)** | **Z** | **p-value (two-tail)** | **CAVE Mean (SD)** | **LE-TABLET Mean (SD)** | **Z** | **p-value (two-tail)** |
| **Performance Expectancy (PE)** | 2.600 (1.140) | 3.200 (0.447) | -1.134 | 0.257 | 3.650 (0.418) | 3.900 (0.137) | -1.342 | 0.180 |
| **Effort Expectancy (EE)** | 2.600 (1.140) | 2.600 (0.454) | 0.000 | 1.000 | 3.400 (0.675) | 3.500 (0.354) | -0.365 | 0.715 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Social Influence (SI)** | 2.600 (1.140) | 3.400 (0.548) | -1.300 | 0.194 | 3.267 (0.435) | 3.800 (0.298) | -1.857 | 0.063 |
| **Facilitating Conditions (FC)** | 2.600 (1.140) | 3.000 (0.306) | -1.095 | 0.273 | 3.600 (0.224) | 3.600 (0.379) | 0.000 | 1.000 |
| **Hedonic Motivation (HM)** | 2.600 (1.140) | 2.867 (0.298) | -0.816 | 0.414 | 4.000 (0.236) | 4.000 (0.000) | 0.000 | 1.000 |
| **Habit (HT)** | 2.600 (1.140) | 2.800 (0.512) | -0.677 | 0.498 | 3.650 (0.454) | 3.750 (0.250) | -0.535 | 0.593 |
| **Behavioral Intention (BI)** | 2.600 (1.140) | 3.133 (0.380) | -1.084 | 0.279 | 3.667 (0.408) | 3.733 (0.365) | -0.378 | 0.705 |

SD: Standard Deviation; $P< 0.05$: statistically significant; $Z_{0.05}=1.960$.

## 4. Conclusion and future perspectives

For both VR technologies, the score of all constructs (with the exception of "Social Influence" for the LE-TABLET) increased significantly from the baseline to the endpoint (Table 1), indicating a greater level of acceptance of the VR technology after its usage. The investigation of the predictive capability of the constructs with respect to the intention to use the VR technology (BI) will be addressed in a future study.

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# Live-chats in postvention: an analysis of interventions with people bereaved by suicide

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**Abstract.** Losing a significant other to suicide increases the risks of depression and suicide. Fear of stigma, fatigue, and lack of services may hinder the help-seeking behavior of suicide mourners or "survivors". This study aimed at exploring characteristics and needs of recent survivors seeking for help online and the pros and cons of the use of live-chats as a first-aid tool in bereavement support. A data-driven thematic analysis with the software ATLAS.ti8 was carried out on 20 live-chat conversations from the major Italian association providing free-of-charge online support. Socio-demographic details were retrieved from the transcripts. Three categories were explored: users' features, users' requests, and online interactions. The users were mainly women (18 of 20), partners, siblings, or parents of the deceased (11 of 20), aged between 24 and 56 years, who had lost their significant other between one day and 12 months before. Users expressed needs to receive practical information on how and where to find support and requests to be emotionally reassured. Features such as anonymity and accessibility were fondly appreciated. Live-chat services represent a safe space where survivors can obtain useful information and start processing their loss. Because of its anonymity and accessibility, a live-chat service may represent a valid first line of support and a tool for prevention of suicidal ideation. The strengths of this study reside in its ecology: differently from a simulated user study, this analysis stems from a real context of emergency.

**Keywords.** Ehealth, Suicide Bereavement, Live-Chat, Qualitative Methods

## 1. Introduction

On the occasion of World Mental Health Day 2019, the World Health Organization chose suicide prevention as the year's focus topic. Suicide is, indeed, a major health problem which is expected to impact the population at an even greater rate, considering the recent sanitary emergency due to the SARS-CoV-2 outbreak [1].

One suicide death impacts several other people within the family and the extended social context [2], the so-called "survivors" [3]. Survivors fear the mark of stigma [4] or feel responsible towards others and actively avoid talking about it [4]. They face a drastic reduction of social support [6], complicated grief and depression [7], and an increased risk of suicide [8]. Timely interventions with survivors, called "postventions" [2], are therefore pivotal and also hold a preventive role. Professionally-led chats are a way to overcome the obstacles survivors face, and the value of this modality of virtual support has been fairly demonstrated [9,10]. Fear of stigma, fatigue, and lack of services may, in fact, hinder their help-seeking behavior.

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The aim of this study was to explore the characteristics and needs of survivors who seek help online, through a synchronous support-tool with trained operators. The present study wants to stress the qualities and limitations in the use of live-chats as a first-aid tool in bereavement support by answering the following questions: a) are the characteristics of users similar to those who seek for help offline? b) what are their experiences with offline support? c) what expressions of appreciation or problematics can be identified in their interactions with the operators?

## 2. Method

This study is a data-driven thematic analysis of 20 live-chat conversations with 20 different users (18 F, 2 M), whose socio-demographic data are reported in Table 1. Detailed information about the users was not collected to grant anonymity and effectiveness of service. However, it was possible to retrieve details from the chat conversations retrospectively. Users contacted the association from different regions of Italy, and only 5 users spontaneously reported their age which ranged from 24 to 46 years old. Overall, the rest of the users were aged between 20 and 50 years old (based on the information written during the conversation and the kinship with the decedent).

The live-chat conversations were retrieved from the archives of an Italian association providing free-of-charge support for traumatic bereavement (i.e., the NGO De Leo Fund), from December 2014 to January 2019. Operators offering support in the chat service were specifically trained and supervised by a psychologist. The inclusion criteria were: a) being more than 18 years old, and b) having experienced a loss from suicide within 12 months. In fact, six participants of 20 contacted the service between 24 hours and three weeks after the loss. Chat duration ranged from 23 to 118 minutes. The total length of the analyzed chats was 19,984 words.

The software Atlas.ti8 [11] was employed to analyze data. As requested in thematic analyses [12], familiarization with the data and codification was firstly operated. Then, themes and codes were created by merging the coded extracts on the basis of identified patterns of meanings across the dataset. A different author later reviewed and refined the themes. Disagreements among coders were resolved by discussion. The study was supported by a grant from MIUR (Dipartimenti di Eccellenza DM 11/05/2017 n.262) to the Department of General Psychology, University of Padua.

## 3. Results

Three main themes were identified, focusing on the users' features, needs, and experience of the live-chat while interacting with the operator. A detailed scheme of the themes, codes, and extracts is reported in Table 2.

*3.1 Users' features.* Nine users contacted the service in a state of suffering. In fact, feelings of shock and numbness due to the recency of the loss were reported by half of the participants. Moreover, users expressed helplessness and an inability to take decisions, which was in some cases due to physical symptoms linked to the shock of the loss such as unbalances in sleep routine and appetite or general fatigue.

A part of the group of users reported experiencing loneliness or actively withdrawing from family and friends. Users' detachment from social life was linked to the general feeling of not being understood and to the subsequent increase of misunderstandings and conflicts after the loss, especially within the family. Several users also reported negative experiences with professional support services or did not know how to find appropriate help. The lack of specific services was a common scenario both for rural and urban areas of the country. Those users reporting to be satisfied with their professional support contacted the chat to obtain additional support or advice. None of the users had previous experience

with live-chat support. The service was generally found while browsing for general information: "Could you tell me how the chat works? I was feeling so overwhelmed that I typed who-knows-what sentence and your website appeared…" (P1, F, Sister).

*3.2 Users' requests.* The most frequent requests involved practical support including advice on the bereavement process or where to find services, costs, and modalities. The second most common need regarded emotional reassurance, for example, on how to behave around others or how to deal with feelings of anger and guilt. Overall, all the users relied on operators for advice, and only one survivor expressed the need to use the service to find peer support from other survivors.

*3.3 Online interactions.* Operators offered non-judgmental support, provided information on available services, and gave direct feedback to the users through empathic listening. Operators were also trained to explore the support network, identify dysfunctional behaviors, and foster users' specific resources to find more efficient coping tools.

Users considered some specific features of live-chats very useful: anonymity, accessibility (both geographical and economical), quick response time, the possibility to write in their own time, receive information in the form of direct links, and the opportunity to take notes from the advice offered by the operators. In fact, some users might have had difficulties to access support in a safe and timely way.

The live-chat was hosted on the website of the association and it was possible for the user to browse the informative webpages (containing further advice about the bereavement process) while chatting. The users' online behavior while browsing the webpage was visible on the operator's chat box. The main drawback of the live-chat tool was represented by connection problems. The conversation was not interrupted abruptly, but the lagging may have impacted the communication's flow. However, no suspiciousness or hostility on the part of the user, which could have stemmed from the inability to see or hear the operator, was encountered. On the contrary, the possibility to write "behind a screen" was listed among the positive qualities of the live chat. Overall, no negative feedback emerged; users expressed gratefulness for the service, and two of them stated they would like to use the chat service again.

## 4. Conclusions

Live chats revealed an important tool to orientate survivors who might be uncertain about how to access services, to offer them non-judgmental support, or to provide advice on specific issues. As for the aim of this study, the characteristics of survivors who seek help online showed as consistent with the literature, hence confirming that online provided support could be appealing to this type of fragile population. The users are mostly distressed and do not feel understood [13], become socially detached [14], and struggle to find proper support [15].

Differently from offline services, and worthy of noting, is the speed in establishing a contact as some users were able to obtain first support the day after their loss. Having suffered the loss within the last 12 months, these users also present numbness and uncertainty [16]. Results show users prefer to receive advice from a reliable source (i.e., a trained operator or a professional, rather than another survivor offering peer support). Moreover, anonymity and accessibility are highly valued together with the opportunity to take time to ponder what to write and reflect on what remains written in the text. Lastly, the exchange of information (e.g., telephone or email contacts) is made easier and quicker through the chat. As the live-chat interface suggests for a quick communication (the text box appears in a corner of the website page and the space for writing is reduced), the general conversation on the part of the users was sometimes very succinct. While short sentences may be useful in emergency conditions, this streamlined way of communication did not allow the sharing of details that could have enriched the context.

The present analysis into live-chat support offers various insights over the growing uses of digital tools in health and psychological services. Overall, a chat service implemented in a website providing support has relatively low management and maintenance costs, provided that the operators are properly trained. The final conclusion to be drawn is that live-chats present numerous pros against its fewer cons. Not intended to be a replacement for face-to-face support, live-chats could represent an important resource in providing first-aid support and normalize overwhelming emotions, as per other online tools [17]. Further studies should contemplate some forms of standardized evaluation for the support received.

The present study contributes greatly to the field of new technologies and the growing services offered through chat. Its strength resides in its ecology, considering that the data analyzed was retrieved from real conversations.

**Table 1.** Sociodemographic details of users.

| Factor | Number (N=20) |
|---|---|
| Gender | |
| Female | 18 |
| Male | 2 |
| Kinship with the departed | |
| Sibling | 11 |
| (ex) Partner | 3 |
| Friend | 3 |
| Distant relative | 3 |
| Age* | |
| Mean | 41.6 |
| Standard deviation | 12.36 |

*Reported by five users of twenty.

**Table 2.** Themes, codes, and extracts from the live-chat conversation between user and operator.

| Themes | Codes | Extract |
|---|---|---|
| **Users' features** | Shock and numbness (10 of 20) | I don't sleep at night anymore, I have continuous flashbacks and am confused and numbed. I apologize for the way I am writing but I don't know where to start (P 13, F, Partner) |
| | Helplessness (7 of 20) | We no longer know what to do to try to feel a little less bad it seems nothing helps (P 14, F, Sister) |
| | Fatigue (5 of 20) | Same symptoms of sadness and listlessness. It is as if we had inherited that malaise that led him to take his own life (P 2, F, Other relative) |
| | Social withdrawal (5 of 20) | I preferred to get away from everyone, I could not bare to force me to smile around them and I cut ties with them all. (P 3, M, Brother) |
| | Feeling not understood (9 of 20) | I understood that others do not want to talk to me about this because they are annoyed of constantly hearing me grieve (P 10, F, Friend) |
| | Family conflicts (4 of 20) | Even with my family there are moments of tension that were not there before. (P 14,F, Sister) |
| | Negative experiences with professionals (9 of 20) | I tried to go to a psychologist. My gosh she made me feel like a moron ... (P 4, F, Sister) |

| | | |
|---|---|---|
| **Users' requests** | Practical support and advice (11 of 20) | Would it be good for his parents [of the decedent] to know that their son was not alone? That he entrusted me with every single day, with every decision? (P13, F, Partner)<br><br>My brother took his life and now I think I am in the middle of a breakdown … if you had any information on available service near me it would be much appreciated. (P14, F, Sister) |
| | Emotional reassurance (6 of 20) | Sometimes I need to talk about it with someone and that's why I ended up on your website. (P16, F, Other relative)<br><br>I am writing to you because I am looking for someone who can convince me that I am not guilty, so that I can start feeling just sad. (P10, F, Friend) |
| **Online interactions** | Empathic listening | Operator: It must be very frustrating for you to keep thinking about this [events that led to the suicide Ed.], but it is also important to remember that you did all that was in your power at that moment". |
| | Exploration of support network & resources | Operator: are you able to talk with anyone about how you feel?<br>User: to be honest, I can't speak with anyone of what happened.<br>Operator: following an event of this kind, the whole family may undergo a strong change and may need time to find the right energies to reorganize [...] It can be difficult to show others your pain and for this reason it was brave of you to contact us today and to share your story.<br>User: honestly, no one of those around can understand how we feel. [...] This is why I preferred to get away from everyone [...].<br>Operator: it is true that few could understand your pain, but it might help to have someone to share your thoughts with. It is important for you to have the opportunity to express your grief and avoid isolation. (P3, M, Brother) |
| | Appreciation of live-chat features | Sometimes it is easier to talk to those who do not know, you are less afraid of being judged. (P14, F, Sister).<br><br>I can't really talk about it without crying but by writing I am able to elaborate more. (P 5, F, Sister)<br><br>This [the live-chat] is the only way I can [obtain support]. If I am able to talk to you at the moment, it is solely because I have the baby asleep on my legs and the big one was taken to the pool by my friend. (P12, F, Other relative) |

Details about the user's ID number, gender, and relationship with the decedent are indicated in brackets at the end of the extract.

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# ANTaging: a Research Protocol for Active Navigation Training with Virtual Reality in Mild Cognitive Impairment

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**Abstract.** Navigation is a multimodal process that requires the active computation of cognitive and bodily cues along with external environmental information. Indeed, according to the embodied cognition framework, the body and the environment build our cognitive representation of the space. This view is supported by findings in the aging population where the decline of bodily information accounts for the deficits in spatial navigation. Consequently, it is crucial to develop innovative rehabilitation solutions in aging that require the active use of bodily and cognitive processing of the space and its elements. Mild cognitive impairment is a geriatric syndrome considered to be a transitional stage between normal aging and dementia. Consequently, it is a preferred time window to administer cognitive rehabilitation programs that could slow down cognitive deterioration. In the current paper, the ANTaging protocol will be presented in its three-step studies: pilot testing, usability study, and proof-of-concept trial.

**Keywords.** Navigation, Spatial Memory, Embodiment, Virtual Reality, Mild Cognitive Impairment, Rehabilitation

## 1. Introduction

According to the framework of embodied cognition, the sensorimotor system helps to define the cognitive representations of the space (1). Indeed, navigation is a complex behavior that implies the active use of bodily and cognitive cues. Idiothetic information (e.g., motor commands, vestibular system, and proprioception), decision-making (e.g., route planning), spatial attention, and spatial information manipulation (e.g., mental rotation) are actively involved during navigation (2). Conversely, during passive navigation, we only use visual information (2). During landmark-based navigation, environmental cues (i.e., landmark, boundaries) help in addition to bodily information to encode and remember locations according to egocentric (i.e., relations dependent to the body) and allocentric (i.e., relations independent from the body) spatial reference frames (3).

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The crucial role of the body during navigation is also supported by evidence showing alterations in aging and dementia, where both bodily and cognitive functions decline and affect spatial navigation and memory (4,5). A crucial stage for administering cognitive rehabilitation to slow down cognitive deterioration is mild cognitive impairment (MCI), which is considered a transition stage between aging and dementia (6).

Virtual reality (VR) could be the preferred candidate for studying and training navigation and memory within an embodied framework in aging. In particular, Tuena and colleagues (7) suggest that by means of immersive VR interventions for spatial memory it is possible to actively tap cognitive and bodily cues through the virtual bodily representation (the involvement of idiothetic information used with immersive VR devices), the spatial affordances (environmental cues coded as action possibilities), and the virtual enactment effect (8) (spatial memory enhancement provided by actively interacting, bodily and/or cognitively, with the virtual space). Indeed, for the spatial memory rehabilitation enhancement, it is suggested for MCI patients to: 1) provide them with a high degree of idiothetic involvement (i.e., immersive VR), 2) use directional aids and salient landmarks as visual cues, and 3) apply an active (cognitive and bodily) navigation task (7).
Here we present the research protocol (Italian Ministry of Health; SG-2018-12368175) of ANTaging (Active Navigation Training: an innovative embodied-based training system for spatial navigation in aging).

## 2. Method

### *2.1. Protocol Design*

ANTaging is a proof-of-concept trial aiming at developing an embodied VR system for active landmark-based navigation rehabilitation in patients suffering from MCI. It consists of three study phases: 1) pilot testing of five navigation interfaces, 2) usability study, and 3) experimental trial. The pilot testing will involve immersive and non-immersive virtual environments to investigate the impact of active navigation cues and passive navigation on allocentric and egocentric frames. The usability study will test the ease of use of the CAVE system for navigation rehabilitation purposes. Lastly, the proof-of-concept trial will test the efficacy of the CAVE active training against the treatment as usual (TAU). The project is approved by the Ethics Committee of the Istituto Auxologico Italiano and participation is possible only after the consent form signature.

### *2.2. Participants*

According to a previous VR navigation training effect size (9), the minimum sample size (GPower) is 32 participants in total for the trial. Participants satisfying the core clinical criteria for MCI (6) will be recruited.

### *2.3. Materials*

For the pilot study, the Oculus Rift S and the 3dRudder foot-motion pad (https://www.3drudder.com/) will be used to navigate in an immersive VR scenario. VR-ready PC and keyboard keys will be used to interact with non-immersive environments. Lastly, the CAVE will be integrated with 3dRudder, 3D glasses, and joypad for the active VR navigation training (usability study and trial).

### *2.4. Measures*

#### *2.4.1. Pilot testing*

A short neuropsychological assessment battery (global cognition and visuospatial memory) and functional (ADL and depression) will be administered. Additional clinical

information will be gathered such as the etiology and phenotype of MCI (6). During the assessment of spatial memory, VR data (measures of time and error) at recall will be saved. Error is calculated as the distance between the actual and recalled position of each object previously learned.

#### *2.4.2. Usability Study*

To assess the usability, qualitative and quantitative approaches will be applied as suggested (10). System usability scale (SUS) (11), thinking-aloud procedure, presence (12), and cybersickness questionnaire (12) will be used in this study.

### *2.5. Trial*

Trial assessment will consist of three-time points: baseline, post-test, and three months follow-up. A comprehensive neuropsychological battery (e.g., (9)) will be administered. Recall VR data will be saved in each session.

### *2.6. Procedures*

#### *2.6.1. Pilot testing*

To assess egocentric and allocentric landmark-based spatial memory and navigation, an object location task based on landmark and boundary recall will be used (3). In a 50m (virtual units) circular pen, patients have to learn the location of four objects (suggested memory span for MCI; (13)) by using an intra-arena landmark (pillar), the boundary (fence), and distal cues (mountain range, clouds). The pillar supports egocentric spatial memory, whereas the fence the allocentric one. Objects will randomly appear one at time; to see the following object, the patient must go to the exact location of the item. Once over it, the object disappears and he/she must find the next one. Each object is presented four times in a random order (3). In the immediate recall phase, each item is randomly presented to the patient. He/she must place the object where it was previously picked in the pen. Randomly, the pillar or the fence are presented to force the use of egocentric or allocentric recall strategies. Each object is tested two times with the pillar and with the fence (eight trials for each spatial frame) (3).

Participants will undergo two experimental sessions (1hr; 2-3 days distance) where egocentric and allocentric spatial memory will be tested with five navigational interfaces (passive, immersive, map, decision-making, and spatial-attentive). In the sensorimotor session, the passive and immersive interfaces are tested, whereas in the cognitive session, the remaining three are used. The two sessions are counterbalanced across participants, and within each session, interfaces are randomized. In each condition, four objects are randomly picked from a list of eight. Living and non-living categories of items are balanced in each random pick.

In the “immersive” condition, participants navigate in the learning phase using a 3D visor and 3dRudder with the use of directional cues (a line to follow to reach the item) and no use of the map or attentional cues. This is done to isolate the idiothetic component. In the recall phase, the same VR apparatus is used; directional cues, map, or attentive cues are not provided. In the “passive” condition, participants simply watch on the PC screen the navigation made by the experimenter (no map, directional, and attentive cues). This is done to isolate the visual system only in a passive manner (2).

In the cognitive session, 2D VR is used (PC screen and keyboard keys) to minimize the involvement of idiothetic information. In the “map” condition, the participant navigates with an interactive map of the pen and directional cues but no attentional cues. This is done to isolate the manipulation of spatial information. In the recall phase, none of the cues are provided: the participant uses keys to replace the items. In the “spatial-attentive” condition before the learning phase, the participant is in the middle of the pen with the pillar, fence, and distal cues, and (s)he is asked to look around with the arrow keys, find some orange markers, and say aloud the number showed in each marker. Markers are placed like so: one

on the pillar, one on the mountain range, and four on the top of the fence (circularly equidistant). Once all the markers are found, the experimenter makes them disappear. The patient starts the learning phase with directional cues but no map. This condition forces the use of attentive resources to the spatial layout and environment before starting the encoding phase. At recall, cues are not given. Lastly, in the "decision-making", directional cues are removed and no map nor attentive cues are displayed. In this sense, the participant can freely decide where to go. In the recall phase, no cue is used. To motivate the patients, instructions are written as a story, where they are asked to help a little girl to collect and replace the items in the pen.

### *2.6.2 Usability Study*

For usability and the trial, the environment is a city square. The usability session lasts 30 minutes and participants are asked to carry out simple tasks in the CAVE. The thinking-aloud procedure is applied during tasks' execution. The participant, by using the 3dRudder and joypad, must find, collect, and replace one item in the square. Comments, thoughts, and non-verbal expressions are written in the thinking-aloud grid. After this part, SUS, presence, and cybersickness questionnaires are administered.

### *2.7. Trial*

In the trial, patients will be randomly allocated (1:1 ratio) to the VR and TAU groups. The two programs will consist of ten training sessions (max 1hr; length: 3-4 weeks) with pre-post and 3 months follow-up testing. Both pieces of training are of increasing difficulty and follow the method of decreasing assistance (14). The TAU consists of "paper and pencil" training for visuospatial memory used at the Rehabilitation Unit (Istituto Auxologico Italiano). In the VR group, participants have to learn four object-locations (see 2.6.1 for details) in a circular square of a city with intra-arena landmark (obelisk), boundary (arcade), and distal cues (clouds, mountains). In the encoding phase, the patients will actively navigate with 3dRudder in the CAVE scenario. Suggested aids to help encoding are directional (15) and attentional cues (16) but not map (15) (see 2.6.1 for description). During recall, patients must reset one object at time (see 2.6.1 for details). The order of obelisk and arcade cues is counterbalanced across sessions (e.g., recall phase session one; O-A-O-A; recall phase session two: A-O-A-O). In the recall phase, the decreasing assistance method is applied as follows during the ten sessions: in the first trial of the first five sessions, the patient is asked to search for a marker showing the position of the object he/she has to put back. In the following trials, the participant must put back each object where he/she thinks it was. When the patient is on the retrieved location, the marker of the correct position is showed and feedback is provided concerning the correct location. The first five sessions are used to recall without errors the position of the items presented. From the 6$^{th}$ session to the last one, in the first trial, the participant must put back each object where he/she thinks it was. When the patient is on the retrieved location, the marker of the correct position is showed and feedback is provided concerning the correct location. In the remaining trials, the patient is only given computerized feedback ("well done": correct response if he/she puts back the item within a ratio of 6.5 virtual units; otherwise "try again, the response is incorrect"). VR data for egocentric and allocentric memory will be calculated only for the last five sessions (first trial with feedback excluded).

## 3. Expected Results

We expect that in the pilot testing, the map will not be useful for MCI (15) and that passive navigation will be worse compared to the other conditions (8). We also hypothesize that allocentric memory will be improved by idiothetic cues (17), egocentric memory will decrease with no directional cues (15), and allocentric frame will benefit from attentional cues (18). In our embodied active navigation training, we expect to observe an

improvement in egocentric and allocentric memory in the last five sessions (VR data) in the VR group, and an improvement at post-test, and possibly at the follow-up, in long-term visuospatial memory and mental rotation abilities in MCI under the VR treatment compared to the TAU.

## Funding

This manuscript is supported by the Italian Ministry of Health (SG-2018-12368175).

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# Understanding the relationship between Traumatic experiences and Compulsive Internet use through the lens of mentalization: A mediation analysis

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**Abstract:** This study aimed to investigate the association between history of traumatic experiences, compulsive Internet use, and reflective functioning in an Italian sample. The relationship between history of traumatic experiences and excessive Internet use was fully mediated by uncertain reflective functioning. Contrary to literature, no gender influence was found. Our preliminary findings provide additional insight into the psychological processes underlying excessive Internet use.

**Keywords:** Compulsive Internet Use, Traumatic Experiences, Reflective Functioning, Psychometrics, Mediation Analysis.

## 1. Introduction

Nowadays, the use of the Internet is an essential element in everyday life. Across the ages, it has become an environment more than a "tool" where a variety of common daily behaviors are situated. However, for a minority of individuals, Internet use can become problematic. Internet addiction (IA) is an emerging social and mental health issue that has significant variance ranging from 0.8%–26.7% dependent on measurement and target population [1,2]. The concept of IA, however, is still a very difficult concept to operationalize fully and clearly. The literature has increasingly focused on the analysis of the psychological and behavioral consequences induced by excessive Internet use [3,4]. The analysis of risk factors on the other hand is still much debated. A key factor is the presence of situational triggers, more particularly stressful life circumstances such as the presence of trauma [5,6]. This is consistent with the compensatory model of problematic Internet use which posits that individuals may engage in online activities as a coping strategy to escape from unpleasant events [7]. Age, gender, and personality characteristics act as key mediators, especially in adolescence [8,9].

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Recently, mentalization skills have also been identified as key factors in the relationship between trauma and addictive online behaviors [10].

Mentalization (or reflective functioning) refers to the capacity of an individual to recognize and understand their own mental states, as well as mental states of others [11]. Research has shown how a variety of traumatic events may negatively affect the development of mentalizing abilities, and this in turn may foster addictive behaviors [6,12]. This study aims to specifically examine the mediating role of mentalization in the relationship between the history of traumatic experiences and the excessive use of Internet.

## 2. Methodology

This is a cross-sectional study conducted online through a survey administered on the platform Google Forms. Data presented in this study are part of a broader investigation on the link among traumatic experiences, mentalizing abilities, and excessive Internet use. Hence, this study is a pilot of a larger research project.

### *2.1. Sample*

The study included 502 subjects, aged between 16 and 57 years (M = 23.79, SD = 4.28). The participants (379 women and 123 men) completed an online survey between March 2020 and November 2020. In the online survey, we collected demographical information and administered three questionnaires: Traumatic Experience Checklist (TEC), Compulsive Internet Use Scale (CIUS), and Reflective Functioning Questionnaire, Italian version (RFQ). Confidentiality and anonymity were rigorously ensured by assigning code numbers instead of names on all questionnaires. The subjects were randomly recruited by a snowball convenience sampling method. The study was designed and carried out according to the Ethical Code of the Italian Association of Psychology (AIP), the European Code of Conduct for Research Integrity (ECCRI), and the 1964 Helsinki Declaration and its later amendments.

### *2.2. Measures*

Traumatic Experience Checklist, only scale “a” (TEC, Italian version) [13], is a self-report measure addressing potentially traumatizing events. It is a reliable and valid self-report instrument that can be used in clinical practice and research. It is made up of 29 items, each of which has three different subscales: “a”, presence/absence of the trauma, “b”, the age in which the trauma occurred, and “c”, what impact they had on the subject (valuated on Likert scale: 1 = none, 2 = a little bit, 3 = a moderate amount, 4 = quite a bit, 5 = an extreme amount). In this study, we considered only the scale “a” as an indicator of the overall traumatic experience occurred (TEC total score).

The Compulsive Internet Use Scale (CIUS, Italian version) [14] is one of the most used and rigorously validated scales internationally to assess problematic Internet use (PIU). It is made up of 14 items, with a Likert response ranging from 0 to 4 (Never = 0, Rarely = 1, Sometimes = 2, Often = 3, Very often = 4).

The Reflective Functioning Questionnaire (RFQ-8, Italian version) [15] is a short self-report measure of reflective functioning (i.e., the ability to understand mental states of the self and others) that is presumed to capture individual differences in hypo- and hyper-mentalizing. The RFQ-8 [15] comprises eight items forming the two subscales “certainty about mental states” (RFQ_C) and “uncertainty about mental states” (RFQ_U). For the scoring, as the literature shows [16], we used the RFQu scale that consists of six items (e.g., "Sometimes I do things without really knowing why"), which are rated on a 7-point Likert scale ranging from 1 (totally disagree) to 7 (totally agree). One item is reverse-scored (i.e., "I always know what I feel"). A high score on the RFQu indicates a lack of understanding of internal mental states including thoughts, emotions, and needs. This choice was dictated by the fact that the “u” scale seems to be the most selective in identifying low mentalization

abilities, which appears to be the most important intervening variable in the excessive behavior of Internet use.

### *2.3. Data analysis*

Data were analyzed with IBM SPSS (version 21) and Jamovi software (2.25). Descriptive statistics were computed for all variables. The Independent Bayesian Factors (BF) were used to examine gender differences in TEC total score, CIUS, and RFQu. Intercorrelations between three test TEC total score, CIUS, and RFQu were evaluated using Pearson correlation coefficients. Simple regressions were performed to demonstrate whether and how TEC total score and RFQu, considered individually, could be good predictors of CIUS scores. Subsequently, we carried out a multiple regression to test their unique effect after controlling for gender. Finally, since the influence of TEC total score in the multiple regression model decreased, we opted for a Mediation Model computed using Jamovi software, exploring whether RFQu scores as a mediation factor can explain the relationship between TEC total score and CIUS.

## 3. Results

No effect of gender is found on the three scores of the questionnaires. The absence of gender differences is an innovative element, analyzed by Bayesian Factor (Table 1). The BF01 index indicates the ratio between the probability of correctness of H0 (male scores = female scores) and the probability of correctness of H1 (male scores ≠ female scores). Indices higher than 3 indicate a strong effect and a consequent strong equality between the groups (i.e BF01 CIUS = 8.62), while effects between 1-3 are moderate (i.e BF01 RFQu = 1.50, BF01 TEC total score = 4.05). The different sample size between males and females is controlled with the analysis. Bayesian Test t on TEC total score was done only for statistical correctness to demonstrate that in our sample there were no significant differences between males and females, affecting the regression analyses and subsequent mediation models (Table 1).

Correlation indices indicate a medium/low positive correlation between TEC total score, CIUS, and RFQu. The correlation between CIUS and RFQu is the highest one [$r(502) = 0.38$, $p < .001$]. Moreover, the correlations between the TEC total score and RFQu scores [$r(502)= 0.135$, $p = .002$] and between TEC total score and CIUS [$r(502) = 0.124$, $p = .005$] are lower.

Therefore, we explored the influence of TEC total score and RFQu as predictors on CIUS as the dependent variable. Firstly, a simple single regression was applied using TEC total score (model fit measures $R = .124$, $R^2 = .015$, $p = .005$) and RFQu (model fit measures $R= .38$, $R^2 = .14$, $p=.005$) as separate predictors, excluding gender, which in both cases was statistically not significant (for the RFQu, $p = .54$, TEC total score, $p = .99$). Then at multiple regression, in which both TEC total score and RFQu were included as predictors, net of the influence of the gender, only RFQu seems to be a good predictor (Model fit $R= .38$, $R^2 = .15$, $p = .001$). The TEC total score scores were not significant ($p = .07$).

**Table 1:** Descriptive statistics and gender differences (Bayesian Factor) for all investigated variables.

| | Group | N | Mean | SD | $BF_{01}$ | error % |
|---|---|---|---|---|---|---|
| **RFQu** | Females | 379 | 22.75 | 7.27 | **1.50** | **2.32e-5** |
| | Males | 123 | 21.29 | 7.57 | | |
| **CIUS** | Females | 379 | 20.41 | 10.74 | **8.62** | **1.27e-4** |
| | Males | 123 | 20.24 | 11.66 | | |
| **TEC total score** | Females | 379 | 3.79 | 3.01 | **4.05** | **6.13e-5** |

| | | | |
|---|---|---|---|
| Males | 123 | 3.40 | 2.99 |

For this reason, we hypothesized that between those three factors, there was a mediation relationship. TEC total score scores probably become significant predictors if mediated by the presence of hypomentalization (i.e., RFQu high scores). Mediation models allow you to explore whether a mediating variable can explain the relationship between two variables. In particular, mediation analysis can help to better understand the relationship between an independent variable and a dependent variable when these variables do not have an obvious direct connection, as demonstrated by the multiple regression results above. The path model below illustrates the mediation model. Here, TEC total score was the predictor, RFQu the mediation factor, and CIUS the outcome variable. While path c describes the direct effect of the predictor variable on the outcome variable, paths a and b together describe the indirect or mediated effect (Figure 1). If there is both an indirect and direct effect, it is called partial mediation. If there is an indirect effect but no direct effect, it is called full moderation.

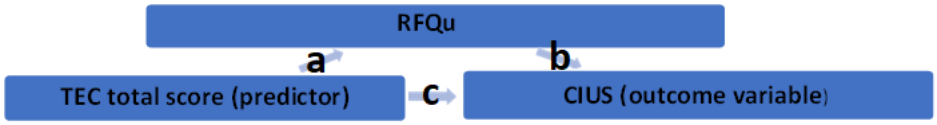


**Figure 1**: Path model of Mediation

**Table 2:** Mediation model

| Effect | Label | Estimate | SE | Z | p |
|---|---|---|---|---|---|
| Indirect | TECa×RFQu×CIUS | 0.182 | 0.0630 | 2.89 | 0.004* |
| Direct | TECa×CIUS | 0.271 | 0.1516 | 1.79 | 0.074 |
| Total | (TECa×CIUS)+ (TECa×RFQu)* (RFQu× CIUS) | 0.453 | 0.1616 | 2.81 | 0.005* |

Hence, high levels of TEC total score are strongly associated with high levels of CIUS only if higher levels of reflective functioning uncertainty acts as mediators. Our results show a full moderation model with a significant but indirect effect of traumatic experience on excessive use of the Internet (p = .004, at the 0.05 level bidirectional). TEC total score scores are good predictors of our model if mediated by the poor mentalizing capacity (high RFQu scores) (Table 2).

## 4. Discussion

The present study found a significant and positive association between presence of traumatic events, high levels of reflective functioning uncertainty, and an excessive use of Internet. This pattern of associations seems to be explained by a mediation model in which the relationship between the presence of trauma and an excessive use of Internet is fully mediated by uncertain reflective functioning. Contrary to previous data on specific forms of problematic Internet use [17,18], gender was not found to be a significant predictor of the pathways among those variables. This was an innovative result and may be explained considering the type and age of the reference sample. Indeed, most of the previous studies analyzed adolescents [12,19], while our research takes into consideration a population with a wide age range with a proportion of adolescents, young adults, and adults. Thus, it may be possible that with increasing age, the influence of gender as a mediator variable fades. Our study reports preliminary data which supports previous findings about the mediating role of hypomentalizing capacity (high scores on the RFQu) [5,12]. From a developmental point of view, the lack of the capability to reflect on and interpret one's own behavior and that of others based on intentional internal mental states such as beliefs, thoughts, and emotions is rooted in primary attachment relationships. It may be possible that unbearable mental states mostly related with cumulative traumatic experiences [13] jeopardize

representational processes of inner states. This process in turn reduces control mechanisms over goal-driven behaviors (i.e., including the use of the Internet), fostering compulsivity [20]. In line with this hypothesis, previous findings have found insecure attachment is a significant predictor of the excessive use of the Internet [21,22]. These findings give emphasis to the hypothesis that for individuals with a lack of mentalizing skills, the use of the Internet may be seen as a temporary withdrawal from painful events, related overwhelming feelings, and dissociated mental states that they are not able to regulate nor integrate in a coherent Self [23,24]. The findings of this study should be interpreted in light of several limitations: a numerical asymmetry in gender (379 females vs 123 males), a non-consideration of the hypermentalization processes, and the quality of traumatic experiences and related processes. Mentalization is a multifaced construct [25] that allows the subject to overcome stressful situations, Nonetheless, the "mentalizing profile" reflects contextual factors and individual differences in attachment patterns and dissociative processes. In this regard, future studies should take into consideration the influence that hypermentalization and pseudomentalization could have on the excessive use of the Internet and the relationship it could have with the presence or absence of trauma and stress [26]. It could be interesting to investigate the nature of traumatic experience (i.e., type of trauma, onset of trauma) instead of just their overall amount in further attempts to outline the existence of different developmental pathways of the excessive use of the Internet.

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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*

# Digital Career Guidance Technologies: Using Virtual Reality

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**Abstract.** In recent years, career guidance has become an increasingly technology-mediated phenomenon. In 2021, we conducted a series of experiments with representatives of different age groups using virtual and augmented reality together with technologies for collecting data on the subject's response to professional content and changing test conditions. The study sample consisted of 10 secondary school students, 10 high school seniors, 10 first-year students, 10 final-year undergraduate students, and 10 graduate students. They passed career guidance tests according to their professional choice and, in addition, from possible related professions. A virtual reality helmet as well as heart rate and skin-galvanic response sensors were used in the tests. The analysis of the collected data shows that there are reliable differences in people's reactions to extreme conditions simulated during the experiment such as a decrease in the test taking time, the introduction of a sound sequence accompanying real professional activity, as well as the simulation of sudden managerial decisions, and possible man-made disasters inherent to various professions. The obtained results of changes in heart rhythm and skin-galvanic reaction data can make highly reliable forecasts with regard to the person's behavior under the conditions of real professional actions, as well as possible ways of preparing for and overcoming difficulties in mastering specific professions.

**Keywords.** Career Guidance, Education, Virtual Reality, Augmented Reality, Heart Rate, Skin Galvanic Reaction

## 1. Introduction

In recent years, career guidance for children, adolescents, and adults has become an increasingly technology-mediated phenomenon. Worldwide, we can observe a surge of interest in the use of virtual and augmented reality (VR and AR) technologies for career guidance. The key point of using VR and AR technologies is the possibility to simultaneously study psychological, biological, and cognitive parameters of the subject's reaction to specific work conditions, its professional content, as well as simulation of extreme states in conditions of professional risks.

According to Halldorsson et al., almost two dozen studies present the results of testing games and applications based on virtual reality using both quantitative and qualitative methodologies. The studies tend to focus on identifying symptoms of anxiety, depression, and phobias during VR training. The review states that the existing evidence is at a very early stage, and studies vary widely in key methodological characteristics. The perception of VR is very different in different age groups [1].

Recently, the first works devoted to adding a psychophysiological component to VR trainings that have already become traditional have appeared. For example, Maarsingh et al. showed the possibility of using VR with biofeedback to improve stress resistance of the participants [2]. Blum et al. showed the possibility of organizing VR with breath rate biofeedback [3]. Fadeev et al. analyzed emotional responses to stress-imposing scenarios in VR in women. The results showed decreased activity of parasympathetic and increased sympathetic autonomic nervous system and less specific response of EEG spectral power in the theta and alpha bands during VR stress [4].

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Thus, current trends point at the need to measure the human state during VR training. Considering the growing popularity of VR professionalization trainings, we decided to concentrate on the study of the human state in such contexts. During the year 2021, we conducted a series of experiments on testing representatives of different age groups with different VR and AR methods together with technologies for collecting data on the subject's bodily reactions to the content and changing VR conditions.

## 2. Materials and methods

The study sample consisted of 10 secondary school students, 10 high school seniors, 10 first-year university students, 10 final-year undergraduate students, and 10 graduate students. They were participants in career guidance tests according to their professional choice and, in addition, from possible related professions.

A Zephyr HxM sensor was used to record nn-intervals. The data were filtered and processed in Jupiter Notebook using package 'hrv-analysis'. Rough filtering of the data was performed by removing nn-intervals greater than 1400 ms and less than 400 ms, as well as those differing by more than 70% from the median of the previous five nn-intervals. Skin conductance was recorded using a sensor that is part of the EEG device. The data was also processed in Jupiter Notebook.

The study design included taking professionalization training sessions in the Oculus Quest 2 VR helmet. For secondary school participants, the training consisted of a targeting game where wins and losses were recorded. For high school and university students as well as for graduates, the training included real professional situations involving interaction with equipment, other people, contingency situations, and sudden decisions. Everything taking place was recorded and saved, and the psychophysiological indicators were synchronized with what was happening in VR.

Statistical processing was performed using SciPy, a Python-based ecosystem of open-source software. We used Student t-test to analyze differences in nn-intervals for the same person in different contexts, and Wilcoxon T criterion to compare average HRV features in the group between different conditions: win/loss, expected/unexpected situation, etc.

## 3. Results and discussion

In secondary school students, we found significant and close to significant differences in HRV in Win and Loss situations - see Table 1.

**Table 1.** Mean HRV features' values in Win and Loss VR conditions in secondary school students (T criterion)

| Feature | Win | Loss | p |
|---|---|---|---|
| mean_nni | 530.7 | 525.1 | 0.084 |
| pnni_20 | 19.6 | 16.5 | 0.049 |
| median_nni | 527 | 520.2 | 0.065 |
| mean_hr | 114.8 | 115.9 | 0.083 |

No differences in skin conductance were found in this group. Perhaps this is due to the high anxiety of the study participants in this age group (11-13 years old), and skin conductivity does not reflect such subtle differences. Thus, HRV analysis appears to be more sensitive for assessing the human state in VR.

In high school seniors, first-year students, final-year undergraduate students, and graduate students, skin conductance increased in response to any uncertain and sudden situations during digital career trainings in VR (T criterion, $p < 0.05$). The response of the heart rhythm was also pronounced. Most statistical measures of HRV showed significant dynamics between different contexts (expected/unexpected situations, etc.) for group analysis (T criterion, $p<0.05$). Individual analysis detected significant decrease in nn-intervals for uncertain situations (Student t-test, $p<0.05$).

Thus, the results of the analysis of the collected data allow us to talk about reliable differences in people's reactions to extreme conditions simulated during the

experiment (the introduction of a sound sequence accompanying real professional activity, as well as the simulation of sudden managerial decisions, and possible man-made disasters inherent to various professions) such as a decrease in the test passage time. The decrease in test passage time was accompanied by episodes of acute stress and general tension of regulatory systems. The obtained results of changes in heart rhythm and skin-galvanic reaction provide a good probability of predicting human behavior in conditions of real professional actions, as well as possible ways of preparation and overcoming difficulties in the mastering of specific professions.

## 4. Conclusion

The obtained results of changes in heart rhythm and skin-galvanic reaction data provide a good basis of predicting human behavior in conditions of real professional actions, as well as possible ways of preparation and overcoming difficulties for mastering specific professions.

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# Testing a music-based virtual reality intervention for upper limb motor rehabilitation in post-stroke hemiparetic patients

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**Abstract.** Hemiparesis affects the majority of stroke patients in the acute phase. In post-stroke motor rehabilitation patients can re-learn motor sequences through repetitive training. Research showed that virtual reality (VR) can be effectively used in upper limb motor rehabilitation by training motor coordination and gestures in an immersive virtual environment. Another promising line of intervention in post-stroke rehabilitation is the use of music, with evidence supporting the notion that a rhythmic accompaniment promotes the recovery of motor coordination in patients with hemiparetic stroke. Furthermore, studies showed a beneficial effect of the observation of movements performed by a third person in patients with post-stroke hemiparesis. Based this evidence, the present study aims at testing the feasibility and efficacy of a novel music-based VR intervention designed for upper limb motor rehabilitation in post-stroke hemiparetic patients. The treatment consists in upper limb repetitive training activities through the imitation of movements synchronized with a musical accompaniment and is delivered in 10 sessions over 2 weeks, supervised by a physical therapist. Participants wear a VR headset through which they observe egocentric 180° 3D videoclips. The experimental condition (group A) will be compared with a no-music condition (group B), to test the specific effect of music, and with traditional physiotherapy rehabilitation (group C), to test the efficacy of the approach. We expect that the patients undergoing the experimental intervention (group A and group B) will show a greater upper limb motor function improvement, as compared to the active control group. As a secondary endpoint we expect the music component to induce a greater motor improvement as compared to the experimental condition without music.

**Keywords.** Music, Hemiparesis, Motor Coordination, Embodied Cognition, Rehabilitation, Virtual Reality

## 1. Introduction

Hemiparesis affects more than 80% of stroke patients in the acute phase (1). In post-stroke motor rehabilitation patients can re-learn motor sequences through repetitive training (2). Research showed that virtual reality (VR) can be effectively used in motor rehabilitation, particularly for upper limb training. In this type of intervention, the patient can train motor coordination and gestures (e.g., grasping and releasing of objects) in an immersive virtual environment (e.g., 3).

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Another promising line of intervention in post-stroke rehabilitation is the use of music, with evidence showing the music effect in improving the recovery of attention and memory and stimulating motor activity, along with overall autonomy and perseverance of patients (4). Studies show that Rhythmic Auditory Stimulation (RAS) and other interventions using a rhythmic accompaniment promote the recovery of walking and arm movements in patients with hemiparetic stroke (5,6).

The synchronization of rhythm and movements provides a sequential structure that facilitates the learning and performance of motor sequences in brain injured patients (e.g., 7). Furthermore, studies show a beneficial effect of Action Observation Training (AOT) in patients with post-stroke hemiparesis (8). Observation of movements performed by a third person can boost neural plasticity in the mirror neuron system, and thus reconstruct the motor representations stored in the patient's memory. Based on the reported evidence on VR, music, and action observation in motor training, the present study aims at testing the feasibility and efficacy of a novel music-based VR intervention designed for upper limb motor rehabilitation in post-stroke hemiparetic patients. Furthermore, the study aims at evaluating the specific contribution of music in the motor improvement following treatment.

## 2. Method

Participants. Post-stroke patients with upper limb hemiparesis (Ashworth scale: 0-2; MRC scale: 3-5) aged between 18 and 80 years, in acute/subacute phase and currently enrolled in inpatient rehabilitation.

Assessment. The baseline, post-treatment and 3-month follow-up assessment will include the following:

- Ashworth scale of muscle spasticity (9);
- Medical Research Council (MRC) Muscle strength scale (10);
- NIH Stroke Scale (NIHSS) (11);
- Motricity Index (12);
- The Chedoke arm and Hand Activity Inventory (CAHAI) – short form (13).

Treatment: Ten daily sessions of 30 minutes, over 2 weeks, supervised by a physical therapist. Interventions will be administered within the traditional physical therapy sessions offered to inpatients by the recruitment center. Experimental Group A: Upper limb repetitive training activities through the imitation of movements (i.e., unscrew the cap of a bottle, pour water into a glass, drink water from a glass, sugaring coffee, placing an object in a box) synchronized with a musical accompaniment (i.e., a selection of classical music pieces). Participants will wear a VR headset (Gear VR, Samsung) through which they will observe egocentric 180° 3D videoclips shot from a first-person perspective, as if the patient himself was performing the movement (14), while listening to music. Experimental Group B: Upper limb repetitive training activities through imitation of movements, without any musical accompaniment. Participants will wear a VR headset through which they will observe egocentric 180° 3D silent videoclips. Active control Group C: Treatment as usual (TAU). Patients will be engaged in upper limb repetitive training activities through traditional physiotherapy rehabilitation.

## 3. Results

As a primary endpoint we expect that the patients undergoing the experimental intervention (group A and group B) will show a greater upper limb motor function improvement, achieving better performance on the testing battery at post-test and follow-up, as compared to the active control group (group C). As a secondary endpoint we expect the music component (group A) to induce a greater improvement as compared to the experimental condition without music (group B).

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