BRAIN. Broad Research in Artificial Intelligence and Neuroscience
ISSN: 2068-0473 | e-ISSN: 2067-3957
Covered in: Web of Science (WOS); PubMed.gov; IndexCopernicus; The Linguist List; Google Academic; Ulrichs; getCITED; Genamics JournalSeek; J-Gate; SHERPA/RoMEO; Dayang Journal System; Public Knowledge Project; BIUM; NewJour; ArticleReach Direct; Link+; CSB; CiteSeerX; Socolar; KVK; WorldCat; CrossRef; Ideas RePeC; Econpapers; Socionet.

2021, Volume 12, Issue 2, pages: 364-373 | https://doi.org/10.18662/brain/12.2/215

Perspective on the Double Edges of Virtual Reality in Medicine – both Addiction & Treatment

Marcel-Alexandru GĂINĂ[1], **Alexandra BOLOŞ**[2], **Ovidiu ALEXINSCHI**[3], **Ana-Caterina CRISTOFOR**[4], **Alexandra-Maria GĂINĂ**[5], **Roxana CHIRIŢĂ**[6], **Cristinel ŞTEFĂNESCU**[7]

[1] Assistant Prof., UMF „Grigore T. Popa" Iași & psychiatry resident within „Socola" Institute of Psychiatry, Romania, marcel-alexandru_t_gaina@d.umfiasi.ro
[2] *Corresponding author:* Lecturer at UMF „Grigore T. Popa" & Senior Psychiatrist within „Socola" Institute of Psychiatry, Iași, Romania, alex_andra_bolos@yahoo.com
[3] Assistant Prof. at UMF „Grigore T. Popa" & Senior Psychiatrist within „Socola" Institute of Psychiatry, Iași, Romania, alexinschi@yahoo.com
[4] Lecturer at UMF „Grigore T. Popa" & Specialist Psychiatrist within „Socola" Institute of Psychiatry, Iași, Romania, ina_cristofor@yahoo.com
[5] Neurology resident at the Neurosurgery Emergency hospital „Prof. Dr. Oblu", Iași, Romania. gaina_alexandra@yahoo.com
[6] Professor Dr., UMF „Grigore T. Popa" & Senior Psychiatrist within „Socola" Institute of Psychiatry, Iași, Romania, d.stigma@gmail.com
[7] Professor Dr., UMF „Grigore T. Popa" & Senior Psychiatrist within „Socola" Institute of Psychiatry, Iași, Romania, cristinel.stefanescu@gmail.com

Abstract: *Although the therapeutic potential of virtual reality has been foreseen since over half a century ago, the lack of graphical processing power made it impossible to apply in medical therapeutic sciences until last decade; nowadays, the hardware required for virtual reality is even 100 times more affordable. A head-mounted display induces immersivity engulfing the subject's eyesight perception in a stereoscopic manner. The same tool that may aid better self understanding and bonding can also trigger psychopathological mechanisms through which the user becomes alienated from the real world. As virtual reality became even more popular during SARS-COV2 pandemic, users worldwide have spent more time into a virtual world. Depersonalization/derealization syndrome can occur if virtual reality is abused. The greater the person's involvement in virtual reality, the greater the chance of a lack of bodily self (depersonalization). Controllers that mimic hands could prevent the subject from acknowledging the real world as true – derealization. Virtual reality's dissociative potential is related to individual psychological traits and prolonged exposure. Children are the most prone to develop behavioral changes. Adults may develop behavioral problems related to virtual reality gaming, gambling, pornography and also social networking through created avatars. Blue light wavelength could harm sleep architecture and circadian rhythm by disrupting melatonin, therefore making virtual reality exposure problematic after sunset. State of the art reveals that using virtual reality in a therapeutic manner, actually facilitates the fight against addictions with cue therapy intended to extinguish conditioned response. The exposure to a substance (nicotine, alcohol, or any other psychoactive recreational abuse potential substances) can trigger craving in a controlled environment, that is malleable in the hands of the therapist. Virtual reality can offer an exposure perspective that is both vivid enough to be a challenge, but also safe enough to ensure patient involvement and to amplify the therapeutic alliance.*

Keywords: *virtual reality, dissociation, addiction, cue therapy, craving.*

How to cite: Găină, M.-A., Boloş, A., Alexinschi, O., Cristofor, A.-C., Găină, A.-M., Chiriţă, R., & Ştefănescu, C. (2021). Perspective on the Double Edges of Virtual Reality in Medicine - both Addiction & Treatment. *BRAIN. Broad Research in Artificial Intelligence and Neuroscience, 12*(2), 364-373. https://doi.org/10.18662/brain/12.2/215

1. Introduction

Virtual reality headsets are technological devices able to induce a sense of presence for the user within a virtual environment that is generated by a software interface throughout the graphical processing power of hardware equipment. Cambridge Dictionary defines *virtual reality* as a set of images and sounds that resemble an interactable environment for the user – therefore including computer 2d generated environments, whereas the Oxford dictionary definition describes the technique in a more specific manner, that includes the head mounted display concept and the ability to interact with the virtual environment via dedicated equipment – "gloves fitted with sensors", the latter being more specific.

From a historical perspective, the prototype Sensorama introduced in 1962 by Morton Heilig has foreseen the potential of using virtual reality as a simulator tool, by trying to stimulate all of the user's senses, but was more of a display than an interactive environment, and was registered as a patent in 1961.

The next milestone is David Evans and Ivan Sutherlands' "Ultimate Display" (Botella, 2017) – also called the "Sword of Damocles" due to its massive dimensions of the headset, that had to be suspended from the ceiling (Sherman & Craig, 2019). The user was also able to move somehow freely in the virtual environment. Meanwhile, after a few decades, the exponential multiplication of transistors per circuit intuited by today's 56 years old Moore's Law fuelled the concept of virtual reality into becoming reality, backed by graphical processing power.

The computer gaming industry has resurrected the development of virtual reality, by raising the demand. The last decade was the peak of this technology, as it became available, affordable and also promoted by user developed content. From 263x230 pixels for each eye in 1995, nowadays native 4k resolution is possible for each eye, and the graphical processing units of 2021 are able to maintain a level of frames per second that is above 95, therefore the central nervous system of the individual might have a hard time discerning reality from virtual environment. Surprisingly, the software is the one that lacks a major leap.

History has taught us that humanity has no limits related to comfort. For 200 000 years, our predecessors have gone to great lengths to be able to provide necessary goods in order to survive. Nowadays, the hunt has been replaced by a touch on a smartphone application or a computer mouse click, the waiting time has been reduced by delivery services that bring that food

straight to the door within an established time schedule. But humanity has not changed on a biological level, and the same hormonal systems hold the key of our affective state, so we merely replace the adrenaline of the fight for survival with the burden of existance without a scale of purpose. Our needs are met, but we are prone to develop anxiety disorders. We are entangled in virtual networks but lack the very core of what has brought us to the very peak of the food chain – social interaction.

It comes as no surprise, then, that the topic of virtual reality seems to elicit a growing interest in the scientific community, resulting in an increasing number of articles published in the National Library of Medicine Pubmed database, with reference to its applicability in medicine, from 739 publications where the keyword was " virtual reality" in December 2001, to 13,991 articles on 07 May 2021.

The **purpose** of this article is to weight the state of the art regarding the therapeutic potential versus side effects of virtual reality (V.R.) exposure techniques and cue reactivity.

Understanding concepts behind V.R.

Immersivity and sense of presence

By immersivity - namely the visualization of an image, with a frame rate per second of at least 95 fps individually, at the level of each eye - the visual cortex is stimulated, auditory stimuli project towards the auditory cortex, and the hippocampus organizes kinesthetic stimuli. Nonetheless, the *immersivity* is the objective part of the virtual experience, dependent on the image projected by the headset, whereas the *sense of presence* is the subjective feeling of actually being in a different environment and can be influenced by the individual's personality traits or medical conditions (Luca et al., 2019; Servotte et al., 2020). Cooptation of all sensory functions, such as wind or olfactory stimulation, exponentially amplifies the difficulty of the central nervous system to discern the virtual world from reality. The immersivity level is directly proportional to the number of senses involved (Miller & Bugnariu, 2016).

Haptic feedback of the controllers give the user the ability to experiment sensitive and vibrational feedback of his actions.

Distractibility

By immersing into a different place, the mind can be distracted from physical stimuli in the real world. This concept is being studied and used to diminish pain, as distractibility interferes with the perception of the pain, but

also with the emotional component that usually modulates and amplifies the pain, through complex circuits involving the anterior cingulate cortex (Gîrlescu et al., 2020), the thalamus, the insula and the primary and secondary somatosensory areas. Hoffman et al. (2007) showed in a small sample study, but with data obtained from fMRI, that using VR or combining it with opioids, decreased the intensity of the pain in comparison with no treatment or with opioids alone. Furthermore, the higher the graphical quality of the VR headset used, the deeper the immersivity and the more important the analgesic effect obtained with VR distractibility (Hoffman et al., 2004).

Using VR concepts to treat

Through the distractibility it can induce, virtual reality has found its applicability successfully, in the case of veterans with grade II and III burns, for whom virtual reality has led to a massive decrease in the required doses of morphine-type analgesics, especially during the painful wound care procedures (Maani et al., 2011). Also, it was successfully used as a distraction method in the rehabilitation of pediatric patients with burns, with a significant decrease in pain intensity and stress (Ali et al., 2021).

In the last 2 years, virtual reality has entered dentists' offices for the first time (Wiederhold et al., 2014), as well as urological medical guidelines, being used as a first-line technique in providing anesthesia in endourethral microsurgical interventions, to the liking of anesthesiologists - by comparison with conventional surgical techniques that required analgesia and complete anesthesia (Alaterre et al., 2020, Luca, Baroiu et al., 2020).

At the same time, virtual reality finds its applicability in a variety of techniques designed to educate or improve the disabling symptoms of psychiatric disorders. The fastest results can be obtained through VRET techniques - or gradual exposure in virtual reality, thus giving the patient a new dimension - vivid enough to provoke the defensive reaction, but safe enough not to paralyze in the face of exploration of various forms of anxiety (e.g. acrophobia, agoraphobia, arachnophobia etc.), being used by Rothbaum since 1995 (Rothbaum et al., 1995).

Exposure to stimuli, exploring the whole world for a patient with dementia, even immobilized in bed, or engaging in physical activity, increases the positive antioxidant effect on the population practicing the same exercise routines outside the helmet, visible by lowering the level of reactive species of oxygen determined in the blood.

Semi-immersive VR techniques have been used successfully in patients with dementia or minor neurocognitive impairment and could therefore be a practical guide for patients with cognitive decline (Kim et al., 2019).

A systematic review by Segawa et al. (2020) showed that there is growing evidence that VR is effective in the treatment of both substance use disorders and behavioral addiction (nicotine, alcohol, cannabis, cocaine, gambling), especially for inducing a very vivid craving effect, in a controlled environment, but could also play an important role in its extinction by exposure therapy.

The SARS-COV2 pandemic has found the gambling industry adapting, while gambling was not affected by the lockdown, as it moved towards virtual mobile devices. The possibility to gamble using a virtual reality (Sandu & Nistor 2020) headset is frightening, as the protective measures of banning a person considered pathological gambler are not feasible anymore.

But presence itself may turn virtual reality into a pornographic rollercoaster, as researchers determined that the level of perceived interaction is directly proportional with the level of salivary oxitocine secreted, therefore the potential for addictive pornography through virtual reality reaches new, unexplored borders (Dekker et al., 2020; Sandu, 2020a; 2020b).

Contraindications and side effects of VR therapy

The main relative contraindication is cybersickness or induced vertigo (Weech et al., 2019). Also, seizures triggered by photic stimulation are commonly mentioned and included in the warnings of most consumer headsets and are an absolute contraindication (Pandita & Stevenson Won, 2020). The only visible limitations are practically given by the cost of the equipment and of the software, respectively, and, even more so, by the professionals' availability to get out of the comfort zone in order to adopt these techniques.

Depersonalization / Derealization and Dissociative disorders

The immersivity leads to various degrees of a specific side effect of virtual reality – *a depersonalization and derealization syndrome*, characterized by a feeling of detachment from itself and the real world. This can have different degrees of manifestation, from mild symptoms of fatigue, daydreaming or headache to true chronic dissociative disorders (Heydrich et al., 2019). A small sample study of 30 participants by Aardema et al., showed by using

different scales to quantify the depersonalization/derealization symptoms, that preexisting dissociative symptoms increase their intensity in the virtual environment, but time of exposure may play an important role in their appearance (Aardema et al., 2010). People suffering from depression or anxiety are more likely to develop these symptoms and also, disfunction of the left temporal lobe could be a risk factor for exacerbating underlying depersonalization symptoms (Lambert et al., 2002).

As technological progress facilitates access to VR and opens the viability of automated exposure (without human contact), the dissociative symptoms induced by virtual reality exposure need to be under the radar of the scientific world, in order to prevent unwanted depersonalization and derealization events. As more data emerge, the possibility of including dissociative disorders as a warning in the consumer headsets instruction book may prove beneficial in order to counter this unwanted side effect. Furthermore, a dissociative disorder scale may need to be applied by researchers.

The *addictive potential* of virtual reality games is nonetheless amplified by the perspectives of online gaming. The users have a hard time detaching from the virtual environment, as their perception of reality is mostly abolished, but their sense of bonding is amplified by multiplayer game scenarios.

Virtual reality – a blue light source

Circadian rhythm perturbation and even jet lag may be encountered with prolonged exposure to blue light (Kim et al., 2018). Aside from eye strain induced by blue light spectrum (450-480 nm) exposure (Porcar et al., 2016), the suppressing of melatonin and increased alertness (Cajochen et al., 2005) may determine circadian rhythm perturbation and even jet lag may be encountered with prolonged exposure, although the effects are hard to measure.

The development of Organic Light-Emitting Diode (OLED) lens with newer V.R. headsets instead of the older liquid crystal display/led emitting display (LCD/LED) lens diminish in theory the level of blue light emitted, but the fact that a head mounted display engulfs the user delivering it straight to the retina has not been researched.

Impact of the SARS-COV2 pandemic

The COVID-19 pandemic has locked people indoors and set workplace and school lectures online, therefore increasing the risk of

developing a form of digital addiction (Luca, Burlea et al., 2020). Furthermore, isolating people increased the chances of developing social anxiety (Sandu & Damian, 2018) in what should be the mental health aftermath of this pandemic. The scientific world managed to survive through virtual conferences which already have strict standards (Sandu 2020c), and probably the hybrid manner (real presence + virtual presence) will continue to be accepted even after the pandemic finally ends (Luca, Ciubara et al., 2020).

Worldwide, people are more open to buying virtual assets, virtual coins manage to replace traditional values such as precious metals, challenging the fundamentals of economy itself. Virtual reality gaming is now on the edge of a major leap, as most of the already abused online gaming industry offers the perspective of an even more addictive environment through virtual reality, and some are even targeted at the V.R. consumer.

Conclusions

In the century where time has become, perhaps, the most important resource, we are witnessing the emergence of new reality techniques designed to facilitate and enhance the therapeutic process of patients with various psychiatric disorders, ensuring good cost-effectiveness and especially having a significant therapeutic impact.

The very characteristics that make virtual reality a valuable tool may prove harmful, through its addictive potential and its risk of inducing/exacerbating dissociative disorders. Mental health professionals should develop means to weigh these side effects and place a strict border between using virtual reality as a therapeutic tool and promoting an addiction.

References

Aardema, F., O'Connor, K., & Cote, S. (2010). Virtual reality induces dissociation and lowers sense of presence in objective reality. *Cyberpsychology, Behavior and Social Networking, 13*(4), 429-435. https://doi.org/10.1089/cyber.2009.0164

Alaterre, C., Duceau, B., & Sung Tsai, E. (2020). Virtual reality for peripheral regional anesthesia (VR-PERLA Study). *Journal of Clinical Medicine, 9*(1), 215. https://doi.org/10.3390/jcm9010215

Ali, R. R., Selim, A. O., & Abdel Ghafar, M. A. (2021). Virtual reality as a pain distractor during physical rehabilitation in pediatric burn. *Burns*. https://doi.org/10.1016/j.burns.2021.04.031

Botella, C. (2017). Virtual reality and other realities. In S. G. Hofmann & G. J. G. Asmundson (Eds.), *The science of cognitive behavioral therapy* (pp. 551–590). Academic Press.

Cajochen, C., Munch, M., Kobialka, S., Krauchi, K., Steiner, R., Oelhafen, P., Orgul, S., & Wirz-Justice, A. (2005). High sensitivity of human melatonin, alertness, thermoregulation, and heart rate to short wavelength light. *The Journal of Clinical Endocrinology and Metabolism, 90*(3), 1311–1316. https://doi.org/10.1210/jc.2004-0957

Dekker, A., Wenzlaff, F., Biedermann, S. V., Briken, P., & Fuss, J. (2020). VR porn as "empathy machine"? Perception of self and others in virtual reality pornography. *The Journal of Sex Research, 58*(3), 273-278. https://doi.org/10.1080/00224499.2020.1856316

Gîrlescu, N., Hunea, I., Diac, M., Damian, S-I., Knieling, A., & Bulgaru-Iliescu, D. (2020). Cerebral Oedema in Diabetic Ketoacidosis. *BRAIN. Broad Research In Artificial Intelligence And Neuroscience, 11*(1), 32-43. http://dx.doi.org/10.18662/brain/11.1/13

Heydrich, L., Marillier, G., & Evans, N. (2019). Depersonalization- and derealization-like phenomena of epileptic origin. *Annals of Clinical and Translational Neurology, 6*(9), 1739–1747. https://doi.org/10.1002/acn3.50870

Hoffman, H. G, Richards, T. L., & Oostrom, T. V. (2007). The analgesic effects of opioids and immersive virtual reality distraction: Evidence from subjective and functional brain imaging assessments. *Anesthesia and Analgesia, 105*(6), 1776 –83. https://doi.org/10.1213/01.ane.0000270205.45146.db

Hoffman, H. G., Sharar, S. R., & Coda, B. (2004). Manipulating presence influences the magnitude of virtual reality analgesia. *Pain, 111*(1), 162– 168. https://doi.org/10.1016/j.pain.2004.06.013

Kim, C., Yoon, H. C., Kim, D. H., & Do, Y. R. (2018). Spectroscopic influence of virtual reality and augmented reality display devices on the human nonvisual characteristics and melatonin suppression response. *IEEE Photonics Journal, 10*(4), 1-11. https://doi.org/10.1109/jphot.2018.2842124

Kim, O., Pang, Y., & Kim, J. H. (2019). The effectiveness of virtual reality for people with mild cognitive impairment or dementia: A meta-analysis. *BMC Psychiatry, 19*(1). https://doi.org/10.1186/s12888-019-2180-x

Lambert, M. V., Sierra, M., & Phillips, M. L. (2002). The spectrum of organic depersonalization: A review plus four new cases. *The Journal of Neuropsychiatry and Clinical Neurosciences, 14*(2), 141-154. https://doi.org/10.1176/jnp.14.2.141

Luca, L., Baroiu, L., Ciubara, A. B., Anghel, R., Bulgaru-Iliescu, A. I., Anghel, L., & Ciubara, A. (2020). Covid-19 and the Spanish Flu. From suffering to resilience, BRAIN. Broad Research in Artificial Intelligence and

Neuroscience, 11(3S1), 01-07. https://doi.org/10.18662/brain/11.3sup1/116

Luca, L., Burlea, S. L., Chirosca, A. C., Marin, I. M., Ciubara, A. B., & Ciubara, A. (2020). The FOMO syndrome and the perception of personal needs in contemporary society. *BRAIN. Broad Research in Artificial Intelligence and Neuroscience, 11*(1S1), 38-46. https://doi.org/10.18662/brain/11.1sup1/27

Luca, L., Ciubara, A. B., Fulga, I., Burlea, S. L., Terpan, M., & Ciubara, A. M. (2020). Social implications for psychiatric pathology of depressive and anxiety disorders, alcohol addiction and psychotic disorders during the COVID-19 pandemic in Romania. Analysis of two relevant psychiatry hospitals. Revista de Cercetare si Interventie Sociala, 69, 261-272. https://doi.org/10.33788/rcis.69.16

Luca, L., Ciubara, A., Ciubara, A. B., Chirosca, A. C., & Sarbu, F. (2019). Youth perceptions towards psychiatry. *European Psychiatry, 56*, S464-S464.

Maani, V. C., Hoffman, H. G., & Morrow, M. (2011). Virtual reality pain control during burn wound debridement of combat-related burn injuries using robot-like arm mounted VR goggles. *Journal of Trauma: Injury, Infection and Critical Care, 71*(1), 125-30. https://doi.org/10.1097/ta.0b013e31822192e2

Miller, H. L., & Bugnariu, N. L. (2016). Level of immersion in virtual environments impacts the ability to assess and teach social skills in autism spectrum disorder. *Cyberpsychology, Behavior, and Social Networking, 19*(4), 246 – 256. https://doi.org/10.1089/cyber.2014.0682

Pandita, S., & Stevenson Won, A. (2020). Clinical applications of virtual reality in patient-centered care. In J. Kim & H. Song (Eds.), *Technology and health* (pp. 129-148). Academic Press.

Porcar, E., Pons, A. M., & Lorente, A. (2016). Visual and ocular effects from the use of flat-panel displays. *International Journal of Ophthalmology, 9*(6), 881–885. https://doi.org/10.18240/ijo.2016.06.16

Rothbaum, B. O., Hodges, L. F., & Kooper, R. (1995). Effectiveness of computer-generated (virtual reality) graded exposure in the treatment of acrophobia. *American Journal of Psychiatry, 152*(4), 626-628. https://doi.org/10.1176/ajp.152.4.626

Sandu, A. (2020a). Pandemic - Catalyst of the Virtualization of the Social Space. *Postmodern Openings, 11*(1Sup2), 115-140. https://doi.org/10.18662/po/11.1sup2/146

Sandu, A. (2020b). Bioethics – Philosophy or Science?. *Logos Universality Mentality Education Novelty: Philosophy & Humanistic Sciences, 8*(1), 44-60. https://doi.org/10.18662/lumenphs/8.1/35

Sandu, A. (2020c). The Principles of Bioethics and their Use in Ethical Decision-Making. *Logos Universality Mentality Education Novelty: Social Sciences, 9*(1), 139-154. https://doi.org/10.18662/lumenss/9.1/39

Sandu, A., & Damian, S-I. (2018). Perceived quality of life and responsibility for own health condition. Micro-research. *Archiv Euromedica, 8*(2), 18-23. http://journal-archiveuromedica.eu/archiv-euromedica_02_2018/PAGES_archiv_euromedica_02_2018_maket_27_12_2018-18_23.pdf

Sandu, A., & Nistor, P. (2020). Digital Dementia. *Eastern-European Journal of Medical Humanities and Bioethics*, *4*(1), 1-6. https://doi.org/10.18662/eejmhb/4.1/22

Segawa, T., Baudry, T., Bourla, A., Blanc, J. V., Peretti, C. S., Mouchabac, S., & Ferreri, F. (2020). Virtual reality in assessment and treatment of addictive disorders: A systematic review. *Frontiers in Neuroscience, 13*, 1409. https://doi.org/10.3389/fnins.2019.01409

Servotte, J. C., Goosse, M., & Campbell, S. H. (2020). Virtual reality experience: Immersion, sense of presence, and cybersickness. *Clinical Simulation in Nursing, 38*, 35–43. https://doi.org/10.1016/j.ecns.2019.09.006

Sherman, W. R. , & Craig, A .B. (2019). Introduction to virtual reality. In B. A. Barsky (Ed.), *Understanding virtual reality* (pp. 4-58). Morgan Kaufmann Publishers.

Weech, S., Kenny, S., & Barnett-Cowan, M. (2019). Presence and cybersickness in virtual reality are negatively related: A review. *Frontiers in Psychology, 10*, 158. https://doi.org/10.3389/fpsyg.2019.00158

Wiederhold, M. D., Gao, K., & Wiederhold, B. K. (2014). Clinical use of virtual reality distraction system to reduce anxiety and pain in dental procedures. *Cyberpsychology, Behavior, and Social Networking*, *17*(6), 359–365. https://doi.org/10.1089/cyber.2014.0203