39. THE IMPACT OF VIRTUAL REALITY ON THE HUMAN BRAIN AND COGNITIVE PROCESSES

Rybak D.V.

Belarusian State University of Informatics and Radioelectronics
Minsk, Republic of Belarus

Liakh Y.V. – Senior Lecturer

This paper gives the review of the use of the influence of virtual reality technologies on the human brain and cognitive processes in neuroscience, surgery and cognitive psychology, as well as in the diagnosis, research and treatment of human health disorders.

In recent years, virtual reality (VR) has been actively used in the entertainment industry. However, virtual reality also offers great opportunities for scientific research and public health. Virtual reality technologies are now actively developing and are widely used in various fields of science, technology, medicine, education and everyday life, as well as a way of teaching high-risk professions. For example, VR can help manufacturers launch virtual tests before they build prototypes. Doctors are able to study the insides of their patients' bodies in details. And people who try to learn something new or become more familiar with something that is complicated may find VR helpful and fun.

The results of research to date demonstrate that virtual reality technologies can have both positive and negative effects on the physical and psychological state of a person.

The currently existing VR systems can be divided into two major classes: desktop VR and immersion VR.

Desktop VR: submergence in VR – through a "window" (computer screen); interaction with VR – control of a body part or object through a controller (mouse, joystick, gyroscope, glove); VR view - from the first or third person.

Immersion VR: submergence in VR – full interactive immersion (VR helmet); interaction with VR – with a glove or suit, sometimes with tactile feedback; VR view – only from the first person.

The allocation of other types of virtual worlds may vary depending on the scope of VR technology.

In psychology and psychiatry, the claim about the effectiveness of VR technologies in the treatment of attention problems, inhibition, memory loss and even dementia, blocking communication, various psychological traumas, etc. has not been disputed for a long time. The more detailed the study of the virtual space the higher the effectiveness of therapy.

Based on the results of a number of neuroscientific studies, researchers and clinicians point out that diagnostic tests using the VR environment have high accuracy, sensitivity and specificity in identifying various dysfunctions and/or deficits in examining subjects with serious illnesses such as neurodevelopmental disorders, schizophrenia spectrum, mood, anxiety, trauma- and stressor-related disorders, neurocognitive and neuromuscular disorders. Moreover, VR environments can be not only a diagnostics tool, but also an effective (neuro) therapeutic method. In addition, VR systems are increasingly being incorporated into the study of natural aging processes and the estimation of effective support in (neuro) geriatric care [1].

Immersion in the VR information environment can also lead to negative consequences. Dependence on overstimulation, on exorbitant stimuli, and, in general, on VR technologies may form. It is important to monitor the content of VR programs. They should not include destructive or antisocial components. These programs should be eco-friendly, that is, correspond as much as possible to the natural functioning of a person's sensory organs, their mental health. It is necessary to provide each subject with full-fledged information about virtual reality, technologies of its functioning, influence on mental health. It is also necessary to provide for the preparation of the individual for interaction with the virtual environment.

An important feature of the therapy process using VR technologies is the possibility of safe human interaction with a threatening object of the real environment. In modern psychology, the directions using virtual reality include VRET, CCBT, VRH and VR-SCT.

VRET (virtual reality exposure therapy) that works with problems of fears and pain is becoming popular for therapeutic purposes in modern psychology. VRET is an altered form of behavioral therapy. When implementing VRET, the patient is immersed in a virtual environment with maximally realistic graphics and appropriate sound. A person, plunging into VR, contacts in the safest mode for themselves with an object or phenomenon that frightens them, learns to use relaxation exercises at the moment of fear, controls the degree of exposure to a threatening object. In a virtual environment, patients are gradually exposed to negative stimuli until desensitisation occurs and they are able to cope with their fear or anxiety. M. Gerardi and his collaborators explored the possibilities of VRET in treatment of PTSD (Post-traumatic stress disorder). In his experiments, he studied the therapeutic possibilities of “The Virtual Iraq” program for the treatment of patients who had participated in military operations in the past [2]. VRET can be considered as an alternative to behavioral or cognitive-behavioral therapy in its classical application, since there is usually no significant difference between the received treatment outcomes [3]. The advantage of VRET is also the fact that it has the results stability over time. At the same time, VRET is extremely sensitive to any technological disruptions and interference, it requires strict clarity and extreme accuracy in conducting. Without a rich sense of presence, the advantages offered by VRET disappear and its ability to induce vivid emotional experiences significantly decreases, demonstrating indicators even lower than after reading a text or listening to an audio recording.

Virtual therapy finds wide application possibilities in the context of rehabilitation activities after physical or psychological injuries.

VR is also used in CCBT (Computerized Cognitive Behavioral Therapy). Data have been obtained confirming the high possibilities of its use in the treatment of a number of anxiety and eating disorders, insomnia and depression.

K. Brian and his colleagues studied the possibilities of using CCBT in the treatment of drug addiction. In their study, participants underwent standard treatment in combination with work in the framework of interactive multimedia computer training. The computer training program consisted of six lessons: understanding and changing the structure of psychoactive substance use; methods of combating the desire to use drugs; refusal to offer drugs and alcohol; problem-solving skills; identifying and changing thoughts about drugs and alcohol; improving decision-making skills. Each lesson was designed for about 45 minutes, including homework, and was available in any order. If desired, participants could pass the same lesson several times. CCBT has shown stable and significant results in patients' recovery, moreover, it has proved to be more effective compared to standard cognitive behavioral therapy [4].

VRH (virtual reality hypnosis) has become widely used in pain therapy. VRH is implemented by providing patients with audio recordings of hypnotic suggestion of pain relief, and then it gradually immerses the participant in the virtual world.

Virtual reality technologies are also being used to treat people with eating disorders. With the help of VR, a doctor can determine which stimuli, social situations and contexts are difficult to manage in the real world and which stimuli lead to destructive eating behavior, increased anxiety or negative emotional experiences. As proper eating behavior develops, new objects and scenarios can be introduced into the virtual environment.

VR-SCT (Virtual Reality Social Cognition Training) has a high therapeutic significance. Thus, studies devoted to improving social skills, social cognition and social functioning of patients diagnosed with autism have confirmed its high effectiveness.

The subjects participated in therapy consisting of 10 sessions performed every 5 weeks. The experiment was conducted using the Second Life ™ program. Avatars representing the user in the virtual world outwardly resembled each participant of the study and the trainer. The subjects mastered various social scenarios as they worked with the program. Social scenarios were constructed in such a way that participants could gain experience of interacting with people in various situations, for example, meeting new people, conflict with a roommate, conducting business negotiations, job interviews, etc. [5].

Brain injury often leads to anxiety, depression, emotional lability, and mood swings. Medication with antidepressants or mood stabilizers could be potentiated by emotional rehabilitation that helps the patient overcome the pain of loss and return to a more stable, healthier place [6].

Currently, on the basis of VR gaming technologies, rehabilitation complexes designed for motor rehabilitation in a virtual environment are being developed and put into practice. Such systems are based on an infrared sensor Microsoft Kinect, capturing the movements of the patient's body and broadcasting them into a virtual environment.

The use of VR allows for a reproducible, objective assessment of cognitive processes underlying attention, memory, information processing, logical sequencing, and problem-solving. The stimulating effect of VR on the human mind is highly beneficial for cognitive rehabilitation.

In conclusion it should be mentioned that virtual reality as a therapeutic tool is rarely used in practice. The reluctance to use this technology is due to insufficient preliminary training of specialists, the lack of necessary equipment for its implementation, and significant financial costs for this. This technology is still a scientific development, implemented mainly in scientific and practical centres and research laboratories.

References:

1. Impact of Virtual Reality Cognitive and Motor Exercises on Brain Health [Electronic resource]. ─ Mode of access: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC10002333/ ─ Date of access: 19.03.2023.

2. Gerardi M., Rothbaum B., Ressler K., Heekin M. Virtual Reality Exposure Therapy Using a Virtual Iraq: Case Report // Journal of Traumatic Stress. — 2008. — № 21(2). — P. 209—213.

3. Opriş D., Pintea S., García-Palacios A., Botella C., Szamosközi Ş, David D. Virtual reality exposure therapy in anxiety disorders: a quantitative meta-analysis // Depress Anxiety. — 2012. — № 29(2). — P. 85—93.

4. Brian K., Charla N., Theresa B., Kathleen C. Quality vs. Quantity: Acquisition of Coping Skills Following Computerized Cognitive Behavioral Therapy for Substance Use Disorders // Addiction. — 2010. — 105(12). — P. 2120—2127.

5. Kandalaft M., Didehbani N., Krawczyk D., Allen T., Chapman S. Virtual Reality Social Cognition Training for Young Adults with High-Functioning Autism // J Autism Dev Disord. — 2013. — 43(1). — P. 34—44.

6. Virtual Reality for Neurorehabilitation and Cognitive Enhancement [Electronic resource]. ─ Mode of access: https://www.mdpi.com/2076-3425/11/2/221. ─ Date of access: 19.03.2023.

7. Huber T., Paschold M., Hansen C., Wunderling T., Lang H., Kneist W. New dimensions in surgical training: immersive virtual reality laparoscopic simulation exhilarates surgical staff. Surg Endosc. https://doi.org/10.1007/ s00464-017-5500-6. Epub 2017 Apr 4.