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Virtual Reality Therapy in the Metaverse: Merging VR for the Outside with VR for the Inside

Editors:

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Virtual Reality Therapy in the Metaverse: Merging VR for the Outside with VR for the Inside

Edited by

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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

Virtual Reality Therapy in the Metaverse: Merging VR for the Outside with VR for the Inside

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Abstract. The Metaverse can be defined as a hybrid (digital/physical) environment offering places for rich user interaction. In this view, the main feature of the Metaverse is a twofold link between the virtual and physical worlds: (a) behavior in the physical world influences the experience in the virtual one and, (b) behavior in the virtual world influences the experience in the real one. Furthermore, any change in the physical world is mirrored in its digital representation (the digital twin), and feedback is sent in the opposite direction (i.e., if the avatar is touched, haptic feedback is provided to the physical body). Currently, this is achieved through 3D shared XR worlds, biosensors and activity sensors (from the real to the virtual world), two-way Internet of Things (IoT) object connections, social media, and wearable devices including smartphones (from the virtual world to the real one). Our view is that bridging technologies that simulate both the external world and the internal world (our bodily experience) will allow the simulated, cognitive, and embodied dimension of the Metaverse to merge, thereby transforming it into the ultimate clinical technology. In particular, it will allow for the emergence of Regenerative VR: the integration of external and internal simulated technologies to rewrite a faulty bodily experience and to regenerate the wellbeing of an individual.

Keywords. Metaverse, Interreality, Virtual Reality, Virtual Reality Therapy, Mixed Reality, Interoceptive Technologies, Regenerative VR

1. Introduction

In his classical 1992 novel *Snow Crash*, Neal Stephenson described the Metaverse as a new digital experience in which virtual spaces offer the same possibilities and opportunities as the real world. In the novel, Stephenson depicted the Metaverse as a digital escape from a physical and less interesting world. However, the actual vision driving the research and development work of many technological companies is instead trying to seamlessly connect the physical and the digital domains [1]. An example of this vision is digital twins [2]: digital representations of real-world entities – an object, system, or process – that are synchronized with the real world.

Following this vision, the emerging Metaverse can be defined as a hybrid (digital/physical) environment offering enhanced places for rich user interaction. In this view, the main feature of the Metaverse is a two-way link between the virtual and physical worlds: (a) behavior in the physical world influences the experience in the virtual world and, (b) behavior in the virtual world influences the experience in the real world. Furthermore, any change in the physical world is mirrored in its digital representation (the digital twin), and feedback is sent in the opposite direction (i.e., if the avatar is touched, haptic feedback is provided to the physical body). This will be achieved through the merging and interaction between different digital technologies: 3D

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shared XR worlds, biosensors and activity sensors (from the real to the virtual world), two-way Internet of Things (IoT) object connections, social media, and wearable devices including smartphones (from the virtual world to the real one).

Currently, XR technologies – virtual reality and augmented reality – have been successfully used for the assessment and treatment of different mental health disorders including anxiety disorders, stress-related disorders, obesity and eating disorders, acute and chronic pain, addictions, and schizophrenia [3-5].

However, the Metaverse aims to become the most advanced form of human-computer interaction allowing individuals to act, communicate, and become present in digital and digitally-enhanced physical environments. Even if these features will further improve the clinical potential of XR technologies, we suggest that there is a significant missing piece to this equation: our physical body.

Our view is that bridging technologies that simulate both the external world and the internal world (our bodily experience) will allow the simulated, cognitive, and embodied dimension of the Metaverse to merge, thereby transforming it into the ultimate clinical technology.

2. Virtual Reality Therapy Today

Virtual Reality (VR) is usually referred to as an interactive 3D visualization system (e.g., a computer, gaming console, or smartphone) supported by one or more position trackers and a head-mounted display. VR is, however, more than a collection of technologies. The term "virtual reality" is made up of two words: "virtual" (nearly as described) and "reality" (the actual state of things). As a result, the term "virtual reality" might be defined as "almost reality" or "near reality," implying that VR is a type of reality simulation. Experiential learning has a long history as a therapeutic practice, and virtual reality's simulation strength makes it the ideal tool for this technique.

Virtual reality allows patients to learn by reflecting on their actions. "One reason it is so difficult to get people to update their assumptions is that change typically needs a prior step – identifying the distinction between an assumption and a perception," according to Glantz and colleagues [6]. "Assumptions shape the reality until they are proven to be false; they appear to be perceptions, and as long as they do, they are resistant to change" (p. 96). Using the VR experience, the therapist can more easily illustrate to the patient that what appears to be a fact is actually a result of his or her thinking.

The simulation potential of VR also transforms it into an advanced imaginal system – a type of experiencing imagery that is as effective as reality at eliciting emotional reactions [7; 8]. Numerous studies have indicated that VR can increase subjectively reported anxiety in phobic participants confronted with a dangerous virtual setting, comparable to the effects seen in in vivo conditions (Powers and Emmelkamp, 2008; Opris et al., 2012). As a result, as indicated by two meta-analyses [9; 10], VR is an effective and equal medium for exposure therapy. In fact, exposure treatment (virtual reality exposure therapy, or VRE) is the most popular clinical application of VR. It is used to replicate an external reality. In other words, virtual reality is employed in clinical settings to make patients believe that something that isn't there is "real."

3. The Body: From the Brain to the Metaverse

"Predictive coding" [11-13] is a common neuroscience idea that suggests our brain actively develops an internal model (simulation) of the body and its surroundings. This model is used to make predictions about the sensory information that will be received and to reduce the number of prediction errors (or "surprise"). Specifically, our brains build an embodied simulation of the body that represents its expected future states to successfully interact with the world (intentions and emotions). This simulation has two distinct properties [14; 15].

It is, first and foremost, a simulation of sensory-motor experiences using visceral/autonomic (interoceptive), motor (proprioceptive), and sensory (e.g., visual, aural) information as sources. Second, embodied simulations are based on the subject's expectations and reactivate multimodal brain networks that caused the simulated/expected result earlier.

One of the most important goals of this process is to reduce the average of surprise (i.e., the gap between intentions and the consequences of enacting them) across all representations and to learn how to model and forecast incoming content.

Virtual reality works similarly; it uses technology to create a virtual experience that people can manipulate and explore as if they were there. In other words, VR technology tries to predict the sensory consequences of users' actions by displaying the same outcome that our brains expect in the real world. As explained by Riva and colleagues [14]: "*To achieve it, like the brain, the VR system maintains a model (simulation) of the body and the space around it. This prediction is then used to provide the expected sensory input using the VR hardware. Obviously, to be realistic, the VR model tries to mimic the brain model as much as possible: the more the VR model is similar to the brain model, the more the individual feels present in the VR world*" (p. 89).

Up until now, VR has been used clinically to make people believe that something that is not present is "real." However, VR simulations of our body can also fool the predictive coding mechanisms that regulate bodily experience, making people feel "real" in situations that are not.

In fact, recent key discoveries in neuroscience are outlining a new conceptual framework suggesting that mental health disorders are linked to the processing of multisensory bodily signals [15; 16]. As recently explained by Paulus and colleagues [17]: "these conceptual models suggest that mental disorders can be broadly characterized by a dysfunction in the way the brain computes and integrates representations of the inner and outer worlds of the body across time. According to this view, changes in mood and anxiety are a by-product of the brain's biased translation of what it expects will happen versus what is actually happening in these worlds, producing a persistent discrepancy/error signal when outcomes are observed." (p. 99).

In this scenario, VR can also be used to structure, augment, and/or replace the body's experience for clinical purposes. Various researchers have used advanced technologies, including VR, to alter bodily perceptions in clinical and non-clinical populations since the discovery of the rubber hand illusion [18] and the emergence of non-invasive brain stimulation methodologies [19].

Brain stimulation techniques, including transcranial direct current stimulation (tDCS), transcranial magnetic stimulation (TMS), and vagus nerve and galvanic vestibular stimulations, have been successfully used to modify both bottom-up [20] and top-down [21] bodily signals. More recently, the use of VR allowed the emergence of a new approach: virtual embodiment. This approach uses virtual reality technologies to trick the predictive coding mechanisms of the brain, thereby inducing in users a sense of ownership over a virtual body. Some researchers are beginning to use virtual embodiment – the use of VR to replace multisensory bodily contents with synthetic ones – for chronic pain and eating disorders therapy [22].

The rationale behind this approach is to use VR's embodiment potential to correct a dysfunctional representation of the affected body/body part. For example, virtual embodiment is currently being used to treat phantom limb pain, which is caused by dysfunctional changes in amputees' representations of their bodies [23]. Additionally, Matamala-Gomez and colleagues used virtual embodiment to obtain pain relief in chronic pain patients [24; 25]. Finally, Serino and colleagues [26] used a VR-based body swapping illusion to correct the dysfunctional representation of the body in anorexia nervosa.

Although randomized controlled trials are not yet available, the above case studies show that VR interventions have a high potential for modifying the experience of the body.

4. Simulating the Inner Body

Existing research, however, suggests that the above-mentioned approaches' effects on higher cognitive processes are only temporary, even in non-pathological individuals. According to Freeman and colleagues [27], the longest follow-up in studies with virtual bodily illusions for correcting body perception in participants with eating disorders is only 2 hours. Why?

Regardless of the success of virtual embodiment, what distinguishes our body from other physical objects is that, unlike other physical objects, we not only perceive it through external senses (exteroception), but we also have internal access to it via inner (interoceptive, proprioceptive, and vestibular) signals [28].

In this view, interoceptive technologies [29] that modulate interoceptive signals can play a critical role in simulating our inner bodily experience in the Metaverse. They include technologies that produce direct modulation of interoceptive signals (for example, c-fiber stimulation [30] or sonoception [28]) as well as technologies that produce illusions by providing false feedback of individuals' physiological states [31].

Figure 1. The different components of Regenerative VR (Adapted from [32])

The integration of technologies able to simulate/stimulate both the external body and the internal one will allow for a new clinical intervention – "Regenerative Virtual Therapy" (RVT) [32] – which uses technology-based somatic modification techniques to restructure the maladaptive bodily representations behind a pathological condition. To achieve this goal, we will combine two different strategies (see Figure 1). First, a technological intervention merging brain stimulation techniques with a high-rewarding and novel synthetic multisensory bodily experience (i.e., a virtual reality full-body illusion in sync with a low predictability interoceptive modulation). Second, a psychological intervention including mindful attention and cognitive reappraisal.

5. Conclusions

The Metaverse can be defined as a hybrid (digital/physical) environment providing places for rich user interaction. In this view, the main feature of the Metaverse is a twofold link between the virtual and physical worlds: (a) behavior in the physical world influences the experience in the virtual one and, (b) behavior in the virtual world influences the experience in the real one. Moreover, any change in the physical world is reflected in the digital representation (the twin) and feedback gets sent in the other direction.

XR technologies – virtual reality and augmented reality – are currently being used to assess and treat a variety of mental health disorders including anxiety disorders, stress-related disorders, obesity and eating disorders, acute and chronic pain, addictions, and schizophrenia [3-5].

However, the Metaverse aims to become the most advanced form of human-computer interaction, allowing individuals to act, communicate, and become present in digital and digitally-enhanced physical environments. Even if these features will further improve the clinical potential of XR technologies, we suggest that there is a significant missing piece to this equation: our physical body.

Our view is that adding technologies that simulate both the external world and the internal world (our bodily experience) will allow the simulated, cognitive, and embodied dimension of the Metaverse to merge, transforming it into the ultimate clinical technology. A critical role will be played by the emergence of interoceptive technologies that produce a direct modulation of interoceptive signals or generate interoceptive illusions by providing false feedback of individuals' physiological states.

The integration of technologies able to simulate/stimulate both the external body and the internal one will allow the emergence of Regenerative VR: the integration of external and internal simulated technologies to rewrite a faulty bodily experience and to regenerate the wellbeing of an individual.

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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, 20

Implicit Measures of Perceived Realness in Virtual Reality

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Abstract. Virtual Reality (VR) provides an interesting form of stimulus presentation due to its capability to elicit lifelike experiences. People often feel present (i.e. as if they were there) in a virtual scenario, but they can additionally obtain a sense of owning a virtual body and experience virtual conspecifics as socially present. These experiences can be assessed explicitly using questionnaires, but several studies have also employed behavioral and physiological measures to trace when people experience a virtual situation as real. This article gives a brief introduction to how implicit measures were used to explore these distinct but related facets of perceived realness in VR and how they may be exploited to better understand mental health conditions.

Keywords. Virtual Reality, Presence, Virtual Body Ownership, Social Presence, Implicit Measures

1. Introduction

Early on in VR research, it was observed that physiological reactions in VR (such as changes in heart rate in response to a threatening virtual situation [8]) can correspond well to those expected in a real-life situation, and it was argued that such measures may be interpreted as objective surrogates of presence. Later research additionally indicated that a weaker fronto-central Mismatch Negativity component (MMN; an event-related component) to task-irrelevant beeping tones in participants' EEG was indicative of their experienced presence [9]. However, [10] concluded that physiological correlates of the sense of presence are not yet sufficiently robust overall. Moreover, since the evocation of physiological reactions often required an induction of specific states (e.g. stress) or additional stimuli (beeping tones), it was argued that behavioral measures could be more suitable to unobtrusively monitored presence instead [2].

In a study by [11], participants were asked to point towards a radio which they had seen both in the real laboratory room and a virtual scene but in different locations. Participants more strongly pointed in the direction of the virtual radio as compared to the real radio when the virtual scene was depicted at a higher visual acuity, substantiating the idea that this behavioral measure may mirror experiences of presence. In a study by [12], participants walked more slowly across a virtual steel girder when exposed to height in VR, following a safety strategy which can be expected in a real-life situation.

Another indirect measure of presence may lie in analyzing how experiences in VR are stored in memory. Here, the observation that treatment effects from virtual reality exposure therapy can transfer well to real life [13] may point to high levels of presence during confrontation with a feared stimulus. Indeed, object learning was found to be facilitated in VR compared to the viewing of a computer monitor [14]. As a more direct test for the realness of VR experiences in memory, our own study tested how well people can distinguish real from virtual experiences in hindsight [15]. Participants viewed 3D models either in reality, VR, or on a computer screen and were later asked to recall where they had seen each model. Participants more frequently misattributed VR and reality compared to VR and the computer monitor as sources of a memory trace, possibly revealing a mechanism driving the good generalization of VR treatment effects. Future research may investigate if a tendency for such source memory errors is predictive of therapeutic success in virtual reality exposure therapy.

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Overall, it was argued that, while a plethora of behavioral markers for presence can be envisioned in various virtual scenarios, the field is still understudied [2], and potential approaches to implicitly monitor presence remain to be exploited. Note that the approaches described here do not allow for a continuous monitoring of presence; they either require the implementation of specific events (e.g. exposure to height, asking participants to point to an object) or are only assessed after the experience (in memory tasks).

2. Implicit Measures of Body Ownership

A large number of studies have documented that people can develop a sense of ownership over a virtual body or body parts. The illusion is facilitated by spatial overlap between the two bodies or body parts, human-like visual representation, visuo-tactile congruency, and visuo-motor congruency [16, 17, 4]. A common indirect measure for the ownership over a virtual or fake hand is a proprioceptive drift [18]. After taking ownership over a hand model which is located at a slightly different position compared to their real hand, participants are asked to indicate its felt position by pointing towards it using their other hand. Here, pointing more towards the location of the fake hand is interpreted as sign of a successful ownership illusion (although it may only index an ownership illusion in situations where visuo-tactile congruency is present [19]). A parallel measure was introduced for assessing the experience of taking ownership over a whole fake body. In a seminal study [20], participants saw their own back from behind by wearing a head-mounted display (HMD) which displayed the live-streamed video recorded by a camera positioned 2 meters behind them. After participants' backs were stroked for one minute (which participants could view on their own backs in front of them), they were passively displaced while being blind-folded and asked to return to their initial position. Participants moved to a position in space closer to where their virtual own body was located, indicating a shift in self-location and thus an experience of the illusory situation as real.

In studies where participants took ownership over a virtual body in VR, the body illusion was furthermore found to be associated with heart rate deceleration [21] and skin conductance reactions [22, 23] following a threat towards the virtual body. In our own research, we investigated continuous walking behavior as a proxy for a body illusion [24]. Participants took ownership over a more corpulent virtual avatar and either experienced intact or deteriorated visuo-tactile congruency when touching their own hips. Participants who experienced intact visuo-tactile congruency more consistently walked in the laboratory as if they were actually more corpulent than before, keeping distances to obstacles in line with being more corpulent.

Additionally, several studies documented how successful ownership over a virtual body different from one's own can alter social cognition [25]. For instance, [26] and [27] observed a shift towards associating oneself with child-like concepts in an Implicit Association Test (IAT) after taking ownership over a childlike virtual body. In the future, these approaches may help to more closely trace body schema disturbances in mental disorders such as anorexia [7] or explore self-associations in mood disorders [26].

3. Implicit Measures of Social Presence

Implicit markers of social presence are reactions towards virtual agents which are comparable to those observed towards real humans. An interesting demonstration for such an effect made use of the social inhibition of return. This effect, where a stimulus is reacted to with additional delay if it was previously reacted to by a conspecific, is commonly observed when interacting with a real counterpart, and was also – albeit in a smaller magnitude – observed when interacting with a virtual agent shown in VR [28]. Another study demonstrated that virtual avatars can induce social stress [29]: when forming a committee in a Trier Social Stress Test (TSST), participants reacted with similarly increased stress markers (both in explicit reports and on a physiological level) as towards a real TSST committee. In order to directly compare the influence of VR on an implicit measure of social presence, we compared gaze behavior towards a virtual agent seen in VR with that of the same scene displayed on a computer monitor [30]. Here, participants in the VR condition more strongly reciprocated the virtual agent's social gaze, pointing to a more natural reaction to this (artificial) social situation and thus to a stronger social presence. Such findings may be helpful in better monitoring and interpreting social avoidance behavior in the course of VR therapy programs for treating social anxiety disorder [31].

4. Conclusion

A large body of research investigated how experiences in VR can involve a sense of presence [2], illusory body ownership [4], and social presence [5]. Common future use cases of VR such as sharing a virtual space in embodied social encounters may incorporate all of these three facets of experiencing a VR situation as real. All three phenomena have seen a thorough investigation of boundary conditions as well as a systematic advancement of explicit measures. By contrast, although there exist examples for implicit measures, such developments currently remain more scarce and fragmented, especially regarding behavioral markers. The development of sensitive and reliable implicit measures of the perceived realness could, especially if they can be assessed in a continuous and nonintrusive manner [2], help to deepen our knowledge on how people experience situations in VR, and allow us to monitor problems and progress during VR therapy programs in a variety of mental disorders.

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Between benevolent lies and harmful deception: Reflecting on ethical challengesin dementia care technology

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Abstract. In the context of dementia care, deception is a common yet controversial practice, generating substantial attention from scholars. Though complicated, consensus has seemed to emerge that, whereas lying is generally frowned upon, benevolent (white) lies can be acceptable if the aim is to improve the life of the recipient. However, with the increasing omnipresence of technology as ameans of improving quality of life and care efficiency, many technologies, implicitly or explicitly, embody deceptive practices. In the current paper, we expand our ethical analysis and understanding of deceptive practices to include technological designs and human-technology relations in dementia care settings, by reviewing current literature and exploring relevant case studies. With our analysis, we hope to create awareness and proactive engagement of technology developers, interaction designers, as well as care professionals, who want to ethically develop and deploy care technologies containing benevolent deceptive elements.

Keywords. Dementia, Care Technology, Deception, Ethics

1. Introduction

Imagine, if you will, the following four scenarios:

i. An elderly lady with middle stage dementia loses her pet dog. After weeks of intense grief, she is given an interactive robot cat, to which she immediately develops a deep attachment. She cares for and caresses the robot continuously, and her grief over the lost dog is significantly lessened. She calls the robot cat “her dog” and uses the name of her deceased dog. When the batteries of the catrun low, she is deeply distressed and calls her informal carer, telling him “the dog is dying”.

ii. An elderly lady in the later stages of dementia occasionally shows intermittent episodes of significant restlessness and emotional distress. The nursing staff, responding to her calls, hand her what looks like an old-fashioned dial telephone that connects the lady to the prerecorded voice of her son. The system responds through scripted questions and answers, where AI-based language recognition and voice stress analysis allow for some level of flexibility and tuning of the conversation. Believing she is talking to her son, the conversation has a soothing effect on the elderly lady who ends the conversation by asking when her son iscoming over to visit her again. The computer responds, in the voice of her son:“I’ll be over this evening” – an answer that puts a big smile on her face.

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iii. The garden of a nursing home for people with middle to late-stage dementia hasits own bus stop. It is designed with all the familiar bus stop signs, timetables, a booth, and a bench to sit on. However, no bus will ever arrive at this stop. It is a fake bus stop erected with the express purpose to attract people with dementia prone to wandering around or off the nursing home grounds – a significant source of stress for caregivers and care facilities. Here, they sit and wait for the bus.

iv. An ambient assisted living facility of a senior couple has been outfitted with a new, state-of-the-art, dynamic lighting system. The system is designed to detectthe mood of the residents and subsequently adjust the lighting in the room to either calm or activate the residents. The system uses sensors and affective computing algorithms to measure and interpret the couple's mood and controlsthe LED-based light settings using a pre-constructed mood model. As the "active" mood lighting kicks in at around 9:00 a.m., the senior couple feel thatit must be a nice bright day outside and plan to go for a walk.

All four scenarios are based on actual, existing technological interventions – some are based on high-tech engineering including AI or robotics, others include physical redesign of familiar environmental characteristics. They all share the aim of wanting to improve the quality of life for people with dementia (PwD) and/or alleviate the care burden for informal and professional carers. They also share the use of deceptive practices to reach that aim. Whereas in recent literature on nursing and dementia care, attention has been growing regarding the use, boundary conditions, and ethical implications of people using benevolent (white) lies as part of caring for PwD, there has been scant attention to the implications of technology embodying deceptive practices in dementia care. The current paper aims to address this urgent issue.

2. Deception, and its use in dementia care practice

In this paper, our contribution will focus on deception in dementia care, and in particular the role that technology can play as a conduit of deception. Deception is "the act of causing someone to accept as true or valid what is false or invalid" (Merriam – Webster). Deception implies intent, as well as an intentional agent (the deceiver), and is typically situated in the context of social interactions between human beings. In most definitions of deception, there is an element of personal gain on the part of the deceiver. Deceptive acts may include acts or statements that mislead or promote a falsehood. Deceptive acts may also wittingly withhold or otherwise hide information required to access or appreciate the truth.

Deception is generally seen as morally reprehensible for a variety of reasons. From some philosophical (e.g., deontological) and religious perspectives, it is seen as a fundamental moral wrong – a universal denouncement of any form of deception. Instrumentalist or consequentialist views of deception attempt to weigh the costs of deception against its potential benefits, creating a more situational or contextualized moral view on deception rather than an absolute denouncement. In this view, there are a variety of cases of deception that are not regarded as clear moral transgressions, such as lying under threat of harm. In general though, deception impinges on the rights of the person being deceived to make a free and informed decision, effectively diminishing that person to a means to achieve the deceiver's purpose, thus negatively impacting their autonomy.

It is important to note that not all lies (or other forms of deception) are necessarily done with malicious intent or for personal gain. The best-known example of this is the white lie, which is a well-intentioned untruth, generally meant to avoid hurting someone's feelings. White lies are frequent, rather trivial occurrences in day-to-day interpersonal relationships, wherein they typically help grease the social wheels and make people feel good about themselves (e.g., "you haven't aged a bit").

When reviewing recent literature on nursing and dementia care, we note that white lies are a commonly used strategy in this context, generally with an aim to serve the best interest of a person with dementia [4]. Moreover, the rationale for deception appears to be more about managing a person's behavior and emotional distress than it is about controlling information. For example, in the more progressed stages of dementia, confabulation is frequently encountered, where a person with dementia may be totally convinced of a parallel but untrue reality, frequently associated with events or relations from one's past life. If this happens, caregivers can reach someone by carefully listening to, and not contradicting, the confabulated stories, essentially validating the person's altered sense of reality [5]. As another example, people with dementia may be reliving an emotionally charged episode from their past (e.g., a stressful episode at work, a sick child, or a dying mother) where they may be highly distressed and may think they urgently need to act on a perceived responsibility. These "time-shifted" stressful experiences can lead to distress and restless behavior. In these cases, it is common for staff to use white lies – such as "your mom is fine" – to comfort and distract the person with dementia [7]. In a recent cross-sectional survey study, Cantone et al. [1] reported on attitudes and behaviours of geriatric and psychiatric nurses towards the use of lies in dementia care. Only a few of the respondents (10 to 12%) stated that they never used lies or that it would never be acceptable to use lies in care practice. Attitudes differed depending on the situation; more respondents were prone to tell a lie "to prevent or reduce aggressive behaviors" than "to avoid wasting time giving explanations." In all, it appears that views on deception and truth-telling in dementia care practice are strongly instrumentalist in nature. Rather than being an intrinsic wrong, deception is evaluated and used in a contextualized fashion, serving the interests of the patient and/or the care provider.

In recent years, a number of guidelines and communication strategies have been published, based on qualitative research amongst care professionals and PwD, on how to deal with deception in dementia care settings. One example is the work by James et al.[4] formulating 12 guidelines, including that a lie should only be told in the best interest of the PwD (e.g., to ease distress), that consideration should be given to an individual's ability to discern truth from falsehood, that family consent should be obtained, the lies should be documented, and that an individualized and flexible approach should be adopted towards each case, weighing the benefits and costs relating to a lie.

In addition to such guidelines, the same group [8] developed a four-stage communication strategy where telling the truth is the first option to meet a resident's need (e.g., wish to see one's husband), and subsequent stages include addressing the underlying need (e.g., comforting in response to perceived loneliness), offering distraction (e.g., ask the PwD to help to set the table), and finally, telling a therapeutic lie. However, in practice, health care professionals often struggle with the interpretation of these guidelines and strategies and may strongly vary in their use of therapeutic lies. Many professionals are also conflicted in striking the right balance between the virtues of being an honest person and doing the right thing given the circumstances. All this is suggestive of a situated and complementary mix of care ethics and virtue ethics – of responding with empathy and integrity on a case-by-case basis where the therapeutic lie should be used sparingly and only when it is used to protect and prevent distress of the person with dementia, and alternative strategies are not available or don't work [2, 6]. Indeed, a recent study using a sample of people with dementia and their carers stresses that in addition to having good intentions, "the carer telling the lie had to really know the person and be cognizant of family preferences" [2].

3. Considering deceptive practices mediated by dementia care technologies

The introduction of care technologies brings new challenges and complexities to the fore in the way they can, intentionally or unintentionally, be embodiments or conduits of deceptive practices. The four scenarios mentioned at the start of this paper – (i) the robot cat, (ii) the AI phone conversation, (iii) the fake bus stop, and (iv) the mood-sensitive lighting – all offer illustrative cases of technologies that are being used, or proposed to be used, in current dementia care practice. They are used here to help reflect on the ethical challenges and tradeoffs that the introduction of technology in dementia care may imply, and specifically where they touch upon the use of deception.

As a consequence of their cognitive vulnerabilities, PwD, especially in more advanced stages of the disease, are more likely than healthy seniors to be unable to distinguish simulated or mediated reality from actual reality. This "illusion of non-mediation" [6] can pertain to social simulations as in cases (i) and (ii), as well as reproductions of physical environments (as in (iii), but also seen, for example, in VR-based bike rides "to work", or in life-size pictures of one's former front door attached to the door of the resident's current apartment). Such simulations/reproductions are frequently meant to encourage connection to socially significant others, stimulate reminiscence, or elicit a sense of familiarity of surroundings. However, little data is available on the extent to which these experiences may also confuse, defamiliarize, and disconnect PwD from their current lived reality. Expectations (e.g., of talking to one's son, of waiting for the bus to arrive) may be violated, and such "reality breakdowns" may reinforce the confusion and alienation that many PwD already experience. Relatedly, the inner complexities of some of the technologies in use may lead to an inaccurate mental model of the workings of the technology, and their derived meaning. Scenario (iv) is but one example of a host of "smart home" innovations where the causal chain of sensing, interpretation, and actuation may remain entirely opaque to the resident. As a consequence, s/he may engage in unproductive interactions in an attempt to exert control or may interpret experiences in ways which are unrelated to physical reality (see also 3).

In relation to our discussion of deception in dementia care, one can generally recognize and acknowledge the positive intentions with which technologies are being developed and introduced. The rationale for these technologies typically includes improving the quality of life of PwD and supporting care efficiency and effectiveness. However, a number of considerations that are part of the guidelines and situated ethics around deception by human care staff and family can also be valuable in considering the ethical cost-benefit tradeoffs when technologies are used as part of deception.

Despite their increased sophistication, technologies generally lack the intelligence (and empathy) required to really know a person, their context, life history, and family preferences. Many technologies have been developed with only bare-bones adaptivity or personalization features that supports the technology's functionality. Most technologies currently in use are typically not receptive to surprise, confusion, anger or disappointment on the part of the PwD, nor can these technologies respond adequately to such responses if they occur. Importantly, even though care technologies have clear moral implications, they are not moral agents in themselves; they cannot take an "all things considered" approach that is required to support ethical decision making. In some cases, the nursing staff may play an active role in choosing to deploy the technology, assessing the ethical pros and cons, and managing or ameliorating any unforeseen, potentially negative effects. In other cases, the technology is omnipresent or always-on, and may impact the PwD - positively or negatively - whether they are being presently attended to by staff or family members or not.

As our review of deception in dementia care demonstrated, deceptive practices by nursing staff are deeply contextualized and adapted to the situation and person at hand. Similarly, this should hold true for the technologies we develop and deploy. In addition to good intentions, technologies need to be used in ways that are adaptive to the situation at hand: to only use deception when other interaction strategies are ineffective, and then to use deception only sparingly and with integrity and restraint. Deception is not intended to create entirely new realities, but rather to defuse potentially harmful or stressful situations. Secondly, when using deception, it is necessary to only do this with a constant sensitivity to a person's needs and responses, the particularities of the context, and family preferences. To echo Casey et al. [2], whoever is doing the deceiving has to really know the person. This requires technology to be developed using person-centered co-design methods to ensure it is genuinely serving the needs of the PwD (the Warm Technology approach, 3). Moreover, after its introduction, care technology really requires constant human involvement to verify and ensure that the technology is still appropriate given changing circumstances and human needs – an explicit and continuous assessment of its fitness-for-purpose and its associated ethical cost-benefit tradeoffs. The complexities of introducing technologies that contain benevolent deceptive elements into care practice thus emphasizes the fact that care technologies should always be designed to supplement rather than replace human care.

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Normative Affordances: Utilising the constraint of context-specific expectation in simulated environments

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Abstract. Affordances are the interactional opportunities that exist between us and our environment. The design processes of simulations (using technologies such as virtual reality and mixed reality) can benefit from considering three distinct forms of affordances. *Possible affordances* are interactional opportunities that exist but are not perceived. *Perceived affordances* appear to offer interaction possibilities but in fact do not. *Normative affordances* are those actions that are consistent with the socially-constrained behavioural expectations of a given setting. By considering these three types of affordances and, in particular, utilising normative affordances in the creation of affordance arrays, it is argued that more compelling narrative experiences can be created with comparatively minimal resources.

Keywords: Affordances, Normative Affordances, Simulated environments

1. Introduction

By virtue of our embodiment, different aspects of our environment become more or less salient. Individual differences between human beings—and between species—create variations in what aspects of the environment are significant. This difference of *umwelt*, or our subjective sense of our own environment as per the work of Jakob von Uexküll (1864–1944), means that even the same environment can tell a very different story for different participants [1]. The eyesight of a bird, a dog's senses of hearing and of smell, and a bat's echolocation system all offer radically different ways of engaging with potentially the same environment [2]. Just as importantly, the diverse needs of organisms lead to a filtering of the environment in different ways. The endurance of this meaningfulness can vary, with something like oxygen in the air being persistently meaningful to those who have lungs, while an interest in food would be circumstantially meaningful depending on recent eating patterns. James J. Gibson (1904–1979), in his work in ecological psychology, described affordances as follows:

> "The affordances of the environment are what it offers the animal, what it provides or furnishes, either for good or ill. The verb to afford is found in the dictionary, the noun affordance is not. I have made it up. I mean by it something that refers to both the environment and the animal in a way that no existing term does. It implies the complementarity of the animal and the environment." [3]

Affordances, in Gibson's view, exist relationally. That is, a chair will be a rather different thing to an adult human than to a child, and to other species like cats or ants. While some things—like oxygen—may be afforded automatically to an organism by its environment, in other cases—like food—resources must be actively sought. For some organisms with simpler needs, there are fewer degrees of abstraction [1]. For human beings, the parameters are substantially more complex. Base needs, as something like the bottom level of Abraham Maslow's [4] hierarchy of human needs, are in and of themselves more involved: varied nutritional needs, shelter, warmth, etc. However, even more complex are the variety of psychological and existential needs that human beings

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possess, and which motivate action. Through life experience, these inherent needs become mediated through patterns of interaction, and we learn effective and ineffective ways of achieving things. We want food, and there may be competition, so eating it first means we're more likely to get it. But, if we take it away from others who want it, they may be less likely to share with us in the future. In this way, natural biological tendencies, as they are enacted in the context of an environment, are shaped and directed.

The role of experiential therapy and training then, whether conducted physically, imaginally, or through simulative tools such as Virtual Reality (VR) and Mixed Reality (MR), is to help develop these relations to ensure the most appropriate affordances are prioritised, and that the strategies for achieving them are sustainable [5]. In recognising this meaningful relationship between the organism and their environment, the distributed nature of the subject becomes more evident, and, for behavioural change purposes, various potential modes of intervention start to stand out. Rather than just focusing on how the person makes sense of the world, can the world be changed, manipulated, or presented in ways that change the person? Fundamentally, we know that the answer is yes. Techniques of behavioural shaping have demonstrated this not just in therapies and trainings, but in advertising, marketing, and shopping reward cards [6]. However, while basic principles such as reward and punishment are effective for certain well-defined behavioural outcomes, it is possible to work at an even finer grain, and to not just leave the cognitive system as a black box in the middle of a variety of environmental cues. Instead, the aim is to meet its nuances, understand them, and scaffold them via environmental supports.

2. Possible and perceived affordances

Gibson's use of the term affordance was directed at the physical environment, but how does such a concept transfer to considering the virtual? In a *Human Computer Interaction (HCI)* context, a field where both affordances and virtuality have been considered significant, Donald Norman [7] describes affordances as follows:

> …"the term affordance refers to the perceived and actual properties of the thing, primarily those fundamental properties that determine just how the thing could possibly be used. […] Affordances provide strong clues to the operations of things. Plates are for pushing. Knobs are for turning. Slots are for inserting things into. Balls are for throwing or bouncing. When affordances are taken advantage of, the user knows what to do just by looking: no picture, label, or instruction needed." [7]

For Norman, an affordance—contrary to Gibson's definition—is the perception of interaction afforded rather than the actuality of that possibility when we attempt to push the plate, turn the knob, insert something into the slot, or throw the ball. Virtual versions of the above which lack such actual interactivity would, therefore, be classed as affordances by Norman but not by Gibson. From Gibson's particularly realist position, an affordance would exist even if it was never detected by an organism.

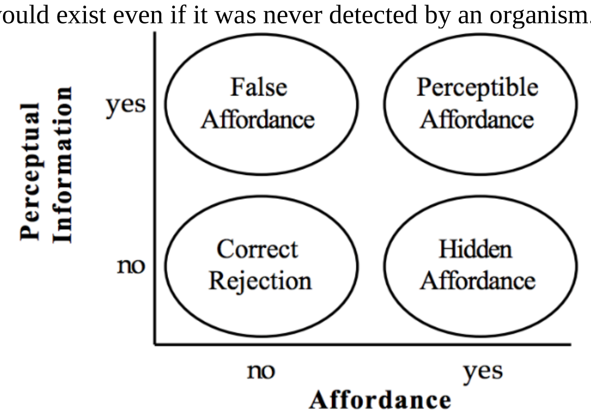

Figure 1. Perceived and possible affordances

In William Gaver's diagram above, affordances may exist and be perceptible (top right) or may not exist nor appear to (bottom left). They may exist and not be perceptible (bottom right) or may appear to exist but in fact not (top left) [8].

William Gaver [8] draws together perceived and actual affordances yielding four categories, as shown in Figure 1 above. On the top row of the grid are circumstances where there appears to be an affordance, which may turn out to be a false affordance or a perceptible affordance that offers actual interactive possibilities. On the bottom row are circumstances where there is no apparent affordance, which may lead to correct rejection if there is in fact no affordance or—if there is—then this is a hidden affordance. For more complex interactions, Gaver considers groups of affordances that are sequential in time or nested in space, leading to the possibility of a combination of the above categories in a given task. For Gibson, only the categories of perceptible and hidden affordances come under the formal definition of affordances. Norman, while not denying the existence of hidden affordances, is interested in his definition in perceived affordances, whether false or not.

In carefully considering these distinctions, it becomes clear that it would be a mistake to conflate the virtual and the digital. A physical door—complete with a handle that does not move and that leads to nowhere—would be an entirely physical object yet it would offer false affordances. A digital door in a virtual simulation may function perfectly to enable progress into another room, albeit also virtual. Affordances are of interest in training, assessment, and therapeutic contexts because as they occur relationally, they allow an insight into psychological phenomena that may not be otherwise accessible. In introducing an affordance, or arrays of affordances for more substantial scenarios, consideration is needed as to what level of interaction is required. For example, in working with a phobia of heights, a perceived sense of height is all that is needed, and an actual fall in no way adds value to the simulation. Whether we make use of physical, virtual, or imagined affordances is likely to be immaterial—all other things being equal—provided we can include the interaction possibilities relevant to the scenario [9].

3. Normative affordances

Figure 2 below shows three notional ways of viewing affordances in the context of narrative scenarios created for therapeutic, training, and assessment purposes.

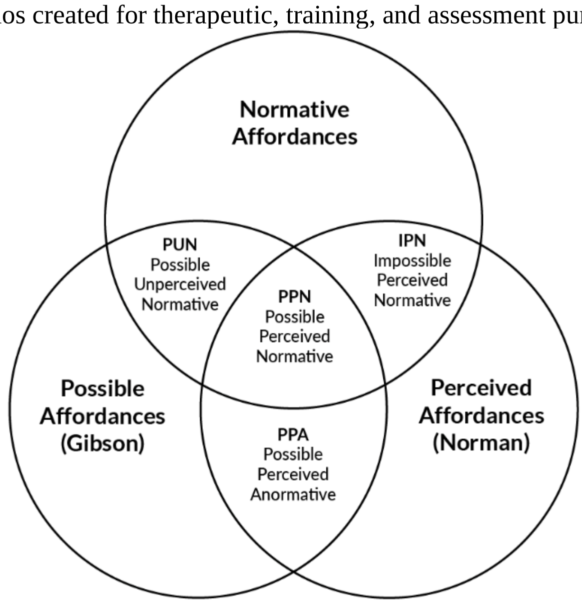

Figure 2. Normative affordances chart

Possible affordances, shown in the bottom left circle of the Venn diagram above, exist but are not perceived. In the bottom right circle, *perceived affordances* appear to offer interaction possibilities but in fact do not. In the top circle, *normative affordances* are those actions that are consistent with the socially-constrained behavioural expectations of a given setting. The intersections show combinations: PPN, PUN, IPN and PPA.

The bottom left circle of Figure 2 above, *possible affordances*, relates to Gibson's notion of affordances as existing whether an agent is aware of them or not. The bottom right circle, *perceived affordances*, relates to Norman's view of affordances as being cues to action, whether or not they are acted on and whether or not such interaction possibilities in fact exist. The upper circle, *normative affordances*, refers to a kind of sociocultural barrier that serves to constrain behaviour. For example, to a passenger with no aviation experience being given a tour of an aircraft cockpit, there are a range of possible affordances in terms of the aircraft's equipment that may not be apparent to a novice, but which are apparent to the pilot. The capacity for such interaction exists and may be recognised as the pilot demonstrates it, or if the passenger later trains as a pilot. However, without any introduction, the passenger may notice—or at least is capable of noticing—a variety of opportunities for interaction—buttons that may be pressed, levers that may be pulled, cabinets that may be opened. However, just because they can be interacted with does not mean that they will as, in most cases, sociocultural conditioning serves to moderate and constrain behaviour to a more limited set of possibilities; these can be considered normative affordances. One of the functions imagination serves is as a testing ground for the violation of these norms: "what would happen if I…?" The results of this thought experiment can be helpful in guiding present behaviour and can also—in imaginal and virtual worlds—have the therapeutic effect of allowing a person to stretch beyond usual socially normative behavioural restrictions. This need not necessarily be because they disagree with them, but sometimes in order to clarify their boundaries and strengthen them [10]. Many forms of media are based upon this principle.

4. Conclusion

In designing therapeutic, training, and assessment environments—as well as simulations more generally—a great deal of leverage can be gained by considering the distinction between perceived and normative affordances. Adding virtual assets when designing a simulation is typically much easier than facilitating detailed interaction with them. However, when storytelling is engaged, it is possible to cast the possibilities for interaction in such a way that interaction will not be expected. When engineered successfully, perceived affordances in a virtual environment can be more numerous than possible affordances, and through the use of narrative-led normative affordances, this never needs to be found out by the participant.

For example, in a rich virtual scene that contains a river: with sufficient presence there may feel like there is a possibility of getting wet (perceived affordance). However, in actuality, there is no river and only the visual appearance of one—and no suitable haptic system to simulate the feeling of interacting with water (possible affordance). If the participant tries to interact with the water, presence will be broken, and if the river is removed from the simulation, the benefits of its inclusion are lost. However, if there is a suitable drop to the river, or if a guiderail is put in place in the simulation, then normative affordances will contain the expectation of interaction with the river while still allowing for the sense that it is in fact possible, maintaining the fidelity contract of participant expectation [11]. This can be further enhanced when a mixed reality approach is taken, with the digital guiderail mapped onto a physical one in real life as a convincer which primes subsequent perception.

If their affordances match, then physical, virtual, and imaginal approaches are functionally equivalent. And, from a narrative design perspective, not all possible affordances need to match—just those that are actually engaged with.

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SECTION III

EVALUATION STUDIES

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

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

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

Wiederhold & Riva, 2004

Empathic interactions in online treatment: experiences of mental healthcare practitioners

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Abstract. Studies on practitioners' perceptions of eMental Health repeatedly report experienced difficulties in establishing empathic interactions when communicating with their clients online – a fact that plays an important role in the adoption, or lack thereof, of technology-mediated treatments. Especially now, in times when social distancing and lockdown measures are effectuated globally to combat the COVID-19 pandemic, the need for high-quality online formats of mental health care has become more urgent than ever. To increase our understanding of the process of achieving empathic interactions in technology-mediated communication, the current paper presents an online survey study using open questions on practitioners' experiences of establishing empathy in online therapeutic interactions (n = 363). Responses were analyzed using thematic analysis. From the derived themes, a conceptual model was built showing several properties of online communication that influence empathy and ways in which these properties affect the therapeutic interaction on emotional, conversational, and relational levels. Additionally, our findings highlight the behavioral strategies practitioners employ to find workarounds to manage these effects and attempt to (re)connect with their clients. Our findings thus provide experience-based insights into the process of building empathy in online treatments – insights that can be used to improve current and future eMental Health technologies, enabling practitioners to reach the desired level of empathic understanding during remote therapeutic interactions.

Keywords. eMental Health, Online Psychological Treatment, Empathic Interaction, Technology-Mediated Communication

1. Introduction

A good empathic interaction and therapeutic alliance are considered important factors to successful therapeutic outcomes [1]. Even though quantitative studies on eMental Health show comparable levels of therapeutic alliance and empathy for face-to-face and online psychological treatments, at least from the clients' perspective [2], reports of mental healthcare professionals repeatedly indicate that online communication compromises empathic interactions [3]. These concerns about relational aspects were found to be among the most prominent obstacles for professionals in their adoption of eMental Health [3, 4]. In order for online treatment to offer a better experience for practitioners and clients alike, it is important to specifically focus on technology-mediated barriers to empathy in online interactions. As a first step to achieve this, we need a deeper understanding of the empathic process in online therapeutic interactions and how this is experienced from the perspective of mental healthcare professionals.

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Empathy has been defined in a multitude of ways, reflecting the variety of fields in which this concept has been researched [1]. Despite the differences, there seems to be a general agreement that empathy refers to an interpersonal process of understanding what another person is experiencing or trying to express, where empathy consists of three components: cognitive (i.e., recognizing others' emotions), affective (i.e., emotional convergence), and behavioral (i.e., emotional responding) [5]. In the field of mental healthcare, Barret-Lennard's Empathy Cycle [6] describes empathy in therapeutic interactions as repeated cycles of therapists attuning to expressed emotions and experiences of clients, followed by empathic responses of therapists that are then received and responded to by clients. The success of these cycles heavily relies on the availability of (non-)verbal cues and one's ability to accurately use this information.

In their comprehensive framework, Grondin et al. [7] describe several ways in which technology-mediated communication affects empathy in online therapeutic interactions. Their main argument is that technology-mediated communication filters out important non-verbal cues which constrains the empathic cycle described above, in line with the so-called “cues filtered out” theories in the field of computer-mediated communication [8]. While the framework provides helpful starting points towards a deeper understanding of practitioners' difficulties with online psychotherapy, it primarily focuses on the negative consequences of technology-mediated communication, whereas technology also provides unique opportunities; options that are unavailable in face-to-face interactions [9]. Moreover, some scholars argue that online communication can actually be more personal and intimate, as people may feel more at ease to self-disclose in relatively anonymous settings (e.g., [10]).

Despite the potential benefits that online psychological treatment offers, such as increased accessibility, convenience, and autonomy of clients [3, 11], the perceived shortcomings in non-verbal communication and empathic attunement keep its potential from being fulfilled. In addition, the COVID-19 pandemic during Spring 2020 and its corresponding social distancing measures forced many professionals to transfer their face-to-face treatments to online means [4, 12], further stressing the need for developing high-quality remote care. Because, until recently, online treatments were not part of standard clinical practice, it was challenging to probe the experiences of a broad range of practitioners and thoroughly explore the source of the reported difficulties. However, the dramatic increase in online therapy delivery during the COVID-19 pandemic enabled us to probe a much broader and potentially more representative sample of healthcare professionals on what exactly practitioners are missing when attempting to establish an empathic interaction online, and on which part of the empathic process they find to be most constrained. With this work, we aim to contribute to improving the quality of remote mental health care by elucidating the most important factors in establishing empathy online and how these affect the therapeutic interaction.

2. Methods

A sample of 363 mental healthcare professionals (74% female, ages ranging from 18 to 70 years, M = 39.1, SD = 11.5) participated in an online survey. Most frequent professions were clinical or counselling psychologists (37%), psychiatric nurses (33%), and social workers (22%). Data was collected from June to September 2020, in the period after the first lockdown due to the COVID-19 pandemic. The entire survey consisted of 33 questions regarding attitudes, skills, knowledge, and use of eMental Health. It included two open-ended items on practitioners' experiences in establishing an empathic online interaction with their clients, which is the focus of the current paper: 1) Could you indicate to what extent you are (not) able to establish an empathic interaction?; 2) Which strategies or information do you use to communicate empathically through eHealth? These items were answered by 350 and 336 respondents respectively, with an average of 18 words per response. The textual responses were analyzed using thematic analysis through the following steps: familiarization with the data, generating initial codes, extracting, reviewing, and defining themes, and drawing up the results [13].

3. Results

Sixteen (sub)themes were derived from the responses to the open-ended questions. These could be divided into four main themes: technology-mediated communication properties, therapeutic context factors, effects on the therapeutic interaction, and behavioral strategies, along with twelve subthemes. Furthermore, the expressions of practitioners indicated how these themes could be related to each other: e.g., "Because the non-verbal information is lacking, you sometimes miss important parts of the communication. Therefore, it is harder to reach a deeper emotional level." Based on this, we integrated these (sub)themes and their interrelations into a conceptual model (see Figure 1).

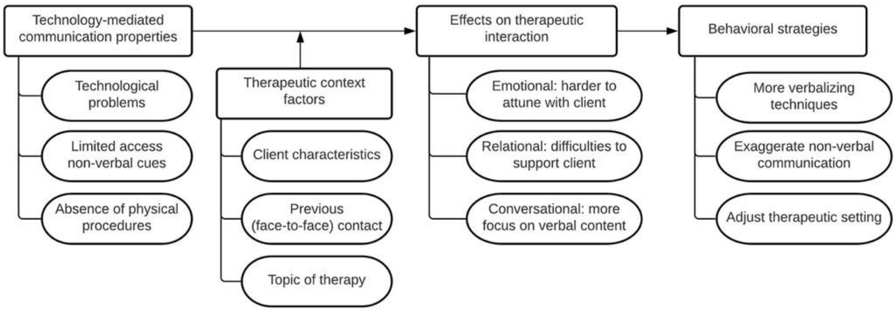

Figure 1 Conceptual model of the derived (sub)themes and relations of practitioners' experiences.

The most frequently reported properties of technology-mediated communication that influence online empathic interactions were technological problems, limited access to non-verbal cues (*"There is literally an increased distance to the client: body language and facial expressions are not, or much less, perceptible for both parties.")*, and absence of situated interaction rituals and social conventions (*"The beginning and closure of an appointment feel incomplete, not being able to give a handshake, walk to the consultation room together, or offer coffee.")*. The extent to which these properties affected the empathic interaction seemed to be influenced by the therapeutic context: client characteristics, previous (face-to-face) contact, and the topic of therapy (*"It goes well when you discuss more superficial topics, but when it concerns very emotional issues, discussing them via a screen does not work."*). The combination of these factors then affected the therapeutic interaction on three levels: 1) emotional: it is harder to stay emotionally attuned with the client (*"When you are communicating in real life, it is easier to feel what something does to someone. This is much more difficult through online contact");* 2) relational: difficulties to support clients and stay connected; 3) conversational: communication is more explicit and verbal (*"I have to verbalize much more of what I see and feel, instead of just 'being there")*. To manage these effects, professionals reported to apply various behavioral strategies to establish an empathic interaction: use more verbalizing techniques (*"Ask explicitly after emotions and experiences and check my observations more often.")*, exaggerate non-verbal cues (*"Use clearer facial expressions, hum louder than I would normally do in a face-to-face interaction"),* and adjust the therapeutic setting.

4. Discussion

The current study focused on practitioners' perceptions of establishing empathic interactions during online psychological treatments. By probing actual experiences with online treatment from a large representative sample, we obtained reports emerging directly from practice, thus addressing the how and why of these perceptions. According to practitioners, various properties of technology-mediated communication affect the therapeutic interaction on the emotional, relational, and conversational level, although the exact effects depend on the therapeutic context. Remote therapy is especially complicated in regard to severe mental health issues, emotionally disturbing topics, and the absence of previous face-to-face contact. Practitioners adopt various strategies to manage these effects, primarily by being more verbally explicit in their communication.

Our findings support the perceptions that practitioners expressed in earlier studies, before they had to use eMental Health regularly [3, 4]. That is, it seems that their general expectation that technology-mediated communication would impede the establishment of an empathic interaction is something they indeed experienced when providing remote psychotherapy. Therein, it has to be noted that there were large differences between the respondents: though most participants indicated struggling with online interactions, others experienced little or even no difference between face-to-face or online modalities, in line with earlier findings that the experienced drivers and barriers differ depending on their level of adoption of eMental Health [11]. Analyses of the quantitative survey data are out of scope for this paper and will be reported elsewhere, but these individual differences should be kept in mind while interpreting the results. In the current study, it has become more explicit which parts of the process are specifically considered troublesome. Our results suggest that particularly the affective and behavioral components of empathy are affected in technology-mediated communication, reflected by the difficulties to emotionally tune in with clients and provide comfort and support. To compensate for this, therapists seem to adopt a more rational communication style by explicitly formulating their observations and conveying their empathic responses through verbal statements instead of non-verbal expressions, such as softly humming or smiling comfortingly. These results are similar to findings of a study that compared different types of empathy in non-therapeutic digital settings [14].

The presented conceptual model is, to our knowledge, the first to provide links between characteristics of technology-mediated communication and the therapeutic context, experienced effects on the therapeutic interaction, and practitioners' behaviors. Based on our insights, we can derive directions for the development of solutions that can address practitioners' needs more precisely and facilitate them in achieving desired levels of empathy in online psychological treatments. One approach is to focus on the technologies either by developing tools that compensate for the experienced lack of non-verbal cues, such as eye-gaze correction technologies [15], or by examining how technologies could bring a unique added value, for example using physiological feedback to extend the gamut of social and affective cues (cf. [9, 16]). Solutions could also be sought in enhancing therapists' skills as research indicates that technology-mediated therapy requires other techniques than face-to-face treatment [17], while only a minority of practitioners has received some form of training in providing online therapy [4].

By focusing specifically on the empathic interaction and gauging experience-based accounts from a broad, representative sample, the current study provides a more detailed and multi-faceted view on practitioners' lived experience of online empathy and their workarounds to enable the delivery of effective care. Hopefully, the gathered insights and directions that come forth from this study can be utilized to improve technology-mediated therapeutic interactions and contribute to eMental Health becoming a full-fledged mode of practicing mental healthcare for both professionals and clients.

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Further Validation of Russian Video Game Addiction Scale (VGAS)

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Abstract. The current study re-examines the psychometric properties of the Russian Video Game Addiction Scale (VGAS). A new sample of video game players (N = 361; 89.2% male; aged 16-55) was added to the existing data pool (N = 515; 74.6% male; aged 16-56). Previously found 7-factor structure of VGAS was confirmed by principal component analysis with varimax rotation, with one highly cross-loaded item excluded. The alpha-values confirmed VGAS' good internal consistency. Three sub-groups based on game-genre preferences were identified in the sample: shooter players (N = 125), RPG players (N = 104), and video game players who preferred other genres (N = 132). Shooter and RPG video game players had higher gaming addiction compared to the "other genres" group. The Dark Triad traits were measured by the Dirty Dozen questionnaire. Machiavellianism positively correlated with gaming disorder in all groups except for RPG video game players. Psychopathy only correlated with gaming addiction in the "other genre" group. Those results matched the existing data, indirectly supporting VGAS' construct validity as a new gaming addiction measurement.

Keywords. Gaming Disorder, Video Game Addiction, Video Game Players, Dark Triad

1. Introduction

The upcoming 11th revision of the International Classification of Diseases (ICD-11) introduces Gaming disorder (6C51) as a specific diagnosis under the "disorders due to addictive behaviors" category. The World Health Organization (WHO) describes gaming disorder as a pattern of online or offline digital-gaming behavior, characterized by impaired control over gaming, video games' increased priority over other activities, and continuation or escalation of gaming despite negative consequences, accompanied by significant impairment in social, professional, or educational life [1]. While there are still ongoing scientific debates over the decision to include gaming disorder in ICD-11 (e.g. [2]), it becomes increasingly important to introduce adequate diagnostic tools to assess and measure the severity of this condition based on diagnostic criteria proposed by WHO. While there are several relatively well-known gaming addiction scales, almost none were ever properly adapted on a Russian sample. Additionally, most of those scales are based on criteria different from that proposed by WHO (e.g., IGD-20 is based on nine Internet Gaming Disorder criteria from DSM-5 [3]). At the same time, in some countries, Russia included, the use of ICD among clinical practitioners is more prevalent. Thus, we aimed to create a Russian Gaming Disorder questionnaire based on ICD-11 criteria that could be useful for Russian psychologists and clinicians as a research tool and screening instrument. The first version of Video Game Addiction Scale (VGAS) included 26 items developed through several stages. First, ten clinical psychology students belonging to a cyberpsychology-related scientific project were tasked to produce 20 or more statements each, describing a typical person with gaming addiction. From the total list of 217 non-repetitive items, 57 most representative ones were extracted under professional psychologists' supervision

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An expert group of four psychologists evaluated the list and shortened it to 28 items, most related to ICD-11 criteria. Two more items were excluded after principal component analysis due to their low factor loads. This 26-item questionnaire version showed good internal consistency and significant correlations withinternet addiction, gaming motivations, and various psychopathological symptoms, indicating its construct validity (on a sample of 515 participants) [4]. This particular study aimed to explore VGAS' psychometric qualities further, and to learn more about video game addiction concerning specific video game genres such as shooters and RPGs (found to be more addictive by some studies, e.g. [5]). Recent studies also suggest that the Dark Triad personality traits play a part in various addictive behaviors including internet and gaming addiction [6,7]. Thus, we included the Dark Triad traits in the further analysis of our questionnaire's construct validity.

2. Method

2.1. Sample

The new sample included 361 regular or occasional video game players (89.2% male) aged 16-55 (M = 20.79; SD = 4.4; Me = 2) reporting to prefer different video game genres: shooters (N = 125), RPGs (N = 104), or other games such as strategy, racing, etc. (N = 132). The questionnaire battery included VGAS (26-item version), and The Dark Triad Dirty Dozen [8], adapted into Russian by Kornilova et al. [9].

Additionally, for further factor structure and reliability evaluation, the data from our previous sample was also included. This sample consisted of 515 regular or occasional video game players (74.6% male) aged 16-56 (M = 24.97; SD = 6.46; Me = 24). For this study, we only used VGAS data.

All the data in both studies was gathered online. Participation in the research was anonymous and voluntary, with an informed consent form provided to all the participants.

2.2. Questionnaires

Video Game Addiction Scale (VGAS) is a new Russian gaming disorder assessment questionnaire, currently in the process of multi-stage validation and psychometric qualities evaluation. The previous stages of VGAS development were briefly described in the introduction section of this article and the previous study [4].

This version of VGAS consists of 26-items, with responses rated on a 5-point Likert scale from 1-strongly disagree to 5-strongly agree. The questionnaire has a 7-factor structure, which we aimed to check and correct in this study and provides 8 measurements.

The overall VGAS score represents the severity of video game addiction symptoms in general. At the same time, its individual factors allow us to evaluate symptoms according to ICD-11 criteria, including various aspects of impaired control over gaming (factors 2 and 3 – behavioral control over gaming and problems with time-management respectively), video games' increased priority over other activities (factor 4 assessed gaming priority directly while factors 1 and 5 represent emotional aspects such as gaming being the primary source of positive emotions and gamer's emotional involvement in video games), continuation of gaming despite negative consequences represented by conflicts with others (factor 6), and neglect of one's health and well-being (factor 7).

The Dark Triad Dirty Dozen (DTDD) [8] is a brief personality inventory used to assess the so-called "dark triad traits" (named so due to their social undesirability and connection with possible malevolent behaviors) – Machiavellianism, narcissism, and psychopathy – in adults without clinically diagnosed personality disorders.

The questionnaire consists of 12 items (as implied by its name), each subscale including 4 items. In the original DTDD, the responses are based on a 7-point Likert scale, while the Russian modification [9] uses a 5-point Likert scale instead but keeps the original structure otherwise.

The measurements obtained through this questionnaire are:

Machiavellianism as cold-hearted manipulativeness, exploitative with indifference to morality and other people's interests
Narcissism as the sense of grandiosity, self-importance, and superiority
Psychopathy as the lack of empathy, accompanied by high levels of impulsivity and recklessness

All data was analyzed by using IBM SPSS Statistics for Windows (Version 22.0).

3. Results

3.1. VGAS Factor Structure and Reliability After the Second Study

In the previous study, principal component analysis (PCA) with varimax rotation suggested a seven factor structure for VGAS. The total percentage of the explained variance for this solution was 52.53%. To further evaluate VGAS reliability and factor structure, we merged new sample data (N = 361) with the previously existing data pool (N = 515), resulting in a total sample of 876. PCA with varimax rotation was again used to identify groups of intercorrelated variables. The same seven factors with the same items were obtained, yet one item previously related to factor 2 was excluded due to high cross loads with factor 4.

The percentage of the explained variance for this solution was 56.29%. Thus, we updated VGAS to consist of 25-items in seven factors. The names of the factors were chosen based on their items:

- Factor 1: Positive emotions due to gaming (e.g., translated from Russian: "My gaming life is more emotional than my life in reality")
- Factor 2: Impaired gaming control (e.g., "I will continue playing video games even if I have important unfinished tasks")
- Factor 3: Problems with time-management while gaming (e.g., "I usually play longer than planned")
- Factor 4: Gaming priority (e.g., "There are few things other than gaming that interest me")
- Factor 5: Emotional engagement in gaming (e.g., "I tend to rage/panic when I cannot control the in-game situation")
- Factor 6: Conflicts with others due to gaming (e.g., "I often argue with my family because of my gaming habits")
- Factor 7: Gaming regardless of own well-being (e.g., "I continue playing even if I feel unwell")

Table 1 includes Cronbach`s α-values (internal consistency) of the whole scale and different factors in the previous study, the current merged sample, and the number of items in previous and current versions of the questionnaire.

Table 1. Reliability test (Cronbach's α) for VGAS and its seven factors (F.1-7): previous and current samples.

	VGAS	**F.1**	**F.2**	**F.3**	**F.4**	**F.5**	**F.6**	**F.7**
Previous sample, N=515	0.856	0.782	0.674	0.584	0.649	0.552	0.635	0.435
Total sample, N=879	0.866	0.808	0.668	0.568	0.631	0.616	0.667	0.456
Items before/**now**	26/**25**	7/**7**	4/**3**	3/**3**	3/**3**	3/**3**	3/**3**	3/**3**

As seen in Table 1, both versions of VGAS have good internal consistency for the whole scale. Alpha-values of the factors were decent considering a few items in most of them, with only small changes between the previous and the current studies.

3.2. Gaming Disorder in Relation to Video Game Genres and the Dark Triad

Welch`s ANOVA with Tamhane's T2 test showed both shooter and RPG game players to have significantly ($p < 0.05$) higher VGAS scores compared to the "other genres" video game players group. Previous studies showed that MMORPG and shooter game players were more likely to exhibit gaming disorder symptoms (based on DSM-5 criteria for Internet Gaming Disorder) [5]. A similar result in our sample, but with ICD-11-based VGAS, suggests that gaming disorder might be game-genre specific and supports the external validity of our questionnaire. Next, Pearson`s correlations between VGAS score and The Dark Triad were calculated; results are presented in Table 2.

Table 2. VGAS (general score) correlations with the Dark Triad scales (Pearson's r), significant only.

	Whole sample (N=361)	Shooters (N=125)	Other genres (N=132)
Machiavellianism	0.216 (p = 0.000)	0.233 (p = 0.009)	0.213 (p = 0.014)
Psychopathy	-	-	0.184 (p = 0.035)

Machiavellianism was the only Dark Triad trait that showed a significant positive correlation with VGAS score on the whole sample. While some authors argue Machiavellianism is the only Dark Triad trait not linked to substance-related and non-substance-related addictions in general [6], it seems to be important in gaming and internet addiction studies [7, 10]. Kircaburun and Griffiths [7] found that higher Machiavellianism was associated with higher online gaming and gambling, among other online activities.

The authors assumed people with a high Machiavellianism trait might use video games to fulfill their need for competition and linger towards online communication to avoid offline social rejection, leading to excessive gaming. Another study [10] also showed direct effects of Machiavellianism and psychopathy on gaming disorder symptoms' severity, while escapism tendencies mediated narcissism's influence in video game players. Our current results partially match those findings and suggest some genre-related specifics of the Dark Triad traits in relation to video game addiction, as RPG video game players did not share the same correlations for shooter and "other genres" video game players.

4. Conclusion

Results from the extended sample supported our previous conclusions about our new ICD-11-based gaming disorder questionnaire VGAS and its 7-factor structure internal consistency and validity. As a new questionnaire, VGAS will still require further research and validation as a diagnostic instrument, specifically in comparison with other existing gaming disorder questionnaires based on different models such as IGD-20 [3]. The links between gaming addiction and the Dark Triad also matched the pre-existing research findings. Thus, we can conclude that VGAS performs similarly to other video gaming addiction questionnaires, further supporting its validity.

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A Motion Controlled Virtual Reality Paradigm for Ostracism Research

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Abstract. Despite being a popular field of study, ostracism research paradigms have been criticised for their abstract nature and lack of mundane reality. The current paper sets out to address the problem of ecological validity through the introduction of a newly developed paradigm that makes use of virtual immersive environments, motion controls, and haptic feedback. Based on the Cyberball-Game (1), this VR tool places participants in a playground where they are asked to play a game of catch with two agents. When passed to them, the player can pick up the ball and throw it to whoever they choose using motion controls. After a period, the other players will only pass between themselves, inducing the feeling of being ostracised in the participant. A pilot study (n = 24) was run to assess the effectiveness of the tool in inducing feelings of ostracism using the *Basic Needs Scale* (2). The sample size was too small to report inferential statistics, but descriptive statistics demonstrate that the tool was successful in inducing an experience of being ostracised when the control (M = 72.46, SD = 10.64) and ostracism (M = 43.73, SD = 11.1) conditions are compared. All participants were successfully able to use the device with no errors. This tool presents significant advantages in comparison to conventional methodology, with greater ecological validity resulting from improved presence and embodiment. Greater experimental control and measurement is also offered when compared to in vivo methods (3).

Keywords. Virtual Reality, Ostracism, Cyberball-Paradigm, Social Stress, Narrative

1. Introduction

Ostracism is the act of leaving out and ignoring an individual or a group in a social context. Being ostracised has been found to have significant and often long lasting adverse psychological and/or physical consequences. The Cyberball-Game (1) is one of the most widely used experimental methods for studying ostracism. Current ostracism research paradigms have been criticised for lacking ecological validity due to their abstract nature and lack of mundane reality (3). The tension between ecological validity and the desire for experimental control is a long-established concern of psychology research (3). Virtual reality offers potential to address this divide, allowing for excellent customisation and detailed data recording while more closely resembling real life scenarios.

The Cyberball paradigm has previously been adapted into immersive virtual environments (IMVE) that make use of head mounted displays (HMD) (4). These tools allow for greater control of proximity and characteristics of avatars but while this program addressed some identified issues, it was still controlled using a keyboard. Motion tracking has been identified to significantly contribute to overall immersion (5). Recent research has also linked embodied and social cognition, with findings suggesting that sensorimotor experiences can shape perceptions of social situations (6).

To account for the limitations of the previous tool, we developed an immersive virtual reality tool based upon the Cyberball-Game (1) paradigm that makes use of motion controls and haptic feedback.

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This tool was developed with the intent of investigating the role of narrative in ostracism outcomes.

2. Method/Tool

2.1. Design

The pilot study used an independent groups design with an ostracism and control condition. Self-reported measures of basic needs fulfilment and distress were used as dependent variables. Basic needs fulfilment was measured using the Basic Needs Scale (2). Distress was measured using the Subjective Unit of Discomfort Scale (7).

2.2. Participants

Twenty-four participants, 20 of which were from a university campus, volunteered for this study (17 female, 7 male, mean age = 27.167, SD = 9.187). Participants were randomly assigned evenly across the two conditions.

2.3. Measures

Basic Human Needs: Participants completed the *Basic Needs Scale* (1). The 12-item scale assesses the fulfilment level of four basic human needs. Each need has three items assessed using a 9-point Likert scale (1-9) of level of agreement. The subscales include (1) *self-esteem*, (2) *belonging*, (3) *control*, and (4) *meaningful existence*. This measure covers the essential human needs that are impacted by the experience of ostracism as identified in previous research (8).

Distress: The level of distress experienced by participants during use of the VR tool was also assessed to determine its level of negative impact. The *Subjective Unit of Discomfort Scale* (7) was used following the completion of the game. The scale has been found to be a valid measure of both physical discomfort (7). Participants were asked to rate their level of distress on a scale that ranged from 0 to 100, with 100 representing the highest level of distress. In the present study, a visual scale with definitions for the number values was used.

2.4 VR Cyberball

This tool was developed in Unity by the first author based on the Cyberball paradigm (1). We designed the immersive environment ostracism experience to be ambiguous by including no dialogue and neutral expressions, along with using simple cartoon models for the players and environment (see Figure 1). This was chosen both to moderate negative impact as well as allow for versatility in study topic/context.

The program situates the player in a bright playground with simple, low polygon count (level of 3D model detail) objects (see Figure 2). Participants are seated during the game with background park ambience noises playing through the headphones. When the participant has the ball thrown to them, it stops a short distance in front of them. From here they can grab the ball and throw it to whichever avatar they choose using the HTC Vive's motion controllers. Participants can throw from a seated or standing position. The gender and number of avatars you can throw to can also be manipulated.

Figure 1. This image displays the VR tool in motion from the perspective of the participant.

Figure 2. This image displays the park environment the participant is placed in.

2.5 Procedure

Testing was conducted on a one-on-one basis in a room on a university campus. All measures were filled out and recorded on an online Qualtrics form along with a basic demographic survey of age, gender, and level of experience with VR. Participants were not informed of the full nature of the experiment, instead only being told that the study concerned embodied cognition. Once they had filled out basic demographic information, they put on the Head-Mounted-Display (HTC Vive, HMD) and were given the chance to adjust to VR and practice throwing balls at a target in a neutral environment with no scenery. Participants were seated during all VR sections of the study.

This practice continued until they had successfully thrown the ball several times and confirmed they were comfortable with the VR setup. This took roughly 5 minutes. Following this, participants completed the VR playground experience. In all cases, for the first minute of the game, the ball was evenly (33%) passed to through manipulated randomisation. In the exclusion condition, following the first minute the other players no longer passed to the participant for the remainder of the game.

At this point, the participant had no ability to interact with the other players, move to another location, or get the ball back. In the control condition, the player was evenly passed to for the full duration of the game. The program closed once 4 minutes had passed from the first throw. The time of 4 minutes was chosen based on previous research along with the results from Hartgerink et al.'s (2015) review suggesting that the length of the game had no clear impact on the mean ostracism effect.

Immediately following the game closing, the participant removed the HMD and completed a series of measures presented in a randomised order. The study in total lasted roughly 30 minutes for each participant.

3. Results

While the sample size of the pilot study was too small to report inferential statistics, descriptive statistics and personal accounts of the experience from the participants demonstrated that the tool was successful in inducing an experience of being ostracised. Participants in the control (M = 72.46, SD = 10.64) and ostracism (M = 43.73, SD = 11.1) conditions reported large differences in scores on the basic needs scale.

All participants were successfully able to use the device and tool with no display or audio errors. The controls for picking up and throwing the ball were intuitive enough that most participants (>80%) only needed a couple minutes of practice to become comfortable with consistently throwing the ball. This was true even for participants with little or no experience in VR, though experienced participants picked it up more quickly. One participant reported audio issues, but this was determined to be a result of the PC's audio settings rather than the tool itself.

4. Discussion

The current paper aimed to build upon and improve traditional ostracism study paradigms, particularly regarding ecological validity and abstraction. The findings of the pilot suggest that VR Cyberball was successful in inducing feelings of ostracism.

This tool presents significant advantages in comparison to conventional methodology, with greater ecological validity resulting from improved presence and embodiment. Greater experimental control and measurement is also offered when compared to in vivo methods [3]. When compared to previously developed VR tools, our tool offers potential for greater immersion and embodiment in the scene thanks to the act of throwing being physically mirrored with motion controls.

These improvements in turn can allow for ostracism research that better reflects real life experiences. With ostracism outcomes recently being found to be largely heterogenous in both the short and long term (9), there remains considerable ground to be covered in understanding the factors that moderate the impact of social exclusion. The use of this tool that allows for greater physical embodiment and immersion may lead to better understanding of the source of individual differences in ostracism outcomes.

One relatively unexplored avenue of interest is the role of narrative. This was highlighted by Richmand and Leary (10) whose model suggests that long term ostracism outcomes are moderated by an individuals' understanding of the event. Linked in with this, existential meaning, one of the identified basic human needs (1), is closely tied with personal narrative (11). This tool was developed to better study this topic.

To further validate this tool, as well as determine any differences in experience compared to traditional paradigms, this method should be utilized in future ostracism research.

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A qualitative and quantitative virtual reality usability study for the early assessment of ASD children.

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Abstract. The diagnosis of autism spectrum disorder (ASD) is usually done using structured and semi-structured interviews directed to children and caregivers. These procedures are administered by certified clinicians who have expertise in the assessment of ASD. However, on one side, semi-structured procedures addressed to children are usually administered in settings requiring ecological validity such as the laboratory; on the other side, structured interviews to caregivers rely on self-report that might be affected by psychological response biases. There is the need to fulfil aforementioned needs, improving ASD assessment procedures through the use of both ecological settings and objective measures. The present study aims to investigate the usability of a novel procedure to assess ASD based on virtual reality (VR) and quantitative measures. 20 children with ASD and 20 children with typical development (TD) performed four basic tasks in the VR system Cave Assisted Virtual Environment (CAVE™) while an examiner analysed the usability of the application as well as children's user experience. Quantitative behavioural variables related to children's performance across tasks were measured. Included tasks required children to interact in the virtual environment with childlike objects. Findings demonstrated that VR application was promising for the assessment of ASD due to good usability in three tasks out of four and positive user experience. Moreover, quantitative behavioural outcomes revealed differences between groups on time spent playing and accuracy across tasks. Quantitative and qualitative usability studies improve the effectiveness of new objective and technology-based ASD assessment procedures, in particular when children represent the population target.

Keywords. Autism Spectrum Disorder, Virtual Reality, Usability, Assessment

1. Introduction

Autism spectrum disorder (ASD) is a neurodevelopmental disorder affecting social skills and interaction, characterized by the presence of restrictive and repetitive patterns of behaviors and interests [1]. Currently, the ASD assessment occurs in clinical settings using the Autism Diagnostic Observation Schedule (ADOS) [2] and the Autism Diagnostic Interview-Revised (ADI-R) [3]. The former utilizes semi-structured observational tasks aimed to qualitatively evaluate children's behaviors in different situations; the latter is a semi-structured interview for caregivers concerning children's behaviors in daily life. Despite these procedures being considered the gold standard in ASD assessment [4], they present some limitations that might affect the objectivity of the assessment process [5-7].

In particular, ADOS usually takes place in non-ecological settings that are far from representing real-life environments, while ADI-R is based on caregivers' reports about children's habits and behaviors that may be biased by subjectivity and further psychological tendencies such as social desirability. To fulfil

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aforementioned needs in the current ASD assessment, new objective technology-based procedures are being developed and tested. In particular, virtual reality (VR) has the potential to overcome the need for ecological validity in ASD assessment [8]. VR can reproduce every-day life situations in controlled settings, providing users the sense of presence as if it was the real world. Moreover, objective measures related to users' behaviors that are recorded by the VR system can improve assessment procedures, supplying quantitative behavioral biomarkers of ASD. In the present study, the usability as well as the user experience in a novel VR procedure to assess ASD early on were tested. In addition, behavioral differences between ASD and typical developmental (TD) children were assessed to initially test the procedure's ability to disentangle ASD. The Cave Assisted Virtual Environment (CAVE™) was chosen as the VR system due to the non-intrusiveness and suitability for ASD children [5-6]. The chosen virtual environment (VE) represented the VE skeleton of a multimodal VR procedure that will be tested in the near future in attempts to foster the early and objective assessment of ASD.

2. Method

2.1. Participants

Forty children with an age range between 3 and 7 years old were enrolled in the study. ASD children were recruited from the Development Neurocognitive Centre Red Cenit in Valencia, Spain, whereas TD children were found through study promotion on social media. Twenty ASD children (age in months = 53.44 ± 13.22; males = 16, females = 4) and 20 TD children (age in months = 59.40 ± 11.95; males = 10, females = 10) took part in the study. ASD children were diagnosed by ADOS-2, and caregivers provided children's assessment reports to participate in the study. ADOS-2 mean scores of ASD children were 12.75 ± 3.68 in social affect, 2.50 ± 1.32 in restricted and repetitive behaviors, and 15.12 ± 4.05 in total score. TD children's caregivers answered a short ad hoc developed questionnaire to ensure the absence of cognitive impairments related to neurodevelopmental disorders. Before the study, the caregivers were informed about the procedure and they gave written consent for the participation of children. Study was approved by the Ethical Committee of the Polytechnic University of Valencia.

2.2. Procedure

ASD and TD children were asked to perform four basic tasks in the VR system CAVE™. These tasks required them to perform basic movements, which allowed the interaction in the VE, as well as in the multimodal VR procedure that will be tested in the near future. The present VE was developed in the Institute for Research and Innovation in Bioengineering (i3B) at the Polytechnic University of Valencia. The VE was projected on one surface of the three-surface CAVETM with dimensions of 4 m x 4 m x 3 m. The CAVETM was characterized by three ultra-short lens projectors in the ceiling, which can project 100° images at 55 cm of distance. Interaction in the VE was provided by the Azure Kinect DK (Microsoft Corporation, 2019), with depth camera in resolution mode 640 x 576 at 30 frames per second. The camera depth of field allowed the user's body tracking over the entire room. The camera was set on a 40 cm high tripod in front of the central surface of the CAVE™ where the VE was projected. The camera did not interfere with the user's vision of the VE. Users interacted in the VE through a non-filled virtual human shape which moved accordingly, mirroring movements of head, trunk, and limbs. To facilitate the personal identification with the avatar and the immersion in the VE, at the beginning of the experience users choose between male and female human shape.

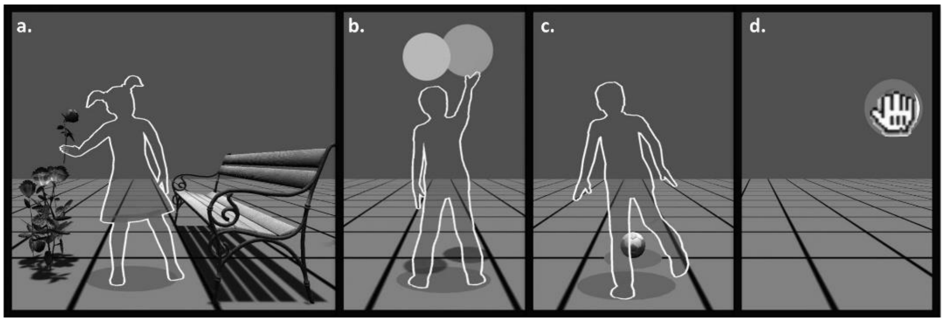

Figure 1: Screen captions of the four tasks. a. FT; b. BT; c. KT; d. HT.

Participants had to perform four basic tasks requiring basic body movements with the purpose of interacting and taking virtual actions. At the beginning of each task, the experimenter instructed children on the goal of the task using basic and standardized sentences. When participants did not understand task requirements, more in-depth instructions were provided. Each task was repeated twice, and task order was randomized. The four tasks were developed to be engaging for children, involving childlike and colorful objects. In the flower task (FT; see Figure 1a) participants had to pick up a flower and move it rightward so as to leave it on a bench, repeating the action five times. In the bubble task (BT; see Figure 1b) children had to move limbs in order to touch thirty colored bubbles falling down in pairs. Users touched them so as to make them explode. The first ten bubbles fell down slowly (i.e., slow bubbles), the second ten fell down more quickly (i.e., moderate bubbles), and the last ten bubbles fell down rapidly (i.e., rapid bubbles). The kick task (KT; see Figure 1c) required moving the lower limbs in order to kick a ball presented on the virtual floor five times. The ball appeared red and then turned green to avoid unintentional kicks. Finally, the hand task (HT; see Figure 1d) required users to guide a virtual hand in the VE by moving their hand to select three buttons representing toys.

Usability and user experience of the application were qualitatively assessed by an expert evaluator who observed children's behavior across tasks, assigning usability scores. Children also had to say which tasks they liked most. Finally, the behavioral performance between groups (i.e., mean time and accuracy) was quantitatively tested.

3. Results

3.1. Qualitative results

The qualitative analysis of children's interaction in the VE reported effective usability and good user experience in the majority of tasks, especially in trial 2, where both groups already learned how to interact. KT and BT were the most enjoyed tasks, due to intuitive interaction, good usability, and entertainment. FT was perceived as more challenging by the ASD group since it required more cognitive effort than BT and KT, and it did not present the same level of entertainment. Finally, HT was the most challenging task for both groups and it was the least liked due to complex usability related to technical features. The hard usability in HT yielded bad user experience. TD children nonetheless were more patient than ASD children in performing the task, and they manifested less frustration over performance.

3.2. *Quantitative results*

Data analysis was performed using SPSS Statistics 22 (IBM, 2018). Outliers in age were checked with the 3 interquartile range method and no subject was excluded from the analysis. Normality assumption was assessed by Shapiro-Wilk's test ($p > .05$), and homogeneity assumption was tested by Levene's test ($p > .05$). One-way ANOVA was used to assess differences between groups on mean time and accuracy in both task trials. Whether assumptions were violated, the Kruskal-Wallis rank-based non-parametric test was conducted.

Group participants were the same age ($F(1, 38) = 2.268$; $p = .140$). In trial 1 of KT, participants spent the same amount of time kicking each ball ($p > .05$), whereas in trial 2, ASD children were slower than TD children ($\chi2(1) = 4.093$, $p = .043$; $\eta^2 = .084$). Regarding accuracy, participants kicked the same number of balls in both trials ($p > .05$). In BT, ASD children were slower than TD children exploding slow bubbles in trial 1 ($\chi2(1) = 9.677$, $p = .002$; $\eta^2 = .228$), moderate bubbles in both trials (trial 1: $F(1, 38) = 25.013$; $p = .0001$; $\eta^2 = .397$; trial 2: $\chi2(1) = 17.129$, $p = .0001$; $\eta^2 = .424$), and rapid bubbles in trial 2 ($F(1, 38) = 8.531$; $p = .006$; $\eta^2 = .183$). In the rest of trials, the two groups acted in the same manner ($p > .05$). Regarding accuracy in BT, ASD children exploded less bubbles than TD children in both trials of all bubble types: slow (trial 1: $F(1, 38) = 17.792$; $p = .0001$; $\eta^2 = .319$; trial 2: $F(1, 38) = 7.080$; $p = .011$; $\eta^2 = .157$), moderate (trial 1: $F(1, 38) = 14.462$; $p = .001$; $\eta^2 = .276$; trial 2: $F(1, 38) = 15.204$; $p = .0001$; $\eta^2 = .286$), and rapid (trial 1: $F(1, 38) = 44.100$; $p = .008$; $\eta^2 = .170$; trial 2: $F(1, 38) = 12.850$; $p = .001$; $\eta^2 = .253$). In both trials of FT, ASD children were slower than TD children in picking up each flower and living it on the bench (trial 1: ($\chi2(1) = 18.723$, $p = .0001$; $\eta^2 = .479$; trial 2: $\chi2(1) = 15.119$, $p = .0001$; $\eta^2 = .392$). Regarding accuracy, there was no difference between groups in trial 1 ($p > .05$), whereas in trial 2, ASD children were less accurate since they picked up less flowers than TD children ($\chi2(1) = 6.829$, $p = .009$; $\eta^2 = .153$). Finally, in HT, ASD and TD children spent the same amount of time selecting each virtual button ($p > .05$). In trial 1 however, ASD children selected fewer buttons than TD children ($F(1, 38) = 8.138$; $p = .007$; $\eta^2 = .176$), while in trial 2 they selected the same number of buttons ($p > .05$).

4. Discussion

The aim of the present study was to qualitatively assess usability and user experience of a virtual application for CAVETM, representing the skeleton of a multimodal VR procedure for the assessment of ASD. In addition, quantitative behavioral differences in performance between ASD and TD children were measured.

The qualitative analysis provided evidence in both groups of good usability and enjoyable user experience in three tasks out of four, and in particular in KT and BT. In KT, TD children immediately got the task, sometimes without needing instructions. On the contrary, even though some ASD children got the task immediately, other ASD children needed either to see an example of how to interact or more than one attempt to kick the ball. Both groups expressed happiness and enjoyment after each kick: the majority of the TD group by smiling, raising their hands, or running, whereas the majority of the ASD group did so by smiling, throwing themselves on the floor, or doing stereotypies with arms and hands. Regarding quantitative analysis in KT, both groups kicked the same number of balls and in trial 2, TD children were faster in kicking than ASD children. This was likely due to the transfer effect between trials in the TD group but not in the ASD group, who likely needed more time to get used to this type of virtual interaction. Considering BT, both groups enjoyed the task, which was reported by the majority of participants as the best one. While TD children showed entertainment staying focused on the task and trying to do it in the best way, some ASD children expressed fun and enjoyment either doing stereotypies or staying calm, fascinated by the falling bubbles. In addition, few ASD children tried to explode bubbles directly on the CAVE^{TM} surface, which might be a consequence of the high-level cognitive load required to take actions in the VE due to the intangibility of the interaction. Aforementioned qualitative observations might explain why the ASD group exploded less bubbles than the TD group in both trials, regardless of bubble type. Regarding time needed to explode each bubble, with slow bubbles in trial 1, TD children were faster than ASD children, whereas in trial 2, ASD children performed the same as TD children, demonstrating also in the ASD group transfer effects between trials. Slow bubbles indeed represent a type of game that ASD children could cope with, even though they were less accurate than TD children. Regarding the other bubble types, TD children were faster in moderate bubbles of both trials, and in rapid bubbles of trial 2. Although these bubble types were more challenging for ASD than TD children, as reflected by their worse accuracy, rapid bubbles in trial 1 were difficult for both groups since they spent the same amount of time to explode them. However, transfer effect between trials facilitated the TD group but not the ASD group.

This might be likely due to the presence of high-level cognitive load in the ASD group due to the higher bubble speed and the interaction intangibility. In FT, the ASD group strived further to understand the task than the TD group. Some ASD children either needed to see an example of how to play or touched the flower on the CAVE™ surface instead of interacting with the virtual human shape. In a few cases, the high-level cognitive effort in ASD caused by mirroring themselves in the virtual human shape was also evident when they tried to leave the flower on the bench and not with the hand used to pick it up. Such observations might explain why TD children were faster than ASD children in both trials of FT. In trial 1, ASD children were as accurate as TD children, but in trial 2 they picked less flowers, likely due to the tiredness caused by the cognitive effort required to interact with the VE. Finally, HT was difficult for both groups and particularly for ASD children who selected fewer virtual buttons in trial 1 than TD group. Compared to the other tasks, the interaction in HT was in a two-dimensional space rather than in three dimensions, and the speed of the virtual hand was difficult to control. Due to poor task usability, the majority of participants got frustrated regardless of group. However, in trial 1, TD children employed strategies to cope with frustration, which led them to select more buttons than ASD in the same amount of time. For instance, they tried to control the virtual hand's speed by holding with the other hand the one they were using for the interaction, or they hid the hand behind their back to take it out and start again. Conversely, some ASD children got frustrated by the disappearance of the virtual human shape, or they expressed frustration with the task by moving the hand quickly and in a casual manner. In trial 2, there was no difference between groups in the number of selected virtual buttons, likely due to more distractibility and tiredness of TD children who coped with frustration in trial 1, but in trial 2 performed equal to ASD children.

5. Conclusion

Along with the traditional assessment of ASD, ecological procedures based on technology and quantitative measures similar to the present one could enhance objectivity in early diagnosis. This usability study can be considered the implementation outset of a multimodal VR procedure for the assessment of ASD that is being developed by the authors. Results confirmed that both groups adequately interacted in the VE, performing basic movements required for taking actions. HT is the only task in which usability and user interaction are going to be discussed and changed, while performance weaknesses of ASD children across the other tasks will be considered to quantitatively disentangle ASD, hence making an objective assessment.

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A Voice Recognition Application for the Semantic and Prosodic Analysis of ASD Caregivers

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Abstract. The voice manifests and conveys numerous components of meaning in addition to words, such as prosody and semantics. Previous studies have found that parents of children with Autism Spectrum Disorder (ASD) seem to have a delayed response time compared to parents of children with typical development (TD). Words and number repetitions, duration of pronunciation, and meaning used by parents vary by child diagnosis as well. The aim of this project is to demonstrate that the parent's voice can be a powerful behavioral biomarker in the diagnosis of ASD. Parental quality of life may also be a strong predictor of the quality of life of children with ASD. Given this goal, we propose the creation of a voice analysis application that through Machine Learning (ML) algorithms, is able to detect elements of prosody and semantics for investigation purposes. The application is based on the Autism Diagnostic Interview-Revised (ADI-R) and contains some personality questionnaires. This article focuses on potential voice metrics to extract for in-depth voice analysis. Findings outlined semantic and prosodic metrics that will be implemented in voice recognition analysis of ASD parents. Future studies are expected to recognize that parents of ASD children have distinct differences in prosodic and semantic levels compared with parents of control children. The uniqueness of this study lies in the creation of a tool focused on the voice, through combined ML and psychological techniques. This application has the potential to empower the ADI-R methodology by meeting the terms of validity and objectivity.

Keywords. Voice Recognition, Autism Spectrum Disorder, Biomarkers, Autism Diagnostic Interview-Revised, Machine Learning

1. Introduction

Humans communicate semantic meanings through the medium of voice. In the act of pronouncing a word along with the linguistic elements, they are intrinsically associated with the prosodic aspects of intonation, tone, rhythm, and intensity of speech. Semantics lies in the study of words' meanings. Significance is configured as an interpretive procedure to explain and give meaning to the events that represent the content of the experiences object of the communication. Prosody on the other hand, performs a key function in the organization and interpretation of speech as it conveys emotional, socio-linguistic, and dialectal information. It thus appears to be a property of the vocal signal that modulates and enhances its meaning.

Voice is shown to be an effective behavioral biomarker in the diagnosis of ASD [1]. The great interest towards the identification of biomarkers for ASD has led to the extensive study of linguistic elements related to the disease [2, 3].

Prosodic and semantic elements have also been investigated from the perspective of caregivers of ASD children. In the same way that children with ASD assimilate parental communicative input for their vocabulary development [4], parents adapt their speech to

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reflect their children's developmental level [5]. For instance, studies suggest that compared with caregivers of TD children, parents of ASD children tend to use less causal talk and fewer desire or cognitive terms [5, 6]. Furthermore, parents of children with ASD use a greater amount of concrete nouns and active verbs and rarely use abstract nouns, stative verbs, adjectives, and adverbs compared to caregivers of TD children [7].

Few studies investigated the relationship of verbal (semantic) and paraverbal (prosodic) communication of parents of ASD children, with their personality and with the development of the pathology in children [8]. Due to these studies, we currently know that some characteristics of parents may predispose to the development of ASD in children. These include personality (i.e., obsessive-compulsive traits, neuroticism characteristics), poor quality of interpersonal relationships, social support (characterized by lower emotional regulation), and cases of psychopathology (i.e., depressive and anxiety symptoms) [9, 10]. Parental quality of life may also be a strong predictor of the quality of life of ASD children. It is known that caregiving for ASD children affects parents' life financially, in combining daily activities or with the presence of depressive symptoms [10].

Biomarker research aims to improve accuracy of disorder diagnoses. So far, the diagnosis of ASD is performed through two complementary tools: Autism Diagnostic Observation Schedule-Second Edition (ADOS-2) which is designed for children older than 2 years, and ADI-R which is addressed to caregivers. This methodology is used to estimate the severity of the disease and for planning an educational project. ADI-R has some limitations. First, being this a qualitative measure, the responses given are evaluated according to the experience and training of the therapist. The professional's interpretation of the data could lead to distortion of the results, thus not making this survey methodology objective and standardized [11]. Furthermore, since ADI-R is an interview, responses could be systematically biased according to the principle of social desirability, therefore influencing the responses given by the caregiver. Finally, this diagnostic takes a long time to administer (from 1 and a half to about 2 hours).

The ultimate purpose of this project is to investigate the effectiveness of treatments on ASD children through the analysis of parental voice. Given this goal and to overcome the limitations of ADI-R, we propose to develop an application that recognizes vocal feature differences between caregivers through ML algorithms, standardizing the tool accordingly. In support of our proposal, studies suggest that analysis of speech production in ASD using ML has the potential to measure biometric data, acoustic patterns, and supplement traditional clinical assessment [2, 12]. The possibility that vocal features could be used as a marker of ASD has also been supported by previous researchers [2]. This article is meant to identify the voice and text metrics that can be extracted through ML techniques to outline a broad overview of voice analysis. Parameters of investigation have been defined considering a later implementation in a wide study. In the following sections, the metrics of semantics and prosody presented have been identified and extracted from a sample of two subjects.

2. Methods

2.1. The Voice Recognition Application

The application includes two randomized phases, the first containing a compilation of 11 psychological questionnaires and a sociodemographic questionnaire that work to obtain a multidimensional profile along with the parent's quality of life. The second part has been formulated according to the 8 dimensions of the ADI-R, thereby synthesizing the original 93 questions into 12 open-ended questions encompassing and satisfying all investigated dimensions. These 12 significant questions can be identified in 3 dimensions of analysis: communication and social interaction (6 questions), language (3 questions), and stereotypies and narrow interests (3 questions). Caregivers are guided by the application's instructions in carrying out both phases, hence completing the task independently.

The GENCAT scale is one of the measures included in the questionnaires that aim to investigate the caregivers' quality-of-life [13]. The remaining ten personality questionnaires are the validated and adapted Spanish versions of the original questionnaires: State-Trait Anxiety Inventory (STAI) [14], Short Big Five Inventory (BFI-S) [15], Emotional Expressivity Scale (EES) [16], Ambivalence Over Emotional Expression Questionnaire (AEQ) [17], Difficulties in Emotion Regulation Scale (DERS) [18], Duke-Unk Functional Social Support Scale (Duke-UNC-11) [19], Behavioral Inhibition/Activation Scales (BIS/BAS) [20], General Self-efficacy Scale (GSE) [21], Perceived Stress Scale (PSS) [22], Symptoms Checklist-90-Revised (SCL-90-R) [23].

2.2. Data Analysis

Inferential statistics will be performed with the results of the questionnaires to gain control over the characteristics of the sample and parents, but also to observe whether there are certain patterns that correlate with the child's type of diagnosis.

The voice recorded in the responses will be analyzed through ML algorithms that identify the semantic and prosodic components. Here, we propose the use of supervised ML to classify the groups to which parents belong and thereby to diagnose ASD to their children or not. Programming language Python (version 3.7.4.) and software LIWC with Spanish dictionary will be used to extract text metrics (i.e., social content, repetitions, negations, etc.). OpenSMILE toolkit will be used to extract voice metrics (i.e., pitch, rhythm, duration, amount, and accent). Specifically, the GeMAPS feature package will be implemented. Finally, the PRAAT (version 6.0.52.) software package will be implemented for speech analysis in phonetics.

3. Results

One-sample data (a parent dyad) were extracted from a preliminary study. The data collected, along with the relevant literature, led to the detection and outline of text and voice metrics relevant for investigative purposes. The semantics metrics listed in Figure 1 were chiefly extracted from LIWC [24] according to ASD literature's criteria. The categories included in "marks added in the transcription", "general" and "spoken categories" investigate the speech's organization. Parameters included in "linguistic processes", "personal concerns" and "psychological processes" investigate the meaning of the expressed content. The six semantic categories together create an inclusive profile of emotional, cognitive, and structural components present in individuals' verbal speech.

TEXT METRICS		
Hand-crafted	Marks added in the transcription	Laughing expressions.
		Incomplete and unfinished sentences.
		Incomplete and unfinished words.
		Word repetition per question.
LIWC	General	Total word count.
		Number of words per question.
		Percentage of words captured in the LIWC dictionary. It allows to control the parameters obtained.
	Linguistic Processes	Functional words (articles, prepositions, conjunctions and pronouns).
		Personal pronouns.
		Impersonal pronouns.
		Past tense verbs.
		Present tens verbs.
		Future tense verbs.
		Conjunctions.
	Personal concerns	Work.
		Achievement.
		Leisure.
		Home.
		Money.
		Death.
	Spoken categories	Uncertainty and non-fluent.
		Sentence reconstruction.
	Psychological Processes	**Social Processes** (family, friends).
		Affective Processes (anxiety, anger, sadness).
		- Positive emotion.
		- Negative emotion.
		Perceptual Processes (see, hear, feel).
		Cognitive Processes.
		Relativity (motion, space, time).
		Biological Processes (body).

Figure 1. Semantic analysis parameters.

The prosodic metrics shown in Figure 2 explore general constructs such as pauses, delay, speed, and duration of answers. GeMAPS measures metrics such as rhythm, accent, and pitch (i.e., fundamental frequency, intensity, phonological duration). These parameters investigate the speech rate and related emotion. F0, shimmer, and jitter have been found to be related to stressful situations, trembling, and nervous speech. Moreover, voice and unvoiced are correlates of confidence and accuracy in speech [25].

VOICE METRICS		
Hand-crafted	Behavioral metrics	**Delay.** *Latency time to press the record button per question*
GeMAPS	Frequency related	**Logarithmic F0** on a semitone frequency scale, starting at 27.5 Hz (semitone 0). For unvoiced frames this parameter is 0. F0 Men (107–140 Hz); F0 Women (170–240 Hz). *Measures whether the frequency is rising or falling, and whether the frequency is acute or grave.*
		Jitter. Deviations in individual consecutive F0 period lengths. *Jitter is the deviation from true periodicity of a presumably periodic signal, often in relation to a reference clock signal.* *Measures micro-prosodic variations of the length of the fundamental frequency for harmonic sounds.*
	Energy/amplitude related	**Shimmer.** Difference of the peak amplitudes of consecutive F0 periods. *Measures micro-prosodic variations of the amplitude of the fundamental frequency for harmonic sounds.*
		Loudness. *Estimate of perceived signal intensity from an auditory spectrum.*
	Temporal features	**Mean Voiced.** The mean length and the standard deviation of continuously voiced regions(F0>0). *Measure average speaking time.*
		Mean Unvoiced. The mean length and the standard deviation of unvoiced regions (F0= 0; approximating pauses). *Measure the mean time of the silences.*
		Voiced Segment. The number of continuous voiced regions per second (pseudo syllable rate). *Speech rate measurement.*
PRAAT	Pauses, speed, duration	**Number of pauses.**
		Total audio duration. *Measure the duration of the recording per question (with pauses).*

Figure 2. Prosody analysis parameters.

4. Conclusions

Findings outlined semantic and prosodic metrics that will be implemented in voice recognition analysis of ASD caregivers. Future studies foresee to include caregivers belonging to 3 different groups based on their child's diagnosis: parents of ASD children diagnosed more than 12 months beforehand, parents of ASD children diagnosed less than 12 months beforehand, and parents of TD children.

Given the theoretical and methodological assumptions made so far, voice is expected to be an effective biomarker in the diagnosis of ASD. Confirming what is measured by the ML algorithms, it is estimated that parents of ASD children (<12 months) will have a delayed reaction/response time in comparison with the other two groups. It is also presumed that this group may exhibit repetitive verbal behaviors and long word pronunciation. Regarding the type of child's diagnosis, we hypothesize that greater severity and less acceptance of the condition correspond to fewer and negative words used by the parent. Finally, questions that cause more stress are expected to produce faster speech than less emotional questions.

Through the metrics now identified, it is expected to detect prosodic and semantic differences between parents of ASD children and parents of TD children. Accordingly, via caregivers' psycho-physiological processes, it would be possible to diagnose ASD in their child.

The present study has the potential to empower the ADI-R methodology by meeting the terms of validity and objectivity. The application uniqueness is that, unlike traditional ADI-R methodology, it allows us to perform an objective analysis of both semantics and prosody through ML techniques. Along with the development of a short and effective methodology, this project proposes a different perspective of diagnosis of ASD through analysis of caregivers' voices. Finally, the application created could have a major impact for clinics specialized in the disease.

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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

Exploratory Factor Analysis of the Virtual Reality Stroop Task

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Abstract. Executive functioning involves various controlled processing abilities such as cognitive workload, attention, and inhibition. A common test of executive functioning is the Stroop Color Word Interference Test. The dual process theory has been used to explain results from the Stroop test and states that automatic processing (e.g., word reading) is understood to be an overlearned behavior that requires little effort or direct control from the participant, while controlled processing (e.g., color-word interference) involves inhibition of prepotent (overlearned) responses. In the current study, 85 participants from a university in the southwestern United States (58% female; M age = 19.82, SD = 2.10) completed the Virtual Reality Stroop Task (VRST). To examine the underlying constructs of the VRST, a factor analysis was conducted. Both principal component analysis (PCA) and principal axis factoring (PAF) were conducted. Further, both oblique and orthogonal rotation methods were conducted. There were 4 factors with eigenvalues greater than one, which accounted for 78.46% of the total variance, however based on scree plots, parallel analysis, and the minimum average partial test, 3 factors were retained. Color naming and word reading loaded onto an automatic processing factor. Simple interference and complex interference were loaded onto a controlled processing factor. The VRST may also discriminate between participants' response accuracy (to Stroop stimuli) relative to low and high stress environmental stimuli.

Keywords. Human Performance, Human-computer interactions, Virtual Reality, Serious Games

1. Introduction

The Stroop Color Word Interference Test is a common test of executive functioning [1]. However, novel technologies such as virtual reality (VR), virtual environments (VE), and augmented reality (AR), which can be collectively categorized as extended reality (XR), may lead to improvements in neuropsychological testing compared to traditional paper-and-pencil tests. Previous work in our lab has found that the Virtual Reality Stroop Task (VRST) has adequate convergent validity with several lower dimensional versions of the Stroop Task such as a paper-and-pencil version Delis-Kaplan Executive Function System (D-KEFS) and an automated computer delivery version from the Automated Neuropsychological Assessment Metrics (ANAM). However, little research has been conducted examining the factor structure of Stroop tests.

One theory which has been used to explain the Stroop effect is dual process theory. Dual process theory suggests that automatic processing requires little effort for overlearned behaviors, and controlled processing requires cognitive effort and involves inhibition of these overlearned responses [2].

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While dual process theory is not the only theory researchers have used to explain the Stroop effect, many agree that inhibiting responses requires mental effort, which many, in turn, increase cognitive load, an ability associated with executive functioning [3]. The VRST was created to utilize aspects of XR to improve upon the traditional Stroop task. The VRST uses external threatening stimuli to attempt to increase cognitive and affective load. Additionally, Stroop stimuli complexity (i.e., word reading vs color naming), and interference complexity (i.e., static vs varying location of Stroop stimuli) are also introduced [4]. These variables were included to manipulate the cognitive load and mental effort required from participants. Indeed, previous work examining using the VRST (high mobility multipurpose wheeled vehicle; HMMWV version) found that optimal performance occurred when participants had a moderate level of arousal (i.e., cognitive and affective load).

However, while the VRST has been shown to have convergent validity with other versions of the Stroop task, so far there is no research examining the underlying cognitive constructure measured by the VRST. Further, little research in general has looked into the factor structure of Stroop tests. One study which examined a computerized version of the Stroop test found a two-factor solution [5]. The current study is designed to examine the factor structure of the VRST. Researchers hypothesized that the VRST will likely have a different factor structure than what was previously found due to additional variables and improvements from incorporating XR technologies.

2. Methods

2.1. Participants

In the current study, 85 people from a university in the southern United States (58% female; *M* age = 19.82, *SD* = 2.10) participated in the current study.

2.2. Virtual Environment

Virtual Reality Stroop Task (VRST): The high mobility multipurpose wheeled vehicle (HMMWV) version of the VRST is a computerized 3D presentation of the Stroop task. Participants viewed the VE using a head mounted display (HMD). Participants responded to stimuli via key press on a keyboard. Within the VE, participants are placed in a middle eastern type of environment and drive a simulated HMMWV on a desert road. Participants also encounter two types of zones: safe zones and ambush zones. In safe zones, participants experience few distractor stimuli such as gunfire, shouting, or explosions. In the ambush zones, a greater number of the distractor stimuli are presented.

The Stroop task within the VRST includes color naming, word reading, simple interference, and complex interferences conditions. The Stroop conditions are presented in both the safe and ambush zones for a total of 8 conditions which were counterbalanced across participants. Stroop stimuli were presented on the windshield of the HMMWV. For the color naming condition, three colored X's were presented. Participants responded to the font color of the X's. In the word reading conditions, participants read color words and responded to the word presented. In the simple interference condition, color words were presented in fonts that matched the written word or were different from the written word. Participants were instructed to respond to the font rather than the written word. Finally, in the complex interference condition, the task was the same as the simple interference condition with the addition that Stroop stimuli could appear in various locations of the windshield compared to previous conditions where Stroop stimuli were presented in the center of the windshield. Participants were able to experience up to 50 items in each condition.

2.3. Analysis

To examine the underlying constructs of the VRST, an exploratory factor analysis (EFA) was performed. Appropriateness of an EFA was conducted by examining the correlation matrix [6], Kaiser-Meyer-Olkin Measure of Sampling Adequacy (KMO), and Bartlett's test of sphericity [7].

Feature extraction was performed using principal components analysis (PCA) and principal axis factoring (PAF). Several methods were examined to determine the number of factors to retain. While common, a cutoff suggested by Kaiser (1960) using eigenvalues greater than 1 may lead to over-extraction [8]. Scree plots, parallel analysis, and the minimum average partial (MAP) test were also examined.

Direct oblimin with delta set to 0 and varimax were both performed and compared. In the current study, the pattern matrix is reported when performing an oblique rotation.

3. Results

Both KMO (0.78) and Bartlett's test of sphericity, $\chi 2(120) = 1003.32$, $p < .001$, indicate that underlying factors likely exist for the VRST. There were 4 factors with eigenvalues greater than 1 for the VRST; the scree plot indicated that 2 or 3 factors should be extracted. Parallel analysis also indicated that 2 factors should be extracted using PCA but identified more than 3 factors for extraction using PAF. However, factors with eigenvalues less than 1 were not considered for extraction. Lastly, both the original and revised MAP test indicated that 3 factors should be retained. Therefore, 3 factors were extracted, accounting for 72.03 and 66.01 percent of variance from PCA and PAF, respectively. Factor loadings for direct oblimin can be found in table 1.

Using PAF as a reference, factor one is likely measuring automatic processing speed. Factor one was positively related to reaction times for color naming and word reading conditions for both safe and ambush zones. It was also weakly related to response times for simple interference in the safe and ambush zones, and response times for complex interference in the ambush zone. Finally, this factor was negatively related to correct responding for the safe zone color naming condition. As scores on this factor increase overall, participants tend to take longer to respond and, in some conditions, provide fewer correct responses.

The second factor is positively related to correct responding in the word reading and simple interference conditions for both the safe and ambush zones. This factor may be related to multi-tasking abilities or task switching. When performing the VRST, participants also drive a virtual Humvee. Because this factor is poorly related to other variables, it may indicate that participants who score high on this factor may be performing task switching and when in more complex situations, this task switching strategy may not be as effective. Therefore, participants may switch to other strategies for performing the task or may simply use less effort as the task become increasingly difficult.

The final factor may be related to performance under high cognitive load. This factor was positively correlated with correct responding in the complex interference condition in both the safe and ambush zone, correct responding in the simple interference condition in the ambush zone, and negatively related to response times in the simple and complex interference conditions for both the same and ambush zones. Again, this factor may indicate when participants are trying to respond accurately when under high cognitive load as it is related to slower response times, and increased correct responding when participants are in conditions with increased cognitive demand.

Table 1. Factor Loadings VRST.

		PCA Factor			PAF Factor		
		1	2	3	1	2	3
Safe Zone	MRT color naming	**0.91**	0.04	0.01	**0.92**	0.04	0.04
	MRT word reading	**0.77**	0.03	-0.02	**0.68**	0.05	-0.07
	MRT simple interference	**0.44**	0.05	**-0.56**	**0.45**	0.01	**-0.50**
	MRT complex interference	0.24	0.26	**-0.80**	0.22	0.22	**-0.82**
	CR color naming	**-0.72**	**0.44**	-0.10	**-0.64**	0.38	-0.08
	CR word reading	0.05	**0.73**	0.04	0.07	**0.58**	0.05
	CR simple interference	-0.05	**0.52**	**0.45**	-0.09	**0.50**	0.35
	CR complex interference	0.13	-0.05	**0.96**	0.12	0.02	**0.91**
	MRT color naming	**0.80**	0.17	-0.22	**0.81**	0.16	-0.19
	MRT word reading	**0.91**	-0.02	0.06	**0.88**	-0.01	0.06

Ambush Zone	MRT simple interference	**0.47**	0.12	**-0.61**	**0.48**	0.08	**-0.58**
	MRT complex interference	**0.48**	0.22	**-0.57**	**0.48**	0.19	**-0.55**
	CR color naming	-0.18	0.36	**0.45**	-0.19	0.34	0.38
	CR word reading	-0.03	**0.90**	-0.07	-0.03	**0.89**	-0.14
	CR simple interference	0.06	**0.45**	**0.68**	0.03	**0.50**	**0.59**
	CR complex interference	0.02	0.23	**0.71**	-0.03	0.26	**0.59**

Note. Principal component analysis (PCA); PCA scores indicate scores from the component matrix; Principal axis factoring (PAF); PAF scores indicate scores from pattern matrix; scores are presented from direct oblimin, with delta set to 0; coefficients with magnitudes >.40 are bolded.

4. Discussion

The factor analysis of the VRST indicated that multiple cognitive constructs are likely measured, as was suggested by previous work [4, 9, 10]. The total number of correct responses for each section of the Stroop task and reaction times for each section of the Stroop task were used in the analysis. The majority of the extraction rules indicated that 3 factors should be extracted. The factors were related to automatic processing speed, multi-tasking abilities or task switching, and performance under high cognitive load. Results indicated that the VRST has well-defined cognitive constructs. Overall, similar patterns of factor loadings were found when comparing PCA and PAF, but factor loadings were generally smaller for PAF as would be expected [11]. However, there was a difference when examining the factor loadings based on choice of rotational method. Factor two accounted for more variability than factor three when using direct oblimin but factor three accounted for more than factor two when using varimax.

The VRST was designed to examine endogenous attention, which is related to participants actively directing their attention to specific stimuli or tasks, and exogenous attention, which occurs when external stimuli influence attentional resources. In addition to measuring automatic and controlled processing found in traditional Stroop tasks, researchers have suggested that the VRST may be an accurate measure of the affective impact of environmental stressors on a participant’s automatic and controlled processing, executive functioning, simple attention, divided attentional abilities, and gross reading speed [10].

Our lab has examined the validity of the VRST compared to other lower dimensional Stroop tasks, finding that they were positively correlated [4, 9, 12]. Further, our lab has found that the Stroop effect was observed even with differences between the various Stroop tests [13, 14, 15]. Computerized assessments, including those utilizing VR, may often assess cognitive domains not used by traditional paper-and-pencil measures [16, 17]. Simply using the computer interface may require more cognitive resources when compared to traditional tests. However, VEs may have greater ecological validity as the tests are more similar to real-world experiences, and the tests may be better predictors of real-world outcomes [9, 18, 19]. A meta-analysis by Neguţ and colleagues (2015) examined the validity of assessments utilizing VR compared to traditional paper-and-pencil measures or computerized measures to VEs designed to measure the same constructs. They found that on average, convergent validity scores were low but acceptable, likely due to significant differences between traditional psychological measures and measures utilizing VR [17].

In summary, the VRST seems to measure several cognitive constructs as was previously theorized. The VRST had factors related to automaticity, multi-tasking abilities or task switching, and performance under high cognitive load. It is likely that the VRST likely taps into additional cognitive constructs and resources compared to traditional measures. Future research may want to focus on a larger sample size than was used in the current study to enhance the stability of factor structures.

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Cognitive stimulation using non-immersive virtual reality tasks in children with learning disabilities

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Abstract. Executive functions comprise a set of higher-order mental processes that are crucial for cognition, emotion and behavior regulation. This study aimed to explore the benefits of a cognitive stimulation program using virtual reality (VR) for improving executive functioning in children identified with learning disabilities. The design of this study consisted of a pilot randomized controlled trial. This study was approved by an ethics committee. Nineteen children were randomly distributed by the experimental group consisting in non-immersive VR cognitive stimulation with tasks and the control group without intervention. A battery to assess executive functions in children was used for assessing the outcomes. The results suggest improvements in most domains of executive functions from pre- to post-intervention. A positive effect was also observed in the response to a questionnaire for parents about behavioral aspects of their children. These improvements were found only in the experimental group, which suggests a positive role of intervention in this population. Despite being a pilot study, these results highlight the positive role non-immersive VR on executive functions of cognitive interventions has.

Keywords. Cognitive Stimulation, Virtual Reality, Childhood

1. Introduction

Executive functions (EF) are a set of cognitive functions including basic and complex cognitive functions such as goal-directed behavior, reasoning, problem solving, and decision making [3]. Several studies emphasize the relationship between EF and educational achievement, suggesting that deficits in executive functioning affect information processing and emotional regulation, leading to school failure [4]. Therefore, this study aimed to assess a cognitive intervention focused on executive functions. This program consisted of a non-immersive virtual reality intervention directed at children in primary education. The study design consisted of a pilot randomized controlled trial with experimental and control groups.

The concept of executive functions was defined by the work of Luria [4] [7], who hypothesized that the frontal lobes of the brain were responsible for controlling and monitoring behavior. Further studies supported this relationship while establishing the association between this region with other cognitive functions such as motor programming, response inhibition, abstraction ability, problem solving, verbal regulation of behavior, behavior modification according to environmental circumstances, and integrity of personality and conscious behavior. Despite the importance of executive functions for self-regulation of behavior, there is a lack of studies investigating the efficacy of training programs directed at promoting executive functions in children. Therefore, this study aimed to assess the usefulness and efficacy of a cognitive training program for improving executive functions contextualized in a virtual reality environment describing school tasks.

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Prior studies using virtual reality in children have suggested promising results in different contexts – among children with hyperactivity and attention deficit [2] [10], autism spectrum disorders [5] [11], cerebral palsy [1], and at the level of special educational needs [6]

2. Methods

2.1. Sample

19 children aged between 6-10 years old were randomly divided into two groups: experimental group with cognitive training using non-immersive VR (CT-VR), and control group without CT-VR.

2.2. Measures

EF were assessed with *Tartaruga da Ilha* [Battery for the Evaluation of Executive Functions in Children] - TI-BAFEC [9]. This test is presented as a book to children that introduces stories about animals in 14 different tasks according to ‘cold’ (i.e., cognition drive) and ‘hot’ (i.e., emotion driven EF), and a questionnaire for parents to assess children’s behavior. The TI-BAFEC has shown good psychometric properties [5].

2.3. Procedure

This study was approved by the ethics committee of the host institution of this study. The intervention was comprised of 8 sessions (two sessions/week) in 6h dosage of intervention with cognitive tasks that involved cognitive abilities such as attention, memory, language, and executive functions. Figure 1 depicts the tasks used in the intervention program.

The program consisted of a combination of six different activities across eight sessions. In the initial session, the participants received practical instructions regarding the program (e.g., keyboard keys, how to interact with objects, main scene, and places) and performed the letters soup activity which consisted of a word completion task of finding the correct letter in four-letter words. The proposed domain for this task is verbal ability and abstraction. In the second session, participants had to participate in two activities. The first was the letter soup and the second was completed inside a virtual sports gym where participants had to organize some equipment according to criteria, i.e., to arrange objects by shapes. The main purpose of this task was to involve categorization. In the third session, the participants had to carry out two activities, the first being to prepare a classroom for a chemistry class which consisted of observing the materials placed on the virtual desk, and then going to the locker at the back of the room and bringing the same materials to the virtual worktable (easiest difficulty, defined by the number of objects). The other activity was the sports gym where participants had to organize the objects by color. These tasks involved visual memory, cognitive flexibility, and categorization. Regarding the fourth session, the participants had to prepare a classroom of medium difficulty according to the instructions received by the virtual teacher, while the second activity was the voltmeter where the objective was to associate the movements of the voltmeter pointer to the corresponding colors, inhibiting a response according to the instruction when the pointer marked the negative or positive voltage (easiest difficulty level, defined by the pointer speed). In the fifth session, two activities were also carried out. The first was the virtual sports gym, where the participants had to attend to shape and color (e.g., blue object inside the blue box, or place the yellow books inside the square yellow boxes) and the second activity used a voltmeter for medium difficulty. Regarding the sixth session, it was carried out on the soccer field, similar to the activity in the sports gymnasium, but this took place in an outdoor environment. Participants had to organize the equipment by color. In the seventh session, the participants carried out two activities, one conducted inside the sports gym where the participants had to organize the equipment according to shape, and finally, the participants had to perform the activity in the soccer field by color. In the eighth and last session of the intervention, the participants had to take part in three activities: the sports gym where they had to organize all the equipment that was out of the boxes, keeping them inside their respective boxes respecting the colors and shapes, a second activity using a voltmeter in the highest difficulty level, and the letter soup activity.

Figure 1. Examples of the tasks used for cognitive stimulation.

Note: Top-left (1) image describes the beginning environment at the school entrance; top-middle (2) the letter soup for verbal ability and abstraction; top-right (3) the chemistry class for visual memory and cognitive flexibility; bottom-left (4) the sports gym for categorization and cognitive flexibility; bottom-middle (5) the voltmeter for inhibitory control; and at the bottom-right (6) the soccer field for categorization and cognitive flexibility.

3. Results

The statistical analysis was conducted using non-parametric tests. To determine which tests to use in the analysis of the results, tests of normality were carried out on the distributions of the responses obtained in the QPPE (Questionnaire for Parents, Teachers and Tutors) and in the TI-BAFEC (see Table 1). Given the small size of the sample, the Shapiro-Wilks test was conducted to assess normality in these interval distributions. The comparisons between assessments were compared with non-parametric tests for related samples (Wilcoxon test) given by the Z values and p-value.

Table 1 depicts the descriptive statistics in mean and standard deviation for values obtained by the two groups in the two assessment moments. The results presented the descriptors Animals and Words, used in naming tasks, with the best results corresponding to higher values (more frequently-named descriptors), suggesting that the experimental group presented better, larger improvements compared to the control group. In the remaining descriptors, the best results correspond to lower values, since they refer to a smaller time or a smaller number of moves in the execution of the task. We can also verify that the experimental group showed better improvements compared to the control group. These data were analyzed using the Wilcoxon test for two related samples. The results show statistically significant differences between pre- vs. post-intervention points in the experimental group for most indices of the TI-BAFEC (p's < .05), suggesting improvements compared to controls, that did not show a significant change.

Table 1 - Values of the TI-BAFEC descriptors in the two evaluation moments

	Initial assessment		*Final assessment*		
Control Group (n=10)	*M*	*SD*	*M*	*SD*	*Z*
Animals	12.50	2.95	12.60	2.80	-.302
Words	13.70	4.69	13.40	4.79	-.832
Quick naming	33.50	8.84	34.70	6.70	-1.586

Animals in disguise_A	32.00	7.92	32.70	6.93	-.880
Animals in disguise_B	30.30	8.41	31.70	8.90	-2.235*
Colorless animals	44.00	12.76	44.80	12.80	-1.725
Animals wrong color_A	43.30	8.50	43.70	9.18	-.796
Animals wrong color_B	50.10	21.01	50.00	21.32	-.054
Game	79.00	8.79	80.40	6.54	-1.184
Experimental Group (n=9)	*M*	*SD*	*M*	*SD*	*Z*
Animals	11.56	2.13	14.67	1.66	2.699**
Words	14.89	5.56	17.11	5.44	2.724**
Quick naming	38.00	12.75	34.44	12.89	-2.680**
Animals in disguise_A	45.89	9.98	40.67	8.90	-2.675**
Animals in disguise_B	45.56	10.21	41.67	9.53	-2.673**
Colorless animals	65.00	24.01	57.78	21.18	-2.670**
Animals wrong color_A	64.11	19.26	59.11	17.49	-2.558*
Animals wrong color_B	69.33	17.97	61.00	14.56	-2.666**
Game	90.33	15.69	83.22	8.63	-2.018*

Note: * $p < .05$; ** $p < .01$

The results obtained by the two groups, control and experimental, in the child's behavior questionnaire were presented at the two moments, which, as already mentioned, had an interval of 30 days between assessments (see Table 2). It should be noted that in the eight descriptors presented in Table 2, the highest scores correspond to an improvement in the child's behavior. Only two descriptors did not show differences at post-assessment.

Table 2. Values of the Questionnaire for Parents, Teachers and Tutors (QPPE) descriptors in the two evaluation moments

	Initial assessment		*Final assessment*		
Control Group (n=10)	*M*	*SD*	*M*	*SD*	*Z*
Can stay focused on activities	3.10	0.57	2.80	0.79	-1.342
Can you wait your turn	3.30	1.16	3.30	1.16	.000
Understands the point of view of others	3.10	0.57	3.00	0.67	-.577
Interrupts other people when remembering something to say	2.80	1.03	2.90	1.10	1.000
Can modify behavior when someone makes her see that she has made a mistake	3.50	0.53	3.30	0.48	-1.414
Can find behavior when someone makes her see that she was wrong	3.50	0.71	3.40	0.70	-.577
Seems to choose behaviors that end up harming him/her	3.20	1.32	3.00	1.25	-1.414
Understands ironic sentences	3.10	0.57	3.10	0.74	.000
Experimental Group	*M*	*SD*	*M*	*SD*	
Can stay focused on activities	2.00	1.32	3.22	0.97	2.598**
Can you wait your turn	2.33	1.00	3.33	0.50	2.460*
Understands the point of view of others	2.88	1.36	3.38	1.06	2.000*
Interrupts other people when remembering something to say	3.89	0.78	2.56	0.53	-2.762**

Can modify behavior when someone makes her see that she has made a mistake	2.38	0.74	3.63	0.74	2.640**
Can find behavior when someone makes her see that she was wrong	2.44	0.73	3.56	0.73	2.887**
Seems to choose behaviors that end up harming him/her	4.11	0.93	2.89	0.93	-2.810**
Understands ironic sentences	2.89	0.78	3.22	0.83	1.342

Note: * $p < .05$; ** $p < .01$

4. Conclusion

These results suggest that the use of VR techniques presents a good potential for adaptation, constituting an efficient tool in terms of intervention in school difficulties. Such intervention programs may also contribute to an improvement in behavior, particularly in terms of social interactions, between the child and those closest to him. Nevertheless, the small sample size and the brief intervention conducted in this study may also undermine some of the results. Another limitation is related to the measure used in our study that lacks a comprehensive validation for assessing executive functions in children. Despite these limitations, the results from this pilot study point towards the ability of VR cognitive stimulation to be used for improving executive functions with children in systematic intervention protocol. It is important that future studies evaluate these effects in larger samples, relying on follow-up assessments to understand the stability of the effects.

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Mind your time: The implications of prolonged Instagram use and drive for thinness in university students

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Abstract. *Objective*. The aim of the study was to explore the impact of prolonged versus limited Instagram use regarding drive for thinness (DFT) in university students. *Method*. 201 students, mainly from the University of Twente, participated in this study. The students completed a survey with emphasis on socio-demographic data, daily Instagram use, present or past mental health diagnoses, and Drive for Thinness (DFT) scale, which assesses concerns about the body shape or weight, diet, and fear of gaining weight. A cut-off score of 60 (daily) minutes was set for Instagram use (N<60 = 119 respondents, N≥60 = 82 respondents). *Results.* There was a significant group difference in DFT between students who engaged <60 minutes versus ≥60 minutes daily on Instagram. There was a positive correlation between DFT and prolonged daily Instagram use (≥60 minutes), but not in the group with limited Instagram use (<60 minutes). In addition, there were gender differences in DFT and Instagram use. On average, females engaged in approximately twice the amount of time on Instagram on a daily basis compared to males. Moreover, there was a significant relationship between DFT and Instagram use in females, but not in males. 18% of the respondents indicated a current or past mental health diagnosis, however there were no differences in DFT or daily Instagram use between respondents with or without a formal mental health condition. A simple regression analysis indicated that daily time spent on Instagram predicts DFT in university students. *Conclusions*. Drive for a thinner body is a major component in predicting the development of formal eating disorders. This study shows the importance of social media use in facilitating a strong desire to have a thinner body, particularly in female students.

Keywords. Drive for Thinness, Social Media, Instagram use, University Students.

1. Introduction

Drive for thinness (DFT) is a multidimensional construct involving cognitive-emotional and behavioral dimensions, and the core of it is weight control or weight loss [1]. Perfectionism, food-related cognitive biases, stress, anxiety, and depressive symptoms, as well as restrictive dieting and food avoidance may be the underlying mechanisms of DFT [1,2]. DFT is regarded as one of the core risk factors in facilitating the development and maintenance of formal eating disorders like anorexia nervosa and bulimia nervosa [3,4]. This is concerning since there is a higher DFT prevalence in the group of adolescent and young adults (AYA), particularly females [5]. DFT in the AYA group is a significant component that may interfere with later adult mental wellbeing [4,6].

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Social media is among the factors that facilitate DFT and body image dissatisfaction implicitly, and some studies highlighted that it promotes unrealistic ideal body aesthetics as a result of an excessive engagement with image/appearance-oriented social networking sites (SNS) [7,8]. Therefore, the aim of the current study was to explore the impact of prolonged versus limited SNS daily use (Instagram) on DFT in a sample of university students.

2. Methods

2.1. Participants

201 students (Mage = 21 years, SD = 2.5) from several Dutch universities (mostly the University of Twente) participated in this study. The inclusion criteria consisted of being enrolled at a university and having a good understanding of English. Frequency and descriptive data of the participants can be observed in Table 1 including gender, nationalities (other nationalities included Lithuanian, Bulgarian, Finnish, Romanian, Egyptian or Italian), education, and mental health status. 18% of the students informed us about their past or current mental health condition (anxiety disorders, mood disorders, trauma and stress-related disorders, and eating disorders). On average, students spent 54 minutes engaging on Instagram daily.

Table 1. Participant characteristics (N = 201)

Characteristics	Total sample *N* (%) / *M (SD)*
Age	21 (2.60)
Gender	
Male	35 (17%)
Female	166 (73%)
Nationality	
Dutch	17 (8%)
German	132 (62%)
Other	52 (30%)
Education	
BSc	162 (76%)
Hogeschool*	23 (16.5%)
MSc	11 (5.2%)
PhD	5 (2.3%)
Mental health condition	
Yes	37 (18%)
No	164 (82%)

*BSc, bachelor; Hogeschool, university of applied sciences; MSc, master; PhD, doctoral program.

2.2. Instruments

Socio-demographic data collected for this study were age, gender, education, daily Instagram use (in minutes), and current or previous (formal) mental health diagnoses (established by a clinician).

Drive for thinness (DFT) is a subscale of the Eating Disorder Inventory-2 (EDI-2) [9], which aims to assess concerns about body shape or weight, diet, and fear of gaining weight. The subscale measures and distinguishes problematic eating symptoms (anorexia nervosa) from nonclinical populations. DFT consists of seven items with a six-point Likert scale response (ranging from “never” to “always”). Within the EDI-2, the DFT subscale showed an internal reliability of 0.89 within a nonpatient population [10]. The DFT subscale had a high level of internal consistency as determined by a Cronbach's alpha of 0.82 in this study.

2.3. Procedure

This study is part of a larger project and was approved by the Ethics Committee of the Faculty of Behavioral, Management and Social Sciences at the University of Twente in the Netherlands. All students participated in this study voluntarily and with their written informed consent. The participants filled out a survey using Qualtrics software, including their socio-demographic data and the DFT subscale. The Qualtrics link was distributed on social media platforms and the SONA system of the university (students received 0.25 credit points for completing the survey).

2.4. Statistical analysis

Data normality was examined using the Shapiro-Wilk test ($p > 0.05$), and parametric tests were utilized. Descriptive and frequency analyses were carried out to examine the sample of the study. To further analyze the data, a cut-off score of 60 (daily) minutes was set for Instagram use ($N_{<60}$ = 119 respondents, $N_{\geq 60}$ = 82 respondents). T-tests for independent samples were run to assess gender differences regarding DFT and Instagram use, differences between students who engage in limited versus prolonged time on Instagram regarding DFT, and differences between participants with or without a mental health condition in terms of their DFT and daily Instagram use. Pearson correlations were used to test the relationship between prolonged Instagram use (≥60 minutes) and DFT, which were analyzed separately for male and female students. In addition, a linear regression analysis was conducted to explore the degree to which time engaging on Instagram (minutes/day) can predict DFT (total score) in university students.

3. Results

The sample data indicated there was a significant group difference in DFT [M(total DFT) = 25.21, SD = 8.01] between students who engaged <60 minutes (M_{DFT} = 23.42, SD = 8.12) versus ≥60 minutes (M_{DFT} = 27, SD = 7.66) daily on Instagram [$t(199)$ = 2.985, $p < 0.001$, d = 0.43, $M_{<60}$ = 23 minutes/day vs. $M_{\geq 60}$ = 100 minutes/day]. There was a positive correlation between DFT and prolonged daily Instagram use (≥60 minutes) ($r = 0.349$, $p < 0.001$), but no relationship was found between DFT and limited Instagram use (<60 minutes) ($p > 0.05$).

Regarding *gender differences*, the results depicted significant differences in DFT [$t(199) = 3.424$, $p < 0.001$, $d = 0.63$) and Instagram use [$t(199) = 2.931$, $p = 0.004$, $d = 0.54$). On average, female students engage in approximately twice the amount of time on Instagram on a daily basis compared to males (M_{male} = 31 minutes vs. M_{female} = 59 minutes). A positive correlation between DFT and daily time using Instagram was found in females ($r = 0.313$, $p < 0.001$) but not in males ($p > 0.05$).

In terms of *mental health conditions*, 18% of the respondents (N = 37) indicated a current or past mental health diagnosis, however there were no differences in DFT or daily Instagram use between respondents with or without a formal mental health diagnosis ($p > 0.05$).

Finally, a linear regression analysis established that daily time spent on Instagram could statistically significantly predict DFT in university students: $F(1, 199) = 21.03$, $p < 0.001$). Average daily Instagram use accounted for 9.6% of the variation in DFT with an adjusted R2 = 9.1%. The regression equation was: predicted DFT = 28.05 + 0.048*(time engaging in Instagram use in minutes/day).

Table 1. Regression analysis summary for time (engaging on Instagram daily) predicting drive for thinness in university students.

Variable	B	95% CI	*β*	*t*	*p*
(Constant)	20.05	[26.46 29.54]		35.82	0.00
Time	0.04	[-0.06 0.02]	0.30	4.58	0.00

R^2adjusted = 0.09; CI = confidence interval for B.

4. Discussion

This study depicted and confirmed previous literature regarding the impact of SNS daily use on young individuals' DFT status. The data showed that the more time engaging on SNSs like Instagram, the greater the DFT scores were in the sample. Previous research highlighted that appearance-related comparisons to an "ideal body" depicted on SNS like Instagram may have an important role in determining DFT especially in young university students [11]. In addition, a mixed-methods systematic review emphasized that SNS exposure to unrealistic (celebrity) bodies enables implicit physical comparisons associated with a greater body image dissatisfaction, a greater desire to have a thin(er) body, and problematic eating behaviors including dieting [12].

Despite the significant difference in DFT between participants spending limited versus prolonged time on Instagram, the respondents with limited Instagram use (<60 minutes) had "higher than normal" scores on the DFT subscale. This is concerning since the sample in this study represented a nonclinical population. Therefore, the high scores on the DFT subscale may posit further mental health-related consideration in the community of university students. Subsequently, a significant link was found between DFT and prolonged Instagram use, which indicates that the more time students engage on Instagram, the higher their desire to have a thin body may be. These results are in line with previous research confirming the concerning impact of SNS on students' drive for a thinner body and concerns with body shape, as well as fear of gaining weight [7,13]. In terms of gender differences, our data are in line with previous studies showing that young females are more affected by exposure to image-based SNSs like Instagram. One possible explanation may be females' greater amount of time spent engaging on Instagram daily compared to males, as seen in the current study. An earlier study indicated different DFT-related factors for women and men. For young females, media influence (e.g. female models) and social pressure were significant mechanisms that increased DFT, although media influence (e.g. male models) and media internalization were found to be significant factors in DFT in men [14]. Nevertheless, the results of our study should be viewed in light of its most important limitation: gender imbalance.

Lastly, engaging daily on social media is a predictor of DFT in university students. A previous study determined that media influence was associated with increased DFT, muscularity, and body image concerns in young females over the course of one year [15]. A solid body of literature indicated the negative impact of engaging with social media platforms on individuals' body image-related concerns and problematic eating behaviors [12]. This posits further attention regarding the psychosocial support system since body concerns at a young age may facilitate risky body-related behavioral patterns, as seen in previous research [15].

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Influence of Photorealism and Non-Photorealism on Connection in Social VR

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Abstract. Traveling for business meetings is not only costly but also has a negative influence on the environment. Many video conferencing platforms have tried to reduce the need to travel, but people still find it relevant to meet face-to-face. Remote meetings via virtual reality (VR) allow users to still have the feeling of being together in the same space. In VR, avatars are used as digital user representations. This study investigated whether photorealistic avatars influence the connection users feel with each other during a VR remote meeting, and whether congruence between environment and avatar realism influences this connection. A 2x2 within-subject experiment was conducted whereby twelve participants had remote meetings in VR with photorealistic and non-photorealistic avatars and environments. Results indicate that when both participants are represented by live video footage of themselves (photorealistic), they feel more connected with each other than when they are represented by a non-photorealistic avatar. Congruence between the avatar and environment did not seem to influence connection. These results may help to improve the value of future remote business meetings.

Keywords. Virtual Reality, Social VR, Connection, Photorealism, Avatars

1. Introduction

During the Covid-19 crisis, synchronous communication platforms have been more important than ever. Video conferencing is often preferred over an audio-only voice call as it facilitates the addition of important non-verbal visual information such as gestures and eye-gaze [12]. However, video conferencing still has significant limitations with respect to communication elements such as joint interactions, gaze direction, and sound localization [3].

Virtual Reality (VR) offers the potential to address some of these limitations as it can give the illusion of being co-located. Recent research suggests that VR offers a greater sense of connection with another person when compared to Skype [10]. VR may also more closely approximate face-to-face meetings by immersing the user in the virtual conversational space [10].

Personalisation of avatars has been shown to increase presence and body ownership [16]. However, higher levels of realism can result in a lower sense of co-presence [7,13], which may be attributable to the uncanny valley effect [14,11]. A potential solution to this is proposed by the TogetherVR platform. Instead of using hyper-realistic graphical avatars, TogetherVR uses depth cameras to transfer live user images into a virtual environment (VE) [2,5].

An additional important factor is the level of realism of the VE, with users experiencing better social communication with higher perceived realism [17]. However, incongruence in realism between the environment and the objects within it can reduce the feeling of presence [15].

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We hypothesise that users will feel a deeper social connection when participants are represented by a photorealistic avatar and when there is congruence in the realism of the avatar and the VE. Additionally, we explore if congruence in realism affects spatial presence and if this could explain why people feel more connected in certain

environments. Spatial presence in this context is defined as the extent to which oneself perceives to be involved in and interacting within the VE [10].

2. Methodology

2.1. Experimental Setup

A 2x2 within-subjects design study was conducted to test the hypotheses. The factors were (i) avatar type and (ii) VE type. The four conditions are presented in Table 1.

Table 1. The four meeting conditions for the study.

	Photorealistic Avatar	**Non-realistic Avatar**
Photorealistic VE	A	C
Non-realistic VE	B	D

Participants were seated on a chair 1.8m in front of a Kinect Azure depth camera. The VR head mounted display (HMD) was the HP Reverb. Conditions A+B were executed using TogetherVR, which alpha-blends video recorded users into the VE [5].

Mozilla Hubs was used for conditions C+D. In these conditions, the users' head and hand movements were mapped to the avatar using the HMD and controllers. In addition, the mouth movement of the avatars corresponded with the microphone's input. Each Mozilla Hub avatar was chosen by the participant based on personal characteristics out of 25 avatars. The VEs were created in Unity and modified using either photographic (realistic) or digitally generated (not realistic) materials. Dimensions of the room and furniture were the same in both VEs. Users received spatial audio from both the platforms directly via the HP Reverb headsets. Figure 1 shows the models of the two VEs and the participant view of the two avatar types.

Figure 1. From left to right: photorealistic VE, non-photorealistic VE, photorealistic avatar and non-photorealistic avatar.

2.2. Procedure

Twelve participants each attended two sessions consisting of 2x5-minute 'business' meetings (A+B or C+D). They were free to choose any topic of conversation except discussion of the experiment. The conversational partners were changed between sessions. During all conditions, participants had to hold the controllers (which were only necessary for movement tracking during conditions C+D).

In both VE conditions, the researcher verbally guided the participants to their seats and then left the VE.

2.3. Questionnaires

Before the experiment, participants were asked to indicate their age range, gender, VR experience level, and acquaintance level of the conversation partner. 'Extraversion' and 'openness to experience' personality questions from the 60-item HEXACO PI-R [1] were also asked. It was expected that people with high scores on extraversion would be more comfortable with the conversation task and people with a high score on openness would be more comfortable in the virtual environment in general.

After each condition, participants completed the Quality of Communication (QoC) questionnaire [4] which includes the four dimensions (i) face-to-face, (ii) involvement, (iii), co-presence, and (iv) partner-evaluation [4]. The single question "How well did you feel a connection with your conversation partner" was an additional measure for connection. Spatial presence was measured using 'presence' components of Li's user experience questionnaire [10]. All connection and spatial presence measures were scored on a 5-point Likert scale. Furthermore, participants had to answer six questions from the simulator sickness questionnaire [8] which were used to judge whether they were able to continue the experiment and to explore whether possible sickness had influenced the results. Lastly, they could add any comments about the experience of each condition in an open question section.

2.4. Participants

The experiment included 12 participants. Because of the design of the experiment, this led to 48 individual evaluations of 24 experiments. Since this experiment was executed during the Covid-19 lockdown, participants were selected based on whether they were able to have the correct setup at home. Ten of the participants were male and the tested population's age varied from 25 to 64. All participants had prior experience with VR (occasionally or regularly), but it differed per couple how well they already knew each other.

3. Results

Table 2. Mean scores (with standard deviations) for the different groups. Results in **bold** are significantly higher than the comparator.

	Avatar		**Environment**		**Congruence**	
Measurement	**Non-real**	**Photo-real**	**Non-real**	**Photo-real**	**Non-real**	**Photo-real**
QoC	3.79 (0.55)	**4.15** (0.38)	3.91 (0.51)	4.03 (0.50)	4.00 (0.44)	3.94 (0.56)
Connection	3.71 (0.75)	**4.04** (0.55)	3.75 (0.68)	4.00 (0.66)	3.96 (0.55)	3.79 (0.78)
Spatial Presence	3.02 (0.99)	**3.63** (0.72)	3.10 (0.94)	**3.54** (0.83)	3.26 (0.79)	3.38 (1.02)

A paired t-test indicated a significant difference in connectedness (QoC) between the avatar types, with higher levels of connection reported with the more realistic avatar ($t(23)=-2.55$, $p<0.05$). The differences were most evident in the subscales face-to-face ($t(23)= 2.12$, $p<0.05$) and co-presence ($W=12.5$, $p<0.05$). The connection question showed a similar difference of 0.33 with a Wilcoxon signed-rank test between the two avatar groups ($W=19.5$, $p<0.05$). Pearson's r showed a moderate positive correlation between QoC and the connection question ($t(46)=6.12$, $p<0.05$) with $r = 0.67$. In addition, another paired t-test indicated that spatial presence was significantly higher in the photorealistic environment than in the non-photorealistic one ($t(23)=-2.65$, $p<0.05$). See Table 2 for an overview of the mean scores on the different measurements.

Paired t-tests did not find a significant difference between congruent and incongruent conditions for both QoC ($t(23)=0.76$, $p=0.45$) and spatial presence ($t(23)=-0.63$, $p=0.53$). A Sobel mediation test indicated that spatial presence was not a mediator variable between congruence and QoC ($z=0.45$, $p=0.66$).

Figure 2 presents the results on QoC for each condition in a boxplot. The boxplot shows a trend towards the importance of photorealism in user representation and environment. Differences between the conditions are not significant ($F(3,44)=2.53$, $p=0.07$) according to a one-way analysis of variance (ANOVA).

Pearson's r shows that the level of extraversion ($t(46)=1.76$, $p=0.08$) and openness ($t(46)=-1.38$ $p=0.17$) measured by the HEXACO PI-R [1] did not influence QoC. Nor was any previous experience in VR (occasionally or regularly) found to have any influence ($t(43)=-0.13$, $p=0.90$) with a t-test. A Wilcoxon signed-rank test suggested that order effect of the conditions did not influence scores on QoC ($W=125.5$, $p=0.72$). No participant reported simulator sickness during the experiment.

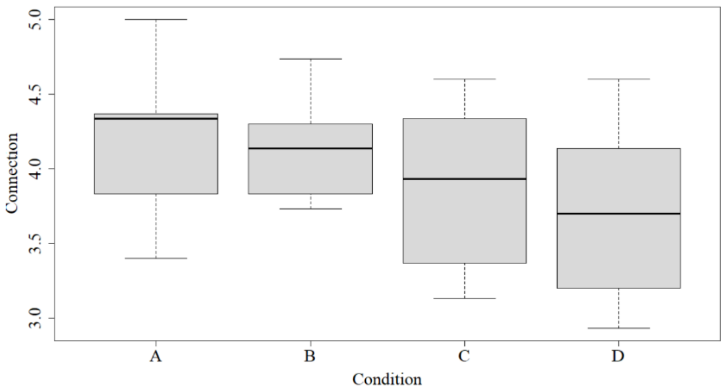

Figure 2. Connection measured by QoC [4] per condition.

4. Discussion

The results indicate that photorealistic avatars might increase the feeling of connectedness between conversational partners. However, the difference was less than 0.5 on a 5- point Likert scale. The finding that co-presence was higher for the realistic avatar appears to contradict the findings of Jo et al. [7]. However, in that study the avatar was a digital creation rather than photorealistic, so there may have been an uncanny valley effect in Jo's study.

The experimental design meant that the two different avatar types were presented via two platforms: Mozilla Hubs and TogetherVR. It has to be studied whether the found effect is also present using different types of avatars. The different platforms may have also had an effect on the results. Mozilla Hubs had a delay of approximately 550ms, whereas TogetherVR's delay was only 400ms. Although these differences in delay have been previously reported as having a differential effect on user satisfaction with communication [6], this effect may have been reduced since the experimental task was a free conversation [9].

The lack of significance between congruent and non-congruent conditions did not support our hypothesis. Results suggest that both realism of the avatar and environment might be more important with respect to connection than the congruence between the two (Figure 2). This lack of significance may be due to the mediating effect of the different platforms, but a larger sample size would be required in order to explore this further. The same trend has been observed for spatial presence, not supporting our hypothesis. One limitation here might be that the differences between the two environments was too large. Comments from the participants in the open question section described that they experienced the non-photorealistic environment as a bare room that felt less inviting (Figure 1).

Future studies are recommended to study the effect of realism using the same platform to control for any underlying variables related to the differences of the two platforms. Also, qualitative studies using VR conferencing for a longer period of time for business meetings are highly recommended.

With the aim of reducing travel, more studies to understand how remote meetings could become as valuable as face-to-face meetings should follow.

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Idealization on Dating Apps: Seeing Fewer Photos of the Potential Partner Leads to Expectancy Violation and Lower Attraction

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Abstract. Online dating apps facilitate the initiation of romantic relationships by helping users connect with new partners and meet them in subsequent face-to-face appointments. However, switching from online to face-to-face dating can induce expectancy violation and diminish attraction. Drawing on expectancy violation theory, we hypothesized that seeing just a few photos of the potential partner on their dating app profile can lead to these negative effects. Users who cannot rely on many photos for forming their impression are expected to idealize the person and show, in the moving from online to offline dating, lower levels of attraction, lower pleasantness of the person's characteristics, and worse expectancies about their personality. To test this hypothesis, 57 single young adults were randomly assigned to one of two experimental conditions: half of them viewed a dating app profile with 18 photos of the potential partner; the other half viewed the same profile but with just 4 photos. Participants then filled out a questionnaire assessing their impressions (i.e., attraction, pleasantness, and expected personality). Later, participants watched a video interview of the person and completed a new questionnaire assessing their updated impressions. Results supported our hypothesis. While participants who had seen more photos maintained their impression as positive and stable, participants who had seen fewer photos showed, after the video, lower physical attraction, lower pleasantness of the person's characteristics (e.g., gestures), and worse expected personality traits. These results have important implications for the study of romantic attraction and online behaviors.

Keywords. Idealization, Expectancy Violation, Attraction, Dating apps, Social Media

1. Introduction

Online dating applications (apps) are social media platforms that facilitate the initiation of a new romantic relationship. Tinder, for instance, helps users connect with new potential partners and possibly meet them in subsequent face-to-face appointments [1]. Although moving from online to offline meetings can enhance some aspects of the social interaction [2], previous research found that switching from online to face-to-face dating—the so-called "modality switching"—frequently induces expectancy violation and, in turn, a reduced romantic attraction [2, 3]. In this sense, the type and the timing of the online interaction can represent relevant factors. Impressions formed through an extended period of online communication fail to match the physical reality experienced during in-person meetings and lead to expectancy violation [2].

Previous scholars tried to identify the causes of this mismatch and the consequent expectancy violation [4]. As computer-mediated communication filters out many social and affective cues associated with human interaction [5], a certain lack of information regarding the potential partner may be responsible for expectancy violation on dating apps. Some characteristics of the potential partner that normally influence how people

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form impressions in face-to-face dating [6, 7] such as linguistic indicators (e.g., voice, vocabulary, tone, and accent) and nonverbal cues (e.g., gestures, posture, proximity), are indeed absent or strongly attenuated in online dating. The paucity of these features leads the individual to *imagine* the unknown features, thus running into a potential violation of expectancy [4]. When information is missing, people still form their impression by applying cognitive schemes [8, 9]. They can rely on "typical types" by completing what they do not know about the potential partner with typical features for that social category (e.g., stereotypical features), or "ideal types" by completing missing information with an idealized version of the unknown features [10, 11]. In intimate relationships, especially if the person already evaluates the partner as desirable and attractive, idealization of missing information is the most likely to occur [12].

The consequences of idealization on dating apps should be consistent with expectancy violation theory (EVT) [13]. According to EVT, while positive violations increase the attraction of the person who violated the expectancies, negative violations decrease the attraction of the violator. Then, since idealization is representing something as perfect or better than in reality, idealizing potential partners on dating apps because of a lack of information should produce negative violations that, in turn, will diminish romantic attraction when the dating switches from the online to the offline modality.

1.1. The Present Research

Based on EVT [13] and previous research on computer-mediated communication and online dating [2, 3, 4, 5], seeing just a few photos of a potential partner on their dating app profile should lead to idealization and, in the moving from online to face-to-face dating, expectancy violation and lower attraction. To test this hypothesis, we conducted an experiment in which participants viewed different versions of a dating app profile before seeing a video of the target person. We expected participants who viewed fewer photos to idealize the unknown features of the target and thus experience, after the video, a negative expectancy violation with (a) lower levels of attraction, (b) lower pleasantness of the person's characteristics, and (c) worse expectancies about their personality.

2. Methods

2.1. Participants, Design, and Procedure

Fifty-seven young adults (98.2% females; Mage = 24.05, SDage = 3.50) volunteered in a 2 x 2 repeated-measure experiment. All participants were single and attracted to men (inclusion criteria). The study had 80% power to detect an effect size of at least f(U) = .38 in within-between interactions ($\alpha = .05$; non-centrality parameter $\lambda = 8.13$; G*Power 3.1).

After they gave their informed consent, participants completed an online survey that consisted of the following parts: some demographic questions, a section that showed the dating app profile of a target person (a young adult man) entailing the manipulation of the number of photos, the first assessment of the dependent variables (i.e., attraction, pleasantness, and expected personality), a video interview of the target person (1.5 mins) and, finally, the second assessment of the dependent variables. At the end of the survey, participants were fully debriefed and thanked for their participation.

2.2. Materials

To manipulate the number of photos on the dating app profile, participants were randomly assigned to one of two experimental conditions. Half of them viewed a profile with 18 photos of the target person; the other half viewed the same profile but with just 4 photos including 1 headshot and 3 photos randomly extracted from the set.

After the first measurement of the dependent variables, participants watched a video of the potential partner that was intended to simulate the modality switch from online to offline dating [2]. For this reason, it purposely revealed those partner's pieces of information that can be usually discovered during the first date such as the person's gestures, posture, voice, and attitudes in social exchanges (e.g., proximity)[1].

The dependent variables were assessed twice, both before and after the video. They included physical attraction (6 items; α = .83), the perceived pleasantness of three objective characteristics[2] of the target person (i.e., gestures/posture, voice, social attitudes), and the expectancy that the target possesses some personality traits including positive (e.g., sociability, warmth; 7 items, α = .83) and negative traits (i.e., jealousy, aloofness; 2 items, r = .30). Answers' scales ranged from 0 (*not at all*) to 10 (*very much*) for attraction, and from 1 (*not at all*) to 5 (*very much*) for all other measures.

3. Results

Results supported our hypothesis (see Table 1). As expected, we documented a between-within interaction effect of the number of photos and the modality switch on physical attraction, $F(1, 54) = 5.16$, $p = .027$, perceived pleasantness of the person's gestures/posture (marginally significant), $F(1, 53) = 3.05$, $p = .086$, and expectancy about personality, both regarding positive traits, $F(1, 53) = 7.03$, $p = .011$, and negative traits, $F(1, 53) = 6.70$, $p = .012$. Specifically, participants reported comparable impressions before the video interview, with no difference between the two manipulated conditions. Instead, after the video, participants who formed their first impressions based on fewer photos updated them with a worse evaluation of the target while other participants confirmed their impressions (Figure 1).

Against predictions, we did not find an interaction effect of the number of photos and the modality switch on the pleasantness of the target's voice, $F(1, 53) = .77$, $p = .383$. Also, perceived pleasantness of the target's social attitudes was unexpectedly affected by the number of photos already before the switch, with participants in the 'fewer photos' condition reporting lower levels of perceived pleasantness than their counterparts, $F(1, 53) = 10.81$, $p = .002$.

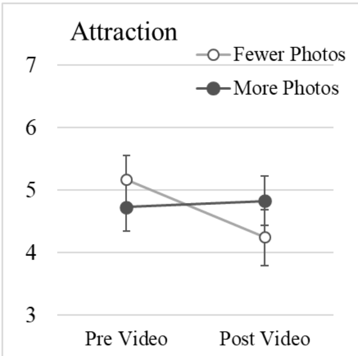

Figure 1. Participants' levels of attraction towards the potential partner before and after the video depending on how many photos they previously viewed on his dating app profile. Error bars represent *SE*s.

In sum, while participants who had seen more photos maintained their impression as positive and stable over time, participants who had seen fewer photos on the dating app profile showed, after the video, a worse impression of the target person. They reported lower physical attraction, lower perceived pleasantness of his gestures and posture, and worse expectancies about his personality (e.g., less sociability, more jealousy).

[1] To facilitate the identification with a real face-to-face date, the video showed the potential partner from the perspective of a young woman that was framed from behind while interacting with him spontaneously.

[2] In the first measurement of perceived pleasantness of the target person's objective features, we asked participants to first imagine some specific characteristics and then evaluate their expectations (e.g., *expected* voice). In the second measurement (i.e., after the video), we asked them to evaluate the pleasantness of the same characteristics but, this time, referring to what they actually observed in the video (e.g., *actual* voice).

Table 1. Participants' mean levels of physical attraction, perceived pleasantness of the target person's features, and expectancy about his personality (positive and negative traits). Standard deviations are in parentheses.

		Fewer Photos *n* = 27	**More Photos** *n* = 30
Attraction	Pre-Video	5.16 (2.10)	4.73 (2.07)
	Post-Video	4.24 (2.30)	4.83 (2.13)
Pleasantness of Gestures/Posture	Pre-Video	3.48 (.80)	3.47 (.57)
	Post-Video	3.00 (.85)	3.41 (.68)
Pleasantness of Voice	Pre-Video	3.44 (.58)	3.20 (.81)
	Post-Video	3.54 (.81)	3.62 (.86)
Pleasantness of Social Attitudes	Pre-Video	3.41 (.84)	3.80 (.55)
	Post-Video	3.27 (1.04)	3.86 (.58)
Expected Personality (Positive)	Pre-Video	3.70 (.51)	3.67 (.37)
	Post-Video	3.46 (.61)	3.73 (.44)
Expected Personality (Negative)	Pre-Video	2.39 (.58)	2.25 (.47)
	Post-Video	2.54 (.56)	2.12 (.56)

4. Discussion

Drawing on EVT [13] and previous research on online dating [2, 3], we predicted and found that seeing just a few photos of the potential partner on their dating app profile can lead users to idealize what they do not know about the potential partner, thus risking experiencing, in moving from online to offline dating, a negative expectancy violation. Future research is encouraged to replicate and confirm the current findings, possibly extending them to other populations (e.g., people attracted by women and/or both genders) or testing the specific role of idealization in mediating the relationship between a lack of information and expectancy violation.

Our results complement previous work on idealization and disillusion in intimate relationships [12]. Since any lack of information may lead to idealization, expectancy violations as a result of a mismatch between idealized and actual features should occur in various social circumstances including traditional dating, stable relationships, and simple friendships—e.g., in the switching from dating to living together.

More broadly, our results have implications for the study of online behaviors. They add to previous research on computer-mediated communication and the effects of a lack of social cues on impression formation [4]. Also, since idealization may affect any impression formation, the proposed process should be relevant for any professionals and scholars interested in the impact of social media use, including those in the organizational field (e.g., for studying/predicting expertise recognition in online teamwork) [14].

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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

Going beyond body exposure therapy. Presenting an innovative Virtual Reality and Eye-Tracking body-related attentional bias task.

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Abstract. The present study provides preliminary findings of an innovative body-related attentional bias modification task (ABMT) using Virtual Reality (VR) and Eye-tracking (ET) technologies. Analyses were carried out on a sample composed of college women (n = 35) who were divided into groups of those with high body dissatisfaction (n = 16) and those with low body dissatisfaction (n = 19). All participants were exposed to an immersive virtual environment in which they were embodied in a virtual body that resembled the measurements of their real body. Subjects performed the body-related attentional bias modification task for 20-minutes. Eating Disorder (ED) symptomatology disturbances and body-related attentional bias (AB) were measured before and after a single session of the VR-ABMT. Results showed a significant ($p<.05$) reduction of fear of gaining weight after the intervention among women with high body dissatisfaction. Our results indicated promising evidence in favor of using this ABMT, particularly among women with high body dissatisfaction. In addition, the current research provides a new application of VR and ET technologies that might open a wide range of possibilities for designing and developing new body-related interventions among patients with EDs and women with body image disturbances.

Keywords. Attentional Bias Modification Training, Virtual Reality, Eye-Tracking, Body Image Disturbances, Fear of Gaining Weight.

1. Introduction

In a phenomenon known as attentional bias (AB), described as the propensity to pay more attention to certain types of stimuli or information (e.g., disorder-relevant information) over other sorts of information [1], adult and young patients with eating disorders (EDs) and women with high body dissatisfaction show a tendency to focus more on self-reported unattractive body parts than other body parts [2-3]. Dysfunctional body-related AB may be responsible for decreasing the effectiveness of body exposure-based treatments used in patients with EDs. For example, some patients may tend to avoid or on the contrary, overlook at those self-reported unattractive body areas, interfering with the exposure-based task.

For this reason, it is necessary to develop new treatment techniques by adding specific components that aim to reduce the body-related AB. One way to target body-related fears is through exposure therapy. Previous studies have shown promising results in this field through the use of mirror exposure therapy [4] or Virtual Reality [5].These techniques usually

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involve the patients systematically observing their body or specific body parts for a certain amount of time [4]. The current project aims to go further and includes AB modification techniques within the body exposure therapy as a method to reduce body-related AB, body dissatisfaction, fear of gaining weight, and body anxiety among patients with EDs (for further details, see clinicaltrials.gov, NCT04786951). The main aim of this study is to develop an innovative body-related attentional bias modification task using VR and ET technologies. Particularly, this study provides preliminary findings of a single session of ABMT among healthy women with high and low body dissatisfaction (BD) levels.

2. Method

2.1. Sample

Thirty-five women at the University of Barcelona participated in the study and were recruited through campus flyers and advertisements in social network groups. The exclusion criteria were a self-reported diagnosis of a current ED, a Body Mass Index (BMI) of less than 17 or more than 30, or a self-reported current severe mental disorder diagnosis. Each participant was given an identification code to guarantee the confidentiality of the data. This study was approved by the ethics committee of the University of Barcelona.

2.2. Measures

The following measures were utilized before and after the task (pre-post evaluation):

- Full body illusion (FBI), body anxiety, and fear of gaining weight (FGW) were assessed by means of visual analog scales (VAS) estimating the intensity of the illusion and the FGW and anxiety related to the whole body from 0 to 100.
- The *Physical Appearance State and Trait Anxiety Scale* [PASTAS; 6] was used as a self-reported questionnaire that assesses body anxiety. The PASTAS is comprised of two self-report scales measuring weight-related and non-weight-related anxiety, but only the weight scale (W) with 8 items was used in the current study.
- The 10-item body dissatisfaction scale of the *Eating Disorder Inventory* (EDI-3 BD; Garner, 2004) was used to assess body dissatisfaction with the whole body and specific body parts. Particularly, the Spanish version of the EDI-3 was used in this study.

AB measures: In accordance with the Weight Scale items of the PASTAS, the same areas of interest (AOIs) were individually drawn onto a 2D frontal view picture of a female avatar and were labeled as weight-related body parts (W-AOIs), i.e., thighs, buttocks, hips, stomach, legs and waist.

The participant’s visual fixation was estimated by the following variables:

- Number of fixations on W-AOIs (NF): number of available fixations on the specified area of interest group (i.e., weight-related AOIs).
- Complete fixation time on W-AOIs (CFT): sum of the fixation duration at the specified area of interest group (i.e., weight-related AOIs) in milliseconds.

2.3. Instruments

Hardware: Participants were exposed to an immersive virtual environment using a VR head-mounted display (HMD) (HTCVIVE Pro Eye) with a precise ET device included (Tobii ET). In addition to the two controllers this HMD usually provides, three additional body trackers were used to achieve full body motion tracking.
Software: The female avatar was designed using the software Blender v. 2.78. A young female avatar wearing a basic white t-shirt with blue jeans and black trainers was created. The avatar also wore a swim cap to avoid any influence of hairstyle. The Unity 3D 5.6.1 (Unity Technologies) software was used to design the VR room, develop the programming

code, and incorporate the virtual avatars within. The virtual environment consisted of a unique room without any furniture except for a large mirror on the wall placed 1.5 m in front of the patient. Participants could see their whole body reflected in the mirror, even when they were moving.

2.4. Procedure

The virtual avatar was generated by taking a frontal and lateral photo of the participant. To match the silhouette of the avatar to the actual silhouette of the participant, different parts of the pictures were adjusted. Simultaneously, the other researchers administered the pre-assessment questionnaires and answered the participant's questions. Next, the full body illusion (FBI) was induced over the virtual body (i.e., to perceive and regard a virtual body as their own real body) using two procedures: visuo-motor and visuo-tactile stimulation. Both procedures lasted three minutes. Once the FBI was induced, the participant's gaze was tracked while they were asked to observe their virtual body in the mirror for 30 seconds to assess body-related AB. During this process, and as a cover story, participants were told to stand still and avoid abrupt head movements while the virtual avatar position was being recalibrated.

The ABMT was based on an adaptation of the AB induction procedure proposed by Smeets et al. [7]. The training was developed by selecting a series of geometric figures (e.g., square, rectangle, and circle) that roughly matched specific parts of the participant's body. Each of these figures had different colors and sizes. Participants were instructed to detect and identify the figures that appeared on different parts of the avatar's body. Specifically, participants were asked to focus their attention on that body part for 4 seconds while it was progressively illuminated. Afterwards, the figure appeared on another part of the body. In 45% of the trials, the geometric figures appeared on weight-related body parts, and in another 45% of the trials, the figures appeared on non-weight-related body parts. In the remaining trials (10%), the figures appeared on three neutral objects located next to the avatar.

2.5. Statistical analyses

The analysis software Ogama (Open Gaze Mouse Analyzer) was used to transform the eye-tracking raw information into suitable quantitative data. An additional data transformation was conducted by calculating the difference for each attentional variable between weight-related and non-weight-related AOIs. For further details, see Porras-Garcia et al. [5]. The outcome of the intervention was analyzed by the statistical software IBM SPSS Statistics v.25. The participants were divided into high vs. low BD levels using the median score of the EDI-BD as a cut-off point (Me BD = 8). Finally, to investigate whether there was an attentional bias modification a mixed between (BD_levels)-within (Assessment_Time) analyses of variance (ANOVA) was conducted. All the assumptions were partially met; there was homogeneity of variances and sphericity, but some data were not normally distributed in some variables.

3. Results

The analyses did not show statistically significant group*time interactions in any of the measures assessed. However, the analysis further revealed main effects of time in fear of gaining weight ($F(1,31) = 4.553$, $p = .041$, partial $\eta2 = .128$). As can be revised in Figure 1.h., all women, regardless of their body dissatisfaction levels, showed a tendency to reduce the fear of gaining weight levels after the intervention. When women with high and low body dissatisfaction were considered separately, the reduction in fear of gaining weight between the pre-post assessment was only significant among women with high BD ($F(1,23) = 5756$, $p = .022$, partial $\eta2 = .158$).

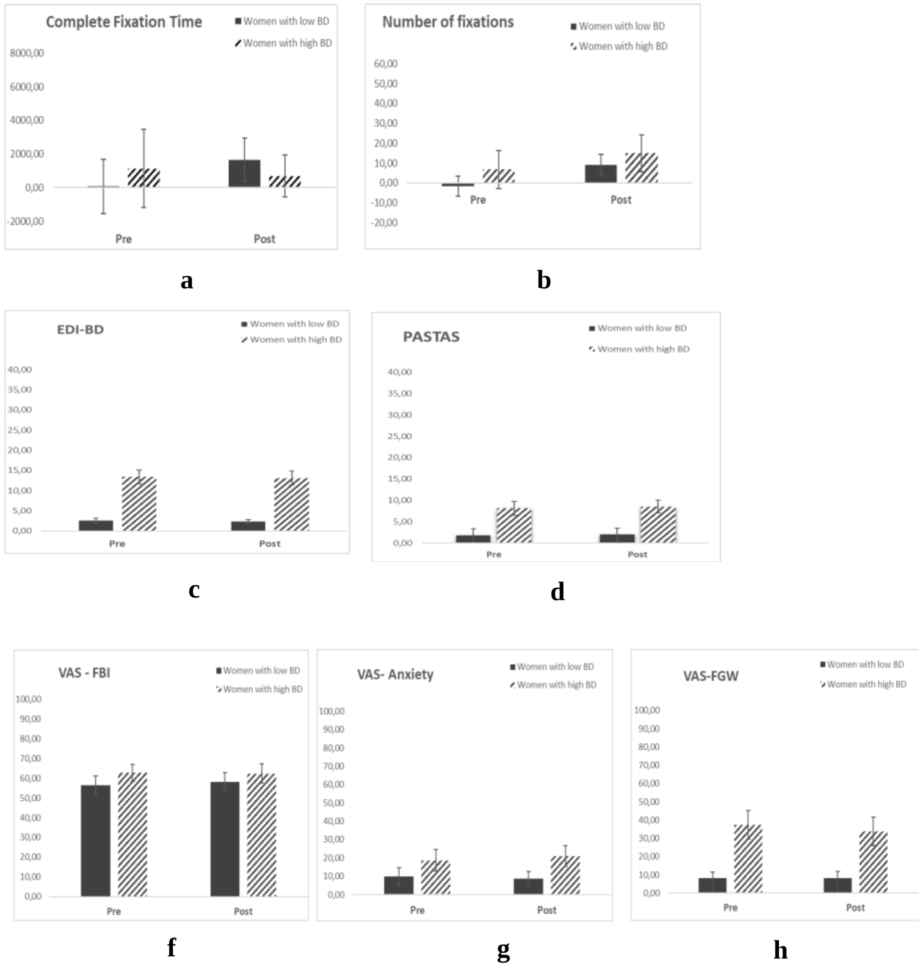

Figure 1. Means of the ED and AB measures between women with high and low body dissatisfaction, before and after the ABMT. Error bars represent standard errors.

4. Conclusions

Our results, although still preliminary, suggest that this procedure can be useful to reduce the FGW reported by healthy women, particularly those with higher body dissatisfaction. These results are noteworthy, since FGW is usually considered one of the more difficult fears to reduce in ED treatments due to the impossibility of directly confronting it through in vivo exposure therapies as with other sorts of fears [8]. However, these findings should be carefully considered since other ED or AB measures were not significantly reduced after the ABMT (e.g., body dissatisfaction). These results are partially in line with those reported by Smeets et al. [7] in which exposure to all body areas in a group of healthy women did not lead to a reduction of ED symptomatology. On the other hand, those women who only attended to their self-reported, most attractive body parts showed higher body satisfaction levels after the task [7]. Therefore, more studies are required to assess whether the sort of ABMT procedure toward the body or the number of sessions (e.g., a long-term intervention) might further improve the effectiveness of this intervention, particularly on those individuals with high body image disturbances or patients with EDs.

Future assessment and treatment of body image and EDs might benefit from the rapid technological advancement in VR and ET technologies and the countless possibilities that both technologies might provide to this field. The current study presented a pioneering

ABMT procedure taking advantage of both VR and ET technologies. The combination of both technologies might open a wide range of possibilities for designing and developing new body-related interventions that gradually retrain automatic body-related attentional processes in patients with EDs.

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The way we look at our own body really matters! Body-related attentional bias as a predictor of worse clinical outcomes after a virtual reality body exposure therapy

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Abstract: Body-related attentional bias (AB) experienced by anorexia nervosa (AN) patients has been associated with body image disturbances and other eating disorders (ED)-related symptoms. The aim of this study was to assess whether the body-related AB reported by AN patients before a virtual reality (VR)-based body exposure therapy predicted worse clinical outcomes after treatment. Thirteen AN outpatients participated in the study. AB was recorded using an eye-tracker incorporated in a VR-Head Mounted Display. Results showed that AN patients attended to their weight-related body parts for longer and more frequently than to their non-weight-related body parts. Statistically significant ($p<.05$) negative and positive correlations between pre-intervention body-related AB measures and the difference between pre- and post-assessment fear of gaining weight, body dissatisfaction, and body appreciation measures were also found. Showing higher body-related AB before the intervention marginally predicted a lower reduction of fear of gaining weight (p =.08 and p=.07) and body dissatisfaction (p = .05 and p=.06) at post-treatment, and significantly predicted a lower increase of body appreciation scores after the intervention ($p<.001$). Results suggest that body-related AB may reduce the efficacy of VR-based body exposure therapy in patients with AN.

Keywords: Anorexia Nervosa, Body-Related Attentional Bias, Virtual Reality, Eye-Tracking, Body Exposure Therapy, Treatment Outcomes

1. Introduction

Body-related attentional bias (AB), understood as the tendency to selectively attend to body appearance-related cues in preference to other information, is a phenomenon observed in Anorexia Nervosa (AN) patients [1]. Previous research found that body-related AB (i.e.

AB toward self-reported unattractive body parts) is strongly related to body image disturbances [2, 3]. However, more research is needed to explore the relationship between body-related AB and other core symptoms of AN such as fear of gaining weight.

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Based on the preliminary findings of a randomized clinical trial with AN patients [4], the objective of this study is to assess whether the body-related AB reported by AN patients before a virtual reality (VR)-based body exposure therapy predicts worse clinical outcomes after treatment. Specifically, patients showing higher body-related AB before the intervention were expected to report poorer outcomes (i.e., lower reduction of fear of gaining weight and body dissatisfaction, and lower increase of body appreciation) after the VR-based body exposure than patients showing lower body-related AB at pre-treatment.

2. Method

2.1. Sample

Thirteen AN outpatients (11 women and 2 men) receiving day-ward treatment at the Eating Disorders Units of the Hospital de Sant Joan de Déu and the Hospital de Bellvitge (Barcelona, Spain) participated in the study. The inclusion criteria were being 13 years or older and a body mass index over 19. The exclusion criteria were serious mental disorders with psychotic or manic symptoms (e.g., schizophrenia or bipolar disorders), sensory complications that precluded exposure (e.g., visual, tactile, or auditory deficits), epilepsy, clinical cardiac arrhythmia, and pregnancy.

2.2. Measures

Fear of gaining weight (FGW), body appreciation (BA), and body dissatisfaction (BD) were assessed before and after the intervention. Self-reported FGW levels were assessed using a visual analog scale (VAS) ranging from 0 (not at all) to 100 (completely). Body image-related measures were assessed using the Body Appreciation Scale (BAS) [5], and the Body Dissatisfaction scale (BD) of the Eating Disorder Inventory (EDI-3) [6].

AB measures included the number of fixations and the complete fixation time on weight-related body parts (Weight-related areas of interest, W-AOIs) and on non-weight-related body parts (Non-weight-related areas of interest, NW-AOIs). In accordance with the *Physical Appearance State and Trait Anxiety Scale* (PASTAS) [7], weight-related areas included thighs, buttocks, hips, stomach, legs, and waist, and non-weight related areas included the remaining body parts (i.e., head, shoulders, arms, décolletage, neck, and chest). The number of fixations and the complete fixation time are considered reliable measures for the assessment of body-related AB and have been widely applied in previous studies using eye tracker (ET) technology [8].

2.3. Technical Features

Patients were exposed to an immersive virtual environment using a VR head-mounted display (HMD-HTC-VIVE). The virtual scenario was designed with the Unity 3D 5.6.1 software and consisted of a small room with a large mirror on the wall placed 1.5 m in front of the patient's avatar, so that patients could see their whole virtual body reflected in it. The avatars (male and female versions) were designed using the software Blender v.2.78. They wore standard clothes (a white t-shirt, blue jeans, and black trainers) and their hair was covered by a gray hat to reduce any influence of hairstyle. The avatars also wore an HMD as the patients did, and their height and size could be adjusted based on the patient's measures. In addition to the two controllers of HTC-VIVE, three additional body trackers were used to achieve full body motion tracking of the avatar. The VR HMD-FOVE-Eye Tracking was used to detect and register the participant's eye movements while looking at the avatar in the mirror.

2.4. Procedure

The study was approved by the ethics committees of the University of Barcelona (Institutional Review Board IRB00003099) and the hospitals that participated in the study. During the first session (pre-assessment), and once the patient signed the informed consent, an avatar (i.e., virtual body) with the same measures of the patient was created and FWG, BAS, and EDI-3-BD questionnaires were administered. Then, the patient was exposed to the virtual environment and full body illusion (FBI) was induced over the virtual body using visuo-motor and visuo-tactile stimulations. Once the FBI was induced, the patient's gaze was tracked while they were asked to observe their virtual body in the mirror for 30 seconds to assess body-related AB. A more detailed description of the avatar development, the visuo-motor and visuo-tactile stimulations, and the eye tracker assessment task procedures are provided elsewhere [9, 10].

Treatment consisted of standard cognitive-behavioral therapy plus five sessions of VR-based body exposure therapy. During exposure sessions, patients were exposed (in the first-person perspective and on a mirror) to an avatar simulating their own body. In the first exposure session, the virtual body had the real-size silhouette and body mass index (BMI) of the participant. Throughout subsequent sessions (maximum 60 minutes, once a week), the virtual body progressively increased its size until showing a healthy weight. Once participants finished the fifth (and last) exposure session, the assessment questionnaires were administrated again.

2.5. Statistical analyses

The OGAMA (Open Gaze and Mouse Analyzer) software was used to transform the raw eye-tracking data into suitable quantitative data. In addition, the difference between weight-related and non-weight-related AOIs was calculated so that a positive outcome meant that the patient had been looking more at the weight-related body parts than at the non-weight-related body parts, and a negative outcome meant the opposite. On the other hand, a difference close to zero indicated that the patient had attended to both the weight-related and the non-weight-related body parts (i.e., there is no attentional bias).

Pearson correlation and linear regression analyses were conducted to assess the association between the attentional bias showed by the patients before the treatment and the outcomes of the intervention (differences between pre- and post-treatment scores in FGW, BD scale of the EDI-3, and BAS). Assumptions were partially met, as some variables were not normally distributed [11]. Analyses were conducted with the software IBM SPSS Statistics v.25.

3. Results

Prior to the treatment, the mean of complete fixation time of patients was 5,197 ms (SD=9,368.79) and the mean number of fixations was 18,77 (SD=15.87), indicating that participants showed an attentional bias to weight-related body parts (i.e. when looking at their avatar, they attended to their W-AOIs for longer and more frequently than to their NW-AOIs).

Furthermore, Pearson correlation analyses showed statistically significant ($p<.05$) negative and positive correlations between pre-intervention body-related AB measures and the difference between pre- and post-assessment fear of gaining weight, body dissatisfaction and body appreciation (Table 1).

Table 1. Pearson correlations between attentional bias measures at pre-treatment and the difference between scores of fear of gaining weight, body dissatisfaction, and body appreciation before and after treatment.

Measures	FGW (pre-post treatment) *r* (*p*)	EDI-3-BD (pre-post treatment) *r* (*p*)	BAS (pre-post treatment) *r* (*p*)
Number of fixations at pre-treatment	-.541* (.043)	-.575* (.025)	.777** (.001)
Complete fixation time at pre-treatment	-.562* (.036)	-.552* (.031)	.720**(.004)

***Note*:** FGW (Fear of Gaining Weight), EDI-3-BD (Body dissatisfaction scale of the Eating Disorder Inventory 3, BAS (Body Appreciation Scale).
** = statistically significant at p<.05 level*
*** = statistically significant at p<.01 level*

Finally, linear regression analyses (Table 2) showed that having higher body related AB levels before the intervention marginally predicted a lower reduction of fear of gaining weight (*p*=.086 and *p*=.072) and body dissatisfaction (*p*=.050 and *p* =.063) after the intervention. In addition, having higher body related AB levels before the intervention also significantly predicted a lower increase of body appreciation scores after the intervention (*p*<.001).

Table 2. Summary of linear regression analyses for attentional bias measures (number of fixations and complete time of fixation) predicting VR-based body exposure therapy outcomes.

Predictors	Dependent variables	Beta	*t*	*p*	R^2	R^2 adj.	*F*	*p*
Number of fixations at pre-treatment	FGW	-.541	-.1.929	.086	.292	.214	3.721	.086
	EDI-3-BD	-.575	-2.224	.050	.331	.264	4.945	.050
	BAS	.777	3.898	.003	.603	.563	15.194	.003**
Complete time of fixation at pre-treatment	FGW	-.562	-2.037	.072	.316	.240	4.151	.072
	EDI-3-BD	-.552	-2.094	.063	.305	.235	4.384	.063
	BAS	.720	3.278	.008	.518	.470	10,744	.008**

***Note*:** FGW (Fear of Gaining Weight), EDI-3-BD (Body dissatisfaction scale of the Eating Disorder Inventory 3 (EDI-3 BD), BAS (Body Appreciation Scale).
* = *statistically significant at p<.05 level*
** = *statistically significant at p<.01 level*

4. Conclusion

As expected and consistent with previous research [2, 3], higher levels of body-related AB at pre-treatment were strongly associated with poorer outcomes (i.e., lower reduction of fear of gaining weight and body dissatisfaction, and lower increase of body appreciation) after the intervention. Consequently, despite a promising reduction in eating disorder symptomatology after the VR-based body exposure therapy [4], our results suggest that body-related AB may have reduced the efficacy of the intervention in some ED measures. The combination of VR and eye-tracking technology could make it possible to control, and even reduce, body-related AB, and thus represents a useful way to improve body exposure therapies in AN.

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A Virtual Reality tool using embodiment and body swapping techniques for the treatment of obesity: A pilot usability study

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Abstract. The objective of the present study, which is framed within the European Union's H2020 project titled SOCRATES, is to examine the usability of a Virtual Reality (VR) embodiment tool for treating obesity. Six healthy adult participants with a desire to make lifestyle changes in terms of eating healthier and doing more physical activity were recruited and were randomly assigned to the experimental group (EG) or the control group (CG). Participants from the EG engaged in a self-conversation aiming at enhancing their self-awareness and, through embodied perspective taking (body swapping), they were embodied alternately in their own virtual representation and in a counsellor's virtual body. Participants from the CG, embodied in their own virtual bodies, participated in a "scripted dialogue" with a counsellor of their choice who asked them about their perceived barriers for engagement with a healthier lifestyle and gave them practical recommendations about how to make lifestyle changes. A mixed-methods design was used, involving a semi-structured interview examining the level of users' satisfaction with the 2 virtual experiences and their uncovered needs, as well as self-report questionnaires including those addressing readiness to change habits, body ownership during the VR experiences, and system usability. The pilot usability study was conducted in July 2021. Then from September 2021 onwards, once modifications to the prototype are carried out based on the usability testing and the final VR tool is ready for use in a clinical setting, a Randomised Controlled Trial will be conducted with 96 participants with obesity to assess its efficacy compared to usual care.

Keywords. Virtual Reality, Embodiment, Motivational Interviewing, Obesity, Usability.

1. Introduction

The rising prevalence of overweight and obesity in several countries has been described as a global pandemic. Guidelines support psychological and behavioural weight management

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interventions including Cognitive Behavioural Therapy (CBT) as a gold standard of psychological treatment [1].

However, treatments often fail in the long-term due to lack of motivation to maintain changes among patients. In fact, most patients experience significant weight regain within a year of completing treatment [2]. A recent study shows that people with obesity along with a personal motivation to lose weight were more likely to report successful weight loss compared to unmotivated people [3].

Motivational Interviewing (MI) is a person-centered approach aiming to help patients strengthen their motivation and commit to change, in line with their own desired outcomes and values [4]. The integration of MI with weight loss interventions has been associated with improvements in health-related outcomes, especially in the long-term [5].

In addition, the incorporation of new technologies among the clinical treatments for obesity has increased steadily in the past few years and has taken on a special relevance during the Covid-19 crisis [6]. In particular, the use of Virtual Reality (VR) with embodiment techniques following CBT principles has proved its preliminary effectiveness in the treatment of eating disorders (ED) and obesity [7]. However, most of these studies essentially deliver the same CBT in a VR environment, and do not exploit VR benefits to promote treatment adherence and real-life behavioural changes – key aspects for having enduring effects.

The SOCRATES project[1], within which the present study is framed, aims to use VR from a user-centered perspective that focuses on the specific needs of people with obesity. For this goal, the project will adapt an existing platform known as *ConVRself* and will use embodiment and body swapping techniques to promote a self-conversation based on MI and CBT principles. By doing so, patients will try to solve some of the root causes of their condition including lack of self-awareness, self-stigmatization, and lack of self-determination. The tool has proved its preliminary effectiveness in using the self-conversation with university students [8].

According to the objectives of the SOCRATES project, the clinical validation study of the *ConVRself* tool will be performed in 2 phases: In Phase I, which is included in this contribution, we will investigate the usability of the tool specifically adapted to the needs of people who desire to make lifestyle changes in terms of eating healthier and being more physically active. Specifically, through this pilot usability study, we will identify and gain information about the specific uncovered needs of people who want to make lifestyle changes and the product details. In Phase II, once modifications to the prototype are completed based on the usability testing and the final VR tool is ready to be tested in a clinical setting, we will conduct a Randomised Controlled Trial (RCT) to assess the efficacy of *ConVRself* as a therapeutic tool that promotes behavioural change among people living with obesity (Phase II). Our hypotheses for Phase I are that the participants from the Experimental Group (EG) would report greater levels of perceived acceptability and usability of the platform compared to the control group (CG), while body ownership, agency, and self-recognition would not differ among groups.

2. Methods

2.1. Sample

Six healthy adult volunteers who expressed a desire to make lifestyle changes in terms of eating healthier and/or being more physically active were recruited. The initial goal to recruit 8 patients with obesity from the Vall d´Hebron University Hospital could not be met due to the Covid-19 pandemic restrictions. In particular, face-to-face visits of these patients in the hospital were restricted and carried out mostly virtually. As a result, we were forced to carry

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[1] The SOCRATES project (*Self Conversation in Virtual Reality Embodiment to Enhance Healthier Lifestyles Among Obese People*) (Grant Agreement No 951930) is a project supported by the European Union's Horizon 2020 research and innovation programme.

out the study with healthy volunteers who were visited at their homes, taking the appropriate precautions.

2.2. Design and Procedure

A mixed-methods design was used, involving semi-structured interviews and self-report questionnaires, with two parallel groups. Ethical approval was obtained from the Ethics Committee of the Vall d´Hebron University Hospital [PR(AG)224/2021].

All participants signed the informed consent to participate in the study. Then, a photography procedure was carried out in which 2 photographs of their front and side were taken for the construction of their avatars. Once the avatars were ready, a brief clinical interview was conducted by a clinical researcher from Vall d'Hebron Institute of Research (VHIR) to collect sociodemographic and clinical information from participants, confirm their eligibility to the study, and assess their readiness to change before the experiment. Then, all participants were randomly assigned to the EG and the CG. Before the beginning of the VR session, a system calibration and a familiarization stage took place. Then, participants had the opportunity to choose among different gender-matched avatar options for their virtual counsellor. Once the experimental session started, participants from the EG were exposed to a 20-minute VR session. In this session, participants engaged in a self-conversation through embodied perspective taking (body swapping), according to which they were embodied alternately in their own virtual representation and in their counsellor's virtual body. Participants started describing to their counsellor the change that they would like to implement in their lifestyle in a simple statement, and were then body swapped to the counsellor's body and responded to that statement by giving positive feedback or asking further questions regarding perceived barriers and facilitators for the change. During the whole virtual session, the clinical researcher accompanied the participants and gave them specific tips about how to formulate questions and give feedback to increase motivation, inspired by the MI principles. Participants from CG were embodied in their own virtual representation and listened to a "scripted" counsellor of their choice that asked about the perceived barriers for engagement with a healthier lifestyle and gave practical recommendations about how to achieve a healthier lifestyle. No body swapping took place for this group. Finally, right after the VR sessions, participants from both groups provided open-ended feedback regarding their satisfaction with the virtual experiences, specific uncovered needs, and responded to two self-report questionnaires.

2.3. Measurements

Sociodemographic variables - *Baseline*: Participants' age, gender, level of education, civil and employment status, and Body Mass Index (BMI) was collected.
Readiness to change ruler [9] - *Baseline*: The Readiness Ruler uses a Visual Analogue Scale ranging from 1 to 10 to assess participants' "preparation" to change.
Suitability Evaluation Questionnaire (SEQ) - *Post-Experiment*: The SEQ is a 13-item questionnaire designed to measure satisfaction, acceptance, and security of use in VR systems.
Body Ownership Questionnaire - *Post-Experiment*: At the end of the VR sessions, participants gave a subjective rating of their illusion of body ownership through a 7-point Likert scale, where -3 means "not at all" and 3 means "very much". The questions were taken from a previous study evaluating *ConVRself* [8].
Users' experience - *Post-Experiment*: A brief debriefing session was carried out after the VR sessions to assess participants' satisfaction with the VR experience, ease of use, and acceptability of the *ConVRself* tool.

2.4. Data Analysis

Thematic content analysis was used to analyse the qualitative data from the interviews while descriptive data were analysed using the Excel program.

3. Results

3.1. Participants' Characteristics

Three male and three female participants took part in the study. The mean age of the sample was 51.2 years (SD=13.26) with 5 out of 6 participants having completed university studies and being employed. Regarding their civil status, 50% were single and 50% married. The mean BMI was 24.06 (SD=2.53) with only 1 participant presenting as overweight. The most frequently reported lifestyle change was to do more physical activity and exercise (100%) while 66% of participants expressed the desire to lose weight and 33.3% to eat healthier. Regarding participants' readiness to lose weight, the mean score was 7.3/10 and their readiness to exercise more was 7.8/10.

3.2. Participants' Experiences

Table 1 summarizes qualitative information from the post-experiment interview for the EG. Participants from the CG, although they enjoyed the experience and found the tool easy to use, they missed a more interactive conversation and personalised experience. The mean of the total SEQ for the 6 participants was 37.8 (SD=5.34; Range=33-46), with participants from the EG showing more satisfaction and acceptance of the tool (M=41.7; SD=5.13) compared to CG (M=34.0; SD=1). Regarding particular items, participants enjoyed the system (Q1, M=4; SD=0.89), they did not feel confused or disoriented (Q8, M=1.8; SD=1.33), and they thought that ConVRself would be helpful for their particular lifestyle change (Q11, M=3.67; SD=0.82). The median of all participants for "Body Ownership" of the self-avatar was 1 (Range=-3 to 2), for "Agency" was 2 (Range=-1 to 3), and for "Self-recognition" was 1 (Range=-1 to 2).

Table 1. Perceived advantages and disadvantages of the VR experience by participants from the EG.

ADVANTAGES		
Domain	**Key themes**	**Examples of users' statements**
Characteristics of the VR platform	Perceived ease of use	- "At the beginning I needed some instructions and guidance from the therapist but then it was easy for me to use it"
	Perceived usefulness	- "It confronts you with your goals and helps you to better organize your ideas" - "It helped me to reflect and feel more aware of the steps that I must follow to achieve my goals in a more concrete and tangible way"; "I have now set a day to take my first step" - "I would recommend the platform to a friend who wants to make any lifestyle change" - "I have been able to immerse myself into the virtual experience, gain confidence and not feel ashamed when explaining my problem to someone I did not know" - "ConVRself can be a time- and cost-saving platform to be used as a complementary tool to face-to-face treatment" - "Sometimes it is better to train people in this way, rather than to take them to the real therapeutic office" - "The whole experience was interactive and real, I felt that I was literally in that place"
	Design – platform	- "I found the virtual environment attractive and cosy, and at the same time, being empty, it was relaxing and promoted my concentration" - "I liked the personalised avatars" - "I found the counsellor really kind and empathetic"
DISADVANTAGES		
Domain	**Key themes**	**Examples of patients' statements**
Characteristics of the VR platform	Negative perception of ease of use	- "I would improve the sensitivity of the controllers as it was difficult to use them properly and to press the buttons that I was asked to in order to continue with the experience"

	Negative perception of usefulness	- "During the self-conversation, I felt disconnected, and a bit stressed with the change of roles (being patient or counsellor). I did not know if I had to talk being myself or the counsellor" - "To use it properly, I consider it essential to receive previous training on the correct use of the platform and also on how to correctly formulate questions for the self-conversation"
	Problems with the design of the platform	- "The self-avatar did not look like me, it was fatter than me, and this was annoying during the experience" - "I would prefer a more realistic virtual environment"
	Lack of personalization	- "It would have been better to personalize the background of the virtual environment. For instance, I would have liked it if I could choose among different backgrounds, such as the therapist's office or a beach. This could increase my introspection capacity"
Individual factors	Age, gender, and education	- "I think that elderly people will have more problems in using the platform"
Characteristics of Oculus Quest 2	Negative perception of ease of use	- "The HMD was heavy and uncomfortable to wear after a bit"

4. Conclusion

All participants found the VR experience to be novel, interesting, and enjoyable. In addition, moderate usability and high satisfaction of participants with the platform was found. Some difficulties in using the VR tool were observed, but it is worth highlighting that most of these issues are considered to be easily overcome with further training of the users on MI and the correct use of the platform. In addition, a supporting strain to better support the HMD device will be used. Regarding platform improvements, we are willing to improve avatar voices and offer users more options to personalize their virtual environments.

No privacy and security issues were reported, nor were difficulties related to the gender or education of the participants. Regarding the age factor for older participants, learning to use these technologies could be harder. Little incidence of simulator sickness was reported, and no further emotional and mental issues occurred. *ConVRself* could be time and cost-saving if all the issues reported are overcome.

The present pilot usability study has provided an important advancement in the development of the SOCRATES project and in particular, the preparation of Phase II. It has showed that the *ConVRself* tool is well-accepted by participants and is now ready to be tested in a clinical setting with real patients living with obesity. In turn, through the Phase II study, we expect to demonstrate the effectiveness of the embodiment body-swapping paradigm to treat obesity while also integrating MI and CBT techniques in a VR context.

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Aphasia360°: A virtual reality intervention for anomia rehabilitation in post-stroke patients

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Abstract. Aphasia is an acquired deficit following acute damage to the central nervous system that involves the difficulty or impossibility of understanding and formulating language. A typical disorder of non-fluent forms of aphasia is anomia. Anomia refers to the difficulty in finding words, in particular when trying to name objects and actions. According to the Embodied Cognition approach (EC), language is tightly connected to the motor system. In this view, language rehabilitation programs should stimulate language through the activation of the motor system. In this approach, since anomic deficits are often due to a weak link between the meaning of the word and its lemma, the Hebbs' principles of coincident and correlated learning can be exploited, i.e., by intensifying the synchronous activation of lexicon and semantics and connecting them with the motor counterpart. In this study, we present an innovative training, based on the EC framework, in which we will make use of new technologies for anomia rehabilitation in post-stroke patients. Specifically, we will use immersive 360° videos representing everyday actions displayed from the first-person point of view, experienced through a head-mounted display. The training will be administered 3 times a week for 4 weeks. The control group will watch standard videos representing the same actions recorded from the third-person perspective. Naming abilities will be tested before and after the training together with other cognitive and psychological measures. We expect that the group who will undergo the 360° video-based training will show greater improvement of performance compared to the control group.

Keywords. Immersive 360° Videos; Aphasia; Anomia; Embodied Cognition, Rehabilitation, Virtual Reality

1. Introduction

Language is an essential function for human beings because it is the one that allows verbal communication and includes skills such as the expression and understanding of phonological, semantic, and syntactic aspects. Aphasia is an acquired deficit following acute damage to the central nervous system that involves the difficulty or impossibility of understanding and formulating language [1]. The loss of one or more language skills has a serious impact on the quality of life of patients [2] as it causes difficulties in many areas of life, i.e., on a personal, social, and socio-economic level [3,4].

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For this reason, the rehabilitation of aphasic disorders is considered of primary importance starting from the subacute phase of the index event and sometimes, compatibly with the resources available, accompanies the patient even in the chronic phase in an attempt to continue improving their communicative skills.

A typical disorder in non-fluent forms of aphasia within the chronic phase is anomia. Anomia refers to the difficulty in finding the lexicon, which can manifest itself in the difficulty in naming objects and actions [5], and may be due both to a deficit in access to the lexicon and to an impairment of the semantic warehouse. If the deficit is at the semantic level, an effective rehabilitation method seems to be the Semantic Feature Analysis [6] which is based on semantic suggestions such as belonging to categories, use of objects, synonyms, etc. If, on the other hand, the deficit is at the level of the lexicon, the treatment is aimed at restoring the phonological/orthographic representation of the word (Phonological Components Analysis; [7]) through the administration of suggestions such as the initial phoneme, the rhyme, etc. In many cases, rehabilitation therapists combine the two strategies into integrated training.

These approaches are based on a vision of the mind and the cognitive system as a computer that manipulates abstract symbols following predefined rules. However, for some decades, the study of the mind and cognitive processes has led researchers to propose a new theoretical paradigm called Embodied Cognition, according to which cognitive processes, including language, are based on multimodal representations whose inputs derive from activation of sensory and motor systems [8]. In other words, our mental operations, although considered to be of "high level", such as reasoning, memory, and language itself, depend on our body to the point that the same neural structures involved in sensory, perceptual, and motor processes are also active when we elaborate concepts, make inferences, recall memories, and use language. Over the years, this theoretical perspective has received robust confirmation from experimental data, especially in regards to the interaction between the motor system and the linguistic system. It is therefore inevitable to also think about the repercussions that this research could have on enhancement strategies for the recovery of language skills. Pulvermuller & Berthier [9], in a reference article in this area, suggest important reflections that arise from the lessons learned from imaging studies that confirm the involvement of the motor system in linguistic processes. If language and action are connected, then the approach that structures the rehabilitation treatment could be overcome only by acting on language skills in favor of a "neuroscience-based" strategy in which language is acted upon by stimulating the motor system. Moreover, since anomic deficits are often due to a weak link between the meaning of the word and its lemma, the Hebbs' principles of coincident and correlated learning can be exploited, i.e., by intensifying the synchronous activation of both systems (lexicon and semantics) and connecting them with the motor counterpart. Previous studies on aphasic patients have shown how treatment through the use of observation-execution of actions is beneficial for the recovery of naming skills [10,11]. With this study, we want to take a further step in the rehabilitation of anomia by exploiting the connection between the motor and linguistic systems on the one hand and the potential offered by new technologies on the other.

2. Method

2.1 Subjects

Subjects are aphasic patients aged between 18 and 80 years with naming disorder in the post-acute phase (index event occurring at least 6 months earlier) and who have already received rehabilitation treatment in the acute phase. The naming disorder will be evaluated with the oral naming subscales of nouns and verbs of the ENPA battery (scores below the cut-off: 8.2 and 6.1 respectively). Patients will be selected from among those requesting access to outpatient aphasia rehabilitation treatment.

Patients with the following conditions will be excluded from the study: concomitant or pre-existing (with respect to the index event) neurological and psychiatric deficits, epilepsy, balance disorders, neglect, and impaired reading and writing.

The analysis of the calculation of the sample size indicated the number of 40 patients as necessary to have a statistical power of the ANOVA with mixed design (2x2) equal to 0.96, considering a Cohen's average effect size d = 0.6 and setting an alpha limit = 0.05.

2.2 *Material*

We built 80 short sentences including a verb with a first singular person and an object. The sentences describe everyday actions such as “I water the plants”. For each sentence, a 360° video has been recorded displaying the action in the first-person perspective. For this purpose, the camera was placed in the middle of the forehead of the actor performing the action. As a result, during the playback, the user has the impression of being the agent of that action. In addition, the same action has also been recorded from the third-person perspective in a standard non-spherical video. In watching this video, the user sees someone else performing the action. Both videos have been enriched with the written sentence and an audio file of the spoken sentence.

2.3 Assessment

The baseline assessment will include the following (T0):

- Aphasia examination using the ENPA battery [12]. It consists of a battery of tests that evaluate different areas of language: repetition, reading, writing, naming, comprehension, numbers, and calculation. The obtained profile evaluates the presence, severity, and main characteristics of aphasia in the subject examined. This evaluation serves as a screening to identify eligible patients and as an initial assessment of the anomic deficit.
- A health-related quality of life measure (EQ-5D-3L [13]). It consists of 2 parts: the EQ-5D descriptive system and the EQ visual analog scale (EQ VAS). The description system includes the following five dimensions: mobility, personal care, habitual activities, pain/discomfort, and anxiety/depression. Each dimension has 3 levels: no problems, some problems, and extreme problems. The VAS EQ records the patient's self-estimated health on a vertical visual analog scale where extremes are labeled "best health imaginable" and "worst health imaginable".
- Functional Outcome Questionnaire - Aphasia (FOQ-A, [14]), which measures the perception that family members have of the patient's communication skills in everyday contexts. The questionnaire consists of 32 items that evaluate different dimensions of communication skills: ability to communicate basic needs, ability to make routine requests, ability to communicate new information, attention, and other communication skills.
- Before starting the training, patients will undergo an initial test which will be used to select the set of personalized stimuli based on their real difficulties. In order to select the linguistic stimuli that will be used during the specific training of each patient, all the stimuli prepared on standard video will be presented 3 times on consecutive days and their naming will be requested. Stimuli that is named at least once will be excluded from the treatment set. From the remaining stimuli, a maximum of 50 will be selected for training.

The post treatment assessment (T1) will include the same measures. The treatment protocol is illustrated in Figure 1.

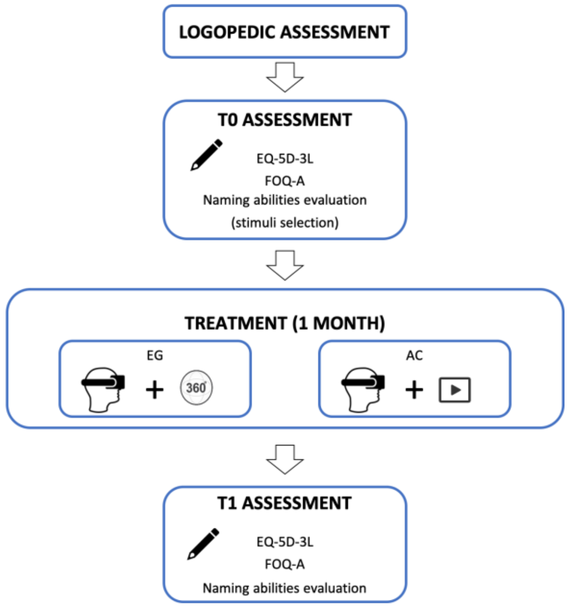

Figure 1: The treatment protocol.

2.4 Treatment

The treatment will be done 3 times a week for 4 weeks. Patients will be randomly assigned to one of the two treatment conditions: the Experimental Group (EG) will undergo the 360° video-based treatment, whereas the Active Control group (AC) will undergo the standard video-based treatment. For both groups, the videos will be displayed through the Oculus Go to make the two conditions more uniform for all the contextual variables that are not specifically manipulated at the experimental level. The patient's task is to listen to the sentence pronounced while observing the scene, and to read the written sentence appearing at the end of the video.

In each session, all the stimuli to be rehabilitated will be presented in random order.

3. Expected Results

As a primary endpoint, we expect greater improvement in naming abilities in patients trained with 360° video-based treatment compared to those undergoing standard video training. As a secondary endpoint, we expect greater improvement in the quality of life in relation to the state of health and communication skills reported by the caregiver in patients undergoing training with 360° videos compared to those undergoing training with standard videos.

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Rescripting emotional eating with virtual reality: a case study

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Abstract. Emotional eating (EE), or eating in response to negative emotions, is a manifestation of difficulties with emotion regulation (ER) for individuals with eating disorders. Although existing ER-focused interventions for eating disorders show promise in reducing symptoms, a significant subset of patients (~50%) experience suboptimal outcomes, with residual symptoms including EE. Innovative approaches targeting ER, and its manifestation as EE, are needed. We developed a novel ER-focused virtual reality (VR) immersive intervention aimed at reducing EE among individuals with a history of a diagnosed binge-type eating disorder, designed to be delivered over seven weekly sessions. Here, we present a case study of a patient with binge-eating disorder who received this intervention in a "real-world" clinical setting. The immersive experiences were delivered by a doctoral-level psychology student using a stand-alone head-mounted display (HMD). They included rescripting techniques aimed to increase awareness and identification of emotional states, resilience, and self-control over eating. Pre- and post-treatment assessments were administered to evaluate EE (Dutch Eating Behavior Questionnaire, DEBQ), eating disorder symptoms (Binge Eating Scale, BES), and emotion dysregulation (Difficulties in Emotion Regulation Scale, DERS). Results show a decreasing trend in emotional eating, emotion dysregulation, and binge episodes at the end of the treatment compared to baseline. This single case suggests value in further evaluation of this novel emotion regulation approach.

Keywords. Emotional Eating, Virtual Reality, Eating Disorders, Emotion Regulation, Binge Eating

1. Introduction

Emotion regulation (ER), a multifaceted process, is defined as the initiation, maintenance, and modification of the occurrence, intensity, and duration of feeling states [1]. ER has emerged as a significant transdiagnostic construct across eating disorders and a relevant intervention target that has proven to be largely modifiable and thus therapeutically addressable. One of the key difficulties with ER in eating disorders is emotional eating (EE), commonly defined as eating in response to negative emotions [2]. Although existing ER-focused interventions for eating disorders show promise in reducing symptoms, a significant subset of patients (~50%) experience suboptimal outcomes, with residual symptoms including EE. Thus, innovative approaches targeting ER and its manifestation as EE are needed.

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Virtual reality (VR)-enhanced treatments for eating disorders show superior efficacy, faster results, and better maintenance compared to non-VR delivery [3-6]. Putative mechanisms of action involve heightened presence and greater emotional arousal which in turn facilitate reappraisal of stimuli and modification of emotional responses that motivate

and maintain new actions. Another strategy to improve ER-focused interventions for eating disorders involves the use of immersive experiences with techniques rooted in cognitive science and basic research such as imagery rescripting, metaphorical journeys, and mindfulness. Imagery rescripting techniques effectively change emotional core beliefs [7] and the associated somatic markers [8]. Somatic markers are physical sensations that are associated with emotions. The somatic marker hypothesis proposes that emotional processes guide behavior and strongly influence decision-making [8]. Re-scripting the somatic marker helps the patient have a new emotional experience that involves the body and thus could influence the patient's behavior and decisions (e.g., EE episodes). Immersive metaphorical journeys, which involve overcoming personal obstacles, provide opportunities to acquire new ER strategies or rediscover existing skills. Mindfulness-focused eating disorder treatments significantly reduce EE and binge eating [9] with putative mechanisms including greater mindful awareness of internal experiences. The present novel ER-focused VR immersive intervention was developed to integrate these strategies to address EE in an immersive environment. To date, almost all studies of immersive technologies with eating disorders were conducted under highly controlled research settings. Here we present a preliminary case report of a patient with EE and binge-eating disorder who received a novel intervention aimed at increasing awareness, identification of emotional states, and self-control over eating. The intervention was delivered in a “real-world” clinical setting.

2. Methods

2.1. Participant

Marina (a pseudonym) is a 54-year-old woman with EE and DSM-5 binge-eating disorder who was referred from the Adult Eating Disorders Program within the Stanford University School of Medicine. Marina had tried multiple treatments to address her symptoms (1 year of prior cognitive behavior therapy and 6 months of dialectal behavior therapy) yet complained of ongoing EE and binge eating. The participant was informed about the purpose of the research and consented to participate as a pilot patient of a larger and novel ER-focused immersive intervention study.

2.2. Measures

An assessment battery was administered pre- and post-the 7-session ER-focused VR immersive intervention. Specifically, the Dutch Eating Behavior Questionnaire emotional eating sub scale (DEBQ-EE) [10] was used to evaluate emotional eating, the Binge Eating Scale (BES) [11] to evaluate binge eating symptom severity, the Difficulties in Emotion Regulation Scale (DERS) [12] to evaluate emotion dysregulation, and the Eating Disorder Recovery Self-Efficacy Questionnaire (EDRSQ) [13] to assess self-efficacy to cope with eating disorder symptoms. In addition, the Beck Depression Inventory Scale (BDI-II) [14] was used to assess the presence of depressive symptoms, the Rosenberg questionnaire [15] to evaluate self-esteem, and the State-Trait anxiety inventory (STAI Y1, STAI Y2) [16] to assess the presence of state and trait anxiety.

2.3. Treatment

The ER-focused VR immersive intervention includes an initial assessment to allow greater personalization of the treatment (one session) followed by an emotion regulation component (two sessions) and an emotional re-scripting component (four sessions) for a total of seven 50–60-minute sessions. The emotion regulation component aims to increase the patient's ability to recognize emotional states. Both sessions begin with a focus on attention exercise in which the therapist reads a script to help the patient focus on the present moment and bodily sensations. This exercise is followed by the immersive ER VR experience in which the patient is guided to implement mindfulness-based strategies to explore landscapes while identifying internal states. The 3-D immersive videos were administered through a stand-alone head mounted display, Oculus Go. Afterwards, the therapist helps the patient identify a safe place by recalling the immersive experience and identifying a moment where they experienced pleasant emotions. Finally, the anchoring phase consists of the therapist helping the patient to link the positive emotion experienced in the virtual environment to a real-life experience. Once the patient retrieves the real-life experience, the therapist encourages them to generate vivid details about the real-life experience while making a hand gesture (closing their thumb between their four fingers) in order to support the patient's ability to re-experience this moment outside of session when needed. The emotional re-scripting component aims to increase the patient's confidence in their ability to experience and skillfully manage challenging emotional states. Each session began with an initial focus on attention exercise, followed by an immersive metaphorical journey that was designed toward healing, with the patient facing obstacles and acquiring or rediscovering skills to achieve a certain outcome. The patient is asked to hold a real object (e.g., key), a sensorimotor reinforcement aimed to increase involvement of the body in the immersive experience. After the video is viewed, the patient is asked to identify their emotions and localize them in their body. If the patient predominantly experiences negative emotions, the therapist leads the patient through a desensitization experience to help them reduce the negative experience through the use of awareness, acceptance, and physicalizing exercises. If the predominant emotion after the immersive experience is positive, the therapist first amplifies the emotion and then anchors it to a real-life experience of the patient. At the conclusion of each session, the patient is given an mp3 audio version of the session and asked to listen to it while holding the real-life object associated with the scene/emotion.

3. Results

Results showed a decreasing trend in emotional eating (DEBQ-EE score), emotion dysregulation (DERS score), depression (BDI score), and anxiety (STAI Y1-Y2) from baseline to end of treatment. Furthermore, the patient showed an increasing trend in self-esteem (Rosenberg) and confidence to eat and perform eating-related activities (EDRSQ score) (see Table 1). The objective changes observed matched the patient's subjective experience of her emotional and cognitive shifts. For example, the first two sessions focused on emotion regulation helped her regain the ability "to breathe". Anxiety, as she called it, prevented her from letting her breath reach her abdomen; it stayed in her throat. For some time, Marina had been experiencing panic attacks that led her to faint. The feeling of suddenly losing consciousness, with dizziness and lightheadedness, led her to turn to food as a possible solution to this dizziness, which led her to binge eat. The mindfulness exercises and the immersive experiences guided Marina in learning how to relax and become aware of the sensations in her body. She learned to welcome these sensations rather than fear them, and to relax the parts of her body that were holding tension and anxiety. Anchoring the positive emotion in the present and safe place allowed her to recover an old sense of freedom and independence that she had long buried in her memory. In the first two rescripting sessions, Marina experienced mainly negative emotions, including a longstanding fear associated with facing obstacles and of being insufficiently able to overcome them. Concretizing the fear by giving it a color, a shape, and a name, allowed her to see it recede from herself and to remove it from the bodily sensation of immobility she had been experiencing for some time. Through these experiences, she was able to give a new meaning and a role to her fears, rewriting them. The two positive emotions that emerged in subsequent sessions were a strong sense of freedom and awe. Through the amplification of these two sensations, Marina reported feeling safe, calm, and confident in herself. Therefore, at each stage of the journey, Marina reinforced emotional stability, resulting in better management of her emotions.

Table 1: Pre-post treatment scores

Measure	Pre-treatment score	Post-treatment score	Cut-offs
DEBQ-EE	5	1.07	< 3.25= absence of clinical EE
DERS	145	57	> 80= clinical range
BDI	32	5	<10 = absent; 10-19 = mild; 20-29 = moderate; >30 = severe
BES	39	1	<17 = absent; >17 = possible; >27 = binge eating disorders diagnosis
STAI Y1	74	28	0-40 = absent; 40-50 = mild; 50-60 = moderate; > 60 = severe
STAI Y2	76	36	0-40 = absent; 40-50 = mild; 50-60 = moderate; > 60 = severe
EDRSQ- Norm Eat	3.2	4.8	No published cut off scores available
EDRSQ- Body I	1.3	2.8	No published cut off scores available
Rosenberg	18	36	<15= low self-esteem

BDI=Beck Depression Inventory; BES=the Binge Eating Scale; DERS= the Difficulties in Emotion Regulation Scale; DEBQ-EE=the emotional eating subscale of Dutch Eating Behavior Questionnaire; STAI Y1, STAI-Y2=the State-Trait anxiety inventory; EDRSQ=the Eating Disorder Recovery Self-Efficacy Questionnaire

3. Conclusion

This case report offers a preliminary account of a novel ER-focused VR immersive intervention in a patient with BED who, despite prior treatment, continued to experience emotional eating as well as residual binge eating. Our results showed that the patient had a positive response to the intervention, as indicated by shifts in pre/post scores on the questionnaires. In addition, the patient reported increased self-awareness of her emotional states, increased self-confidence, decreased urges to emotionally eat, and cessation of binge eating by the end of treatment. These positive findings support further research of this novel intervention in larger patient samples that include comparison controls and long term follow up.

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SECTION VI

WORK IN PROGRESS

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

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

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

The immersive 3D objects' library for applying non-invasive brain stimulation in research on the motor control and the mirror neurons system: a call for collaboration[1]

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Abstract. We have developed and tested a library of 3D objects for the study of motor control in immersive reality (https://p3d.in/TK7k3). The use of this stimulus material (e.g., as on the Figure 4a) opens up new opportunities for evaluating physiological parameters when using the method of neurotherapy in virtual reality. In combination with the Non-Invasive Brain Stimulation (NIBS) methods such as Transcranial Magnetic Stimulation (TMS), we propose to explore the effects of functional activity of the mirror neuron system on a large scale for further approbation of advanced and promising neurorehabilitation protocols.

Keywords. 3D, Mirror Neurons System (MNS), Non-Invasive Brain Stimulation (NIBS), Immersive Reality for Neurorehabilitation

1. Introduction

The study of the motor control in immersive reality [environments] allows us to identify physiological differences between traditional approaches of neurotherapy (for example, mirror therapy after a stroke) and "non-traditional" using virtual reality (VR) coupled with TMS for the functional effect(s) of the mirror neuron system (MNS). Also, the activation of the human MNS can be a good objective criterion for more widely practical application in rehabilitation programs.

2. The research of the MNS system with NIBS

The classic approach to the investigation of MNS involves single pulse TMS application over the motor cortex in order to elicit motor evoked potentials (MEPs) from the contralateral (to the site of stimulation) arm muscles in human volunteers. This requires the subject to observe an experimenter grasping objects, so called "transitive hand actions", or performing meaningless arm gestures – "intransitive arm movements".

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Evidence (of Fadiga et al., 1995 [1]) has shown that the observation of both transitive and intransitive actions determined an increase of the recorded MEPs [2]. Therefore, we have developed 3D hands in open-source 3DCG software toolset Blender version 2.92.01

(Blender Foundation, Netherlands) which were sketched from a scratch, modeled and mashed, and integrated in a simple environment (a light table with a white ball and grey-colored interior). The grasping movement is animated to the hand as well. Additionally, we have created 2 to 4-second video clips involving the hands' movement (you can see 2D shots from clips on Figures 1a, 1b, 1c, 2a, 2b, and 2c). A hand-made hand is an (virtual) asset. It may be exported and used in the process of developing an experimental design on a virtual platform (e.g., on cross-platform game engine Unity).

2.1. Action observation and the MNS

The mirror neurons are not reacting to the mere observation of a movement (purely motoric), but their activity is also related to the intention of the action execution. This account identifies a precise role for the MNS in our ability to infer intentions from other people's actions [3]. Here, we have developed the stimuli for NIBS testing in a VR-contained hand grasping a ball (the movement from the front view point, 0°: Figures 1a-1c, and the movement from the opposite view point, -180°: Figures 3a-3c). So, we had prepared and adopted those stimuli for testing subjects in the project studying the effects of MNS. Interestingly, by animating the 3D hand and customizing movements as a constructor (see library: [4]), the researcher might play with them or create a design of his/her study in an easy way. Importantly, any design will be standardized and circulated (lab2lab) ecologically.

2.2. Study of the empathy for pain, racial bias, and the MNS

Evidence showed a reduction in amplitude of MEPs which is specific to the muscle of a hand being pricked during observation [5]. The empathic behavior may be based on 'mirror-matching' simulation of others' states. Its inference about the sensory qualities of others' pain and their automatic embodiment in the observer's motor system may be crucial for the social learning of reactions to pain [5]. For testing the empathy for pain, we have developed (other) models of damaged hands (Figure 4a).

Additionally, it has been shown that observation of empathy for pain-related stimuli from black and white humans elicits an implicit racial bias [6]. The research found that observing pain in the same racial group induced a reduction in corticospinal excitability that is specific to the muscle (specific location of the observed hand) which participants observed being affected. For testing the racial bias of the MNS, we have created an additional model of a hand with black skin (Figure 4b) wherein we switch the model of the hand and use it for the same grasping movements (presented in Figures 1a-1c) according to different race groups (i.e., African-American and Caucasian).

Figure 1a. Grasping a ball (1st frame of movement). **Figure 1b.** Grasping a ball (2nd). **Figure 1c.** Grasping a ball (3rd). CC BY-NC-ND [4]

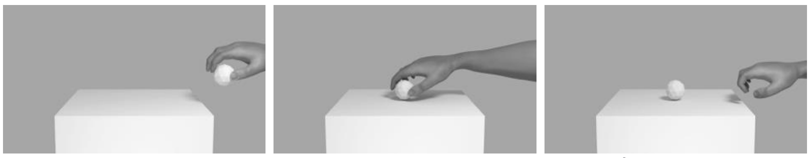

Fig. 2a. Backing a ball (1st frame of movement). **Figure 2b.** Backing a ball (2nd). **Figure 2c.** Backing a ball (3rd). CC BY-NC-ND [4]

1 https://www.blender.org/

Figure 3a. Grasping a ball: opposite view (1st frame of movement). **Figure 3b.** Grasping a ball: opposite view (2nd). **Figure 3c.** Grasping a ball: opposite view (3rd). CC BY-NC-ND [4]

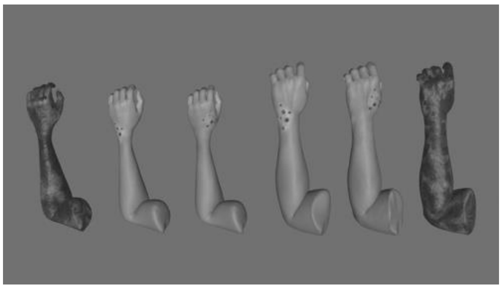

Figure 4a. Damaged hands. CC BY-NC-ND [4]

Figure 4b. Hands with white skin and hands with black skin. CC BY-NC-ND [4]

3. The advanced research with NIBS in immersive reality: a call for collaboration

We have developed a set of 3D objects and examples of standard movements (e.g., Figures 1a-1c; for deep exploring go to: [4]) for its application in neuroscience research. It is by applying this library in collaborative work that an immersive and unified stimuli approach could be tested and implemented widely. 3D virtual stimuli can be useful in advanced study of neurotherapy and personalized remote neurorehabilitation. We propose to scientific groups with a specialty in (human) motor control to discuss and share ideas about mirror therapy and VR in order to create novel neurophysiological projects. We expect that the mirror neurons' effect measured using TMS-induced MEPs can be a predictor of the effectiveness of the therapy. For example, by using a training MNS' protocol in assisted VR, measured MEP index will allow for determining and specifying an optimal approach to the use of therapy, including in VR.

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Meta Cognition on the Internet: Expected Meta-Accuracy for Human and AI Virtual Assistants' First Impressions about Us[1,2]

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Abstract. On the Internet, we encounter different types of interaction partners – some human, some AI. How we believe they perceive us upon our very first encounter sets the ground and may determine the outcome of the subsequently unfolding interaction. In a between-subject online experimental design, we studied the expected accuracy with which imagined human and AI Internet virtual assistants form first impressions. We measured expected meta-accuracy as the absolute difference between participants' self- and meta- (perceived interaction partner's viewpoint) perception along the two central dimensions of social cognition (warmth and competence). We anticipated that 1) expected meta-accuracy would be higher for human than for AI virtual assistants and 2) expected meta-accuracy would increase with increasing perceived human-mind-like abilities of the virtual assistant. We found proof for the second line of predictions and uncovered evidence for primacy of the warmth dimension in Internet meta cognition. Our results are in line with and extend previous knowledge about mind perception to the field of Internet meta cognition. Our work is pioneering in the study of meta cognition of first impressions on the Internet and promises an interesting route for uncovering previously unexplored aspects of online communication. With the ultimate goal of applying theoretical knowledge to the practical facilitation of Internet communication, we present ideas for further exploration of the area of online meta cognition. Our suggestions include different operationalizations of the primary phenomenon of interest, varying embodiment levels, and strengthening experimental manipulation to probe for the Uncanny Valley phenomenon in Internet meta cognition.

Keywords. Meta Cognition, Meta-Accuracy, First Impressions, Internet, Virtual Assistants

1. Introduction

How we believe others perceive us on the Internet sets the ground for our subsequent interactions with them. Here we studied the expected accuracy with which people understand the first impressions that human and AI virtual assistants (VAs) may form about them (meta-accuracy). Given the central role of mind attribution to and felt presence of VAs for their perception on the social and cognitive level, e.g., [1,2,3], we predicted: 1) higher expected meta-accuracy in human than in AI VA encounters, and 2) positive correlations between expected meta-accuracy, perceived human-mind-like abilities of the VAs, expected meta-accuracy, felt VA presence, and previous VA experience.To match the social and cognitive levels of VA perception, we operationalized first impressions in terms of the universal dimensions of social cognition—warmth and competence [4].

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[2] Pre-registration protocol and extensive methodological detail: osf.io/rgxbq

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2. Method

In a between-subject design, 211 (106 female) participants aged 18–36 years (M = 24.39, SD = 4.95) participated in a simulated first-impression-type of online encounter with a hypothetical human or AI VA. Participants imagined landing on a website that relies on an unembodied VA for enhancing user experience. They read a welcome message from the assistant and responded to the assistant's request to introduce their personality briefly in writing (so that the VA could better help them). Once participants submitted their description, a brief pre-programmed message from the VA thanked them, encouraged them to continue browsing the website, and to ask questions if they needed assistance. This marked the end of the simulated encounter. Adhering to definitions of warmth and competence [2], participants then rated on 7-point Likert-type scales (1 = lowest extreme, 7 = highest extreme) as to how warm and how competent they believed they had described themselves (self-perception). Next, on the same type of scales, participants took the perspective of the VA and indicated as to how warm and how competent they believed the VA had seen them (meta-perception). Finally, also on similar scales, participants rated the VA's ability to think and feel, the strength with which they felt the VA's presence, and their past experience with the type of VA they had just encountered.

3. Results

We computed a Meta-Accuracy Score for each dimension (warmth and competence) as the absolute value of the difference between participants' self- and meta-perception. A larger Meta-Accuracy Score signifies a larger difference between self- and meta-perception and thus indicates lower expected meta-accuracy.

Contrary to our predictions, mean Meta-Accuracy Score for the human VA condition was not higher than that for the AI VA condition for either dimension (one-tailed independent samples Student's t-tests, both ps > .1). However, participants in the human VA condition believed they had described themselves as warmer than those in the AI assistant condition (one-tailed independent samples Student's t-test, t(209) = −1.83, p = .035, Cohen's d = 0.25; Mhuman = 4.96, SDhuman = 1.36; M_{AI} = 4.62, SD_{AI} = 1.35). In addition, participants perceived the human VA as more capable of thinking (one-tailed independent samples Student's t-test, $t(209) = -2.64$, $p = .004$, Cohen's d = 0.36; M_{human} = 4.52, SD_{human} = 1.81; M_{AI} = 3.87, SD_{AI} = 1.74) and feeling (one-tailed independent samples Welch's t-test, $t(187.84) = -3.64$, $p < .001$, Cohen's d = 0.50; M_{human} = 3.19, SD_{human} = 2.03; M_{AI} = 2.30, SD_{AI} = 1.51) than the AI VA. There was also a tendency for the human assistant to be perceived as more present than the AI one (one-tailed independent samples Welch's t-test, $t(208.09) = -1.59$, $p = .057$, Cohen's $d = 0.22$; M_{human} = 3.78, SD_{human} = 1.39; M_{AI} = 3.45, SD_{AI} = 1.56).

As predicted, meta-accuracy increased with increasing perceived human-mind-like abilities and felt presence of the VA (Table 1). Experience with the respective VA type was not significantly correlated with meta-accuracy (all *p*s > .1).

Table 1. Pearson correlation coefficients for the associations between expected meta-accuracy and perceived virtual assistant human-mind-like abilities, felt VA presence, and past VA experience.

	VA Thinking Ability	**VA Feeling Ability**	**VA Experience**	**VA Felt Presence**
Meta-Accuracy Warmth	$r = -.12$* $r_{human} = -.15$ $r_{AI} = -.07$	$r = -.21$** $r_{human} = -.24$** $r_{AI} = -.15$	$r = -.06$ $r_{human} = -.06$ $r_{AI} = -.05$	$r = -.15$* $r_{human} = -.11$ $r_{AI} = -.18$*
Meta-Accuracy Competence	$r = -.12$* $r_{human} = -.08$ $r_{AI} = -.14$	$r = -.14$* $r_{human} = -.18$* $r_{AI} = -.08$	$r = -.01$ $r_{human} = -.12$ $r_{AI} = -.12$	$r = -.12$* $r_{human} = -.09$ $r_{AI} = -.14$

Note. All tests one-tailed, for negative correlation (higher Meta-Accuracy Score indicates larger difference between self- and meta-perception and thus lower meta-accuracy)
* $p < .05$, ** $p < .01$, *** $p < .001$

4. Discussion

We present evidence that human-mind-like abilities of VAs are associated with expected meta-accuracy of first impressions in Internet encounters. Our results are in line with previous findings [1,2] and extend them into the field of Internet meta cognition. Our observations also suggest primacy of warmth over competence [4] in meta cognition online. We propose that further research explores broader operationalizations of meta-accuracy [5] and includes varying degrees of embodiment [3] and human-likeness to probe for the presence of the Uncanny Valley phenomenon in Internet meta-accuracy [1].

Our work undertakes the study of a largely unexplored but highly relevant in the digital age area of human cognition – meta-accuracy of first impressions on the Internet. We outline an initial idea of how the known principles of human-AI interaction may guide meta cognition on the Internet.

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Virtual reality for relaxation in a pediatric hospital setting: an interventional study with a mixed-methods design

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Abstract. Accumulating evidence supports virtual reality (VR) as a feasible and effective method to alleviate anxiety and pain in pediatric patients during specific medical procedures. However, adoption of VR in clinical practice is limited. To address implementation barriers, this intervention study with a mixed-methods design focuses on the feasibility, acceptability, tolerability, and preliminary effectiveness of Relaxation-VR, a VR application aimed to provide relaxation as it is used for anxiety, stress, and pain reduction for children in hospital. Primary outcomes include intervention completion, technical issues, the pediatric Simulator Sickness Questionnaire (tolerability), and visual analogue scales (VAS) addressing ease of use, likeability (feasibility), and future use (acceptability). Secondary outcomes include pre-to-post-changes in the Self-Assessment Manikin, VAS, and Faces Pain Rating Scale-Revised to measure happiness and stress, anxiety, and pain, respectively. We present preliminary data of 51 participants of this ongoing study. A minority of participants (10/51) quit the intervention prematurely for reasons including discomfort, disliking the application, technical issues, and willingness to see the medical procedure being performed. Only 5 out of 51 participants reported technical issues including start-up issues and low battery levels. Ease of use, likeability, and future use of the intervention were favorably scored. No adverse events and minimal VR sickness symptoms were reported. Compared to baseline, participants reported less anxiety, less pain, less tension, and more happiness while using Relaxation-VR. These preliminary findings indicate that Relaxation-VR is acceptable, feasible, and tolerable, and can reduce anxiety, tension and pain, and increase happiness in pediatric patients with various medical conditions.

Keywords. Virtual Reality, Pediatrics, Relaxation, Anxiety, Stress, Implementation

1. Introduction

Accumulating evidence supports virtual reality (VR) as a feasible and effective method to alleviate anxiety and pain for pediatric patients during specific medical procedures (1,2). However, adoption of VR in clinical practice is limited due to multiple implementation barriers. To improve translation from research to practice and address implementation barriers, the current study focuses on the feasibility, acceptability, tolerability, and preliminary effectiveness of Relaxation-VR, a VR application (prototype) aimed to provide relaxation, used in this study to reduce anxiety, stress, and pain for children in hospital as assessed by pediatric patients, their parents, and clinical staff.

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2. Methods

The study sample consists of 55 pediatric in- and outpatients aged 4 to 16 years, recruited in two Belgian hospitals. Data of 51 participants has been included in analyses. Relaxation-VR was used with different types of patients with various reasons for hospital admittance (e.g., examination and/or treatment of gastrointestinal complaints, appendicitis, eating disorder, surgery). 19 participants used Relaxation-VR during a medical procedure, and 30 participants used Relaxation-VR as a means to relax during a longer hospital stay (missing N=1).

Relaxation-VR is a VR application (prototype) aimed to relax its users. In this study, we assess whether this application can be used to reduce anxiety, stress, and pain by distracting the patient in a relaxing and interactive environment. Relaxation-VR consists of three levels (breathing exercises, meditation exercises, interactive games) and is administered via a commercially available VR headset (Oculus Go). To assess the feasibility, acceptability, tolerability, and preliminary effectiveness of Relaxation-VR as an intervention for a variety of pediatric patients, we conducted an interventional study with a mixed-methods design. Primary outcomes include intervention completion, technical issues, visual analogue scales (VAS) addressing ease of use and likeability (feasibility), future use (acceptability), and the pediatric Simulator Sickness Questionnaire and adverse event reporting (tolerability). These outcomes were measured after completion of the VR intervention. Secondary outcomes include the Self-Assessment Manikin to measure happiness and stress, VAS to measure anxiety, and the Faces Pain Rating Scale-Revised to measure pain. These measures were administered at baseline and after completion of the VR intervention to assess pre-to-post-changes. Data collection is completed, but data analyses are ongoing.

3. Results

Concerning feasibility, a minority of participants (10/51) quit the intervention prematurely for reasons including discomfort, disliking the application, technical issues, and willingness to see the medical procedure being performed. Only 5 out of 51 participants reported technical issues including start-up issues and low battery levels. Ease of use (M=15.31, SD=22.22) and likeability (M=13.92, SD=21.12) of the intervention were favorably scored (0= easy to use/fun, 100= difficult to use/not fun at all). Future use of the intervention (acceptability) was also favorably scored (M=16.10, SD=26.19) (0= I want to use it again, 100= I do not want to use it again at all). Regarding tolerability, no adverse events and minimal VR sickness symptoms were reported. Compared to baseline, participants reported less anxiety, less pain, less tension (stress), and more happiness while using Relaxation-VR (Table 1).

Table 1. Mean, standard deviation, t-value and p-value of the secondary outcome measures.

		Baseline	Post	
Outcome measure	**N**	**M (SD)**	**M (SD)**	**t-value**
Anxiety (VAS)	50	32.82 (28.09)	14.34 (18.48)	5.53*
Pain (FPRS-R)	51	2.65 (2.37)	1.55 (1.69)	3.80*
Tension (SAM)	50	4.86 (1.90)	2.92 (2.33)	7.16*
Happiness (SAM)	51	5.94 (2.03)	7.29 (2.07)	-4.99*

*Note. FPRS-R = Faces Pain Rating Scale – Revised, VAS = Visual Analogue Scale, SAM = Self-Assessment Manikin; *p<.001*

4. Conclusion

These preliminary findings indicate that Relaxation-VR is acceptable, feasible, and tolerable for a variety of pediatric patients and that the use of Relaxation-VR can reduce anxiety, pain, and tension (stress), and increase happiness in pediatric patients with various medical conditions.

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