Datsun O., Demchenko N.

FEATURES OF THE PREVENTION OF EMOTIONAL BURNOUT OF TEACHERS BY ART THERAPY IN THE CONDITIONS OF WAR

Abstract

The article considers one of the actual scientific and practical problems of modern psychological science – prevention of emotional burnout of teachers in war conditions. Ensuring the effectiveness of the process of educational and pedagogical interaction is possible only on condition of preserve of the mental health of all its participants. It is topical in the time of standing of constant stress factors of war. ***The purpose*** *of the study: to develop new methods of prevention of emotional burnout of teachers by means of art therapy. The following* ***research methods*** *were used to solve the set tasks: analysis of scientific literature; online poll; performance of tasks for reflection, analysis of products of activity of pupils at performance of the developed individual tasks.* ***Results****: based on the empirically analysis the putting hypothesis was confirmed that most teachers have a feeling of emotional burnout during the war. The specifics of workload of teaching activities often do not motivate to detailed study of specifics of the display of one's own emotional state, at the same time they have a desire immediately go to stage of receiving psychological help as classes for the prevention and correction of emotional burnout among teachers. For prevent of emotional burnout among teachers, we have developed a corrective program using art therapy materials. Working conditions during martial law require the search for simple and effective methods for creating new methods. In our opinion, these are the «Methodology of spontaneous drawing using edible materials «Tree», the technique «Spot» and «Thoughts about autumn» developed by us.* ***Conclusions****: it is empirically confirmed that in the conditions of war, most teachers experience emotional burnout. The proposed methods of prevention of emotional burnout among teachers can be recommended for use in complex programs of correction and prevention of emotional burnout.*

Key words*: emotional burnout; emotional burnout during the war; methods of art therapy; prevention of emotional burnout among teachers*

DOI
УДК 159.938.26

A. Kurapov, O. Dubynskyi, O. Balashevych, H. Tsurikova

CONTROLLED VERSUS UNCONTROLLED VIRTUAL REALITY: PSYCHOPHYSICAL RESPONSE

Abstract

Virtual reality gains popularity due to its wide range of applications, starting with entertainment and ending with a whole set of educational programs. It surely has its positive sides and drawbacks. ***The current study focuses*** *on the evaluation of the psychophysical response to the ability to control and manipulate virtual reality. It also focuses on the impact virtual reality has on the ability to perform spatial modeling. The study's sample includes 140 participants.* ***The research has form*** *of a classic experiment involving two experimental groups and one control group. While the second experimental group consisted of 40 respondents and could only observe virtual reality without being able to influence their actions in it, the first experimental group consisted of 44 participants who could control their actions in virtual reality (they could move, jump and choose places from which you could look at nature in virtual reality). The control group only passed the proposed tests measuring spatial modeling skills and was not involved in virtual reality. Psychophysical response was measured using a polygraph.* ***The results*** *show that being able to control VR makes the experience more immersive, increasing emotional response and stress, while not being able to control it causes less stress and engagement.* ***The conclusion is*** *that short virtual reality sessions have a positive effect on the ability to perform spatial modeling tasks.*

Key words: *cognitive processes; virtual reality; psychophysical response; spatial modeling*

Introduction. Virtual reality (VR) has achieved widespread application due to its continuous increase in applicability and significant potential for enhancing the way people interact. This technological concept uses electronic devices to create a computerized three-dimensional environment with events and objects that appear real and create an immersive feeling for the user in their surroundings. Beyond the typical gaming applications of fully immersive and non-immersive simulations, VR holds considerable potential, such as semi-immersive simulations in educational and training purposes, exposure therapy, and design in the automotive industry. The ability of semi-immersive simulations to design physical environments as suppliers of virtual reality enhances this application. Despite the remarkable potential VR has, mishandling of the technology can result in remarkable adversities. Health concerns and injuries are the primary challenges VR faces. Another major challenge is the inability to control VR, especially in fully immersive simulations, with considerable control among non-immersive and semi-immersive simulations. This challenge has evoked various assumptions among people regarding the differences between controlled and uncontrolled VR, including discrediting non-immersive simulation as a VR category. Exploring the difference between controlled and uncontrolled VR is essential to developing approaches in which people can react to the ability and inability to control VR.

Technological innovations like virtual reality have remarkable effects on their fields of application, and users should comprehensively understand various concepts surrounding their applicability. Controlled and uncontrolled VR are among the essential concepts in this technology, and several speculations regarding their differences cause different assumptions among VR researchers. Applying implications from these conclusions can cause remarkable adversities among users, especially patients undergoing VR-related clinical intervention. Haar, Sundar, and Faisal (2021) report that VR is among the methodological variables that help people control and maneuver their surroundings, but there is significant ambiguity regarding manipulating the technology. An example of such issues surrounds the puzzle of whether motor learning in VR transmits to the typical world. Keshner and Lamotgane (2021) add that this ambiguity eliminates the consideration of the user's motor ability during the designation of VR devices. Some researchers, like Tanjung et al. (2020), argue that the inclusion of control devices that use finger and hand motion in VR technology enhances interaction in the system by guaranteeing the user considerable control. Keshner and Lamogante (2021) provide a counterargument to such findings, claiming that the user still experiences uncontrollable perceived self-motion, creating a challenge that hinders the interpretation of numerous sensory inputs. The ambiguity regarding VR control ability among various researchers shows inconsistency in the existing research findings, suggesting a need to explore the topic.

Additional diversity in perspectives among researchers regarding humans' ability and inability to control VR systems and the resultant psychophysiological reactions to VR stimuli enhances the demand to distinguish between controllable and uncontrollable VR. Sousa et al. (2021) argue that the user moves several body parts in active VR (AVR), while a sedentary VR (SVR) user only moves their fingers as they experience interacting with the computer-generated environment. The researchers argue that the user has less control in AVR than in SVR, but the former allows the user increased participation, such as mastery, role-playing, innovation, and physical body motion (Sousa et al., 2021). Tanjung et al. (2020) suppose that using VR control tools promotes interactivity within VR and that the user has considerable control of the system. Other body movements like nodding, pointing, grasping, and loosening the grip represent remarkable psychophysiological stimuli (Tanjung et al., 2021). The two studies support contrasting ideas since the former shows a considerable psychophysiological response in AVR with little reaction in SVR, while the latter depicts dependable feedback to SVR stimuli.

The significant contrast among the findings on the differences between controllable and uncontrollable VR, and the resultant psychophysiological reactions lead to the aim of the current study. The present research aims to identify the differences in psychophysiological responses to controlled and uncontrolled VR stimuli. Notably, VR has remarkable potential, such as promoting the intervention of several disorders, but healthcare researchers require credible evidence to apply the technology comprehensively. Achieving the aim will follow various objectives, including conducting an experimental design with two experimental groups and a control group, discussing the experiment's results' analysis, and deriving helpful conclusions regarding the findings' applicability. Realizing the study's aim will improve insight into the literature regarding psychophysiological responses to VR stimuli and enhance its usage in respective fields.

Recently, VR has gained widespread usage, and users apply it in other fields beyond playing games. Tanjung et al. (2020) report that this usability has motivated researchers to explore the technology extensively and develop control approaches to enhance interactivity in VR. These control techniques include promoting head and body motion, using hands to perform activities like pointing, grasping, and loosening grips (Tanjung et al., 2020). Keshner and Lamontagne (2021) report that VR develops computerized environments containing virtual objects of the typical world or an entirely unnatural digital environment. The user's presence and immersion in the digitalized environment lead them to believe in the surrounding reality (Tcha-Tokey et al., 2018). Resultantly, the user interprets several sensory inputs with the neural amalgamation of visual signals, vestibular gestures, and proprioceptive indications, causing perceived self-movement. Keshner and Lamontagne (2021) add that humans must associate sensory information with the motion context, assess the presence of a link between the visual movement and their vestibular reception, and design their motion to ultimately meet the environment's demands. This necessity demands considerable control of the digital environment. Researchers have prevalently explored controllable VR to develop more control approaches and promote its usability in meeting the environment's requirements.

Some researchers have assessed the argument between humans' ability and inability to control VR, providing suggestions to explain controllable and uncontrollable VR. Penn and Hout (2018) report that VR creates a digital environment where the user views it as the typical world, leaving them little doubts about the physical inexistence of their perceived surroundings. Penn and Hout (2018) add that in an immersive VR environment, the user experiences a virtual world similar to their experience in the real world, believes their existence in it, or feels like a member of the virtual environment. Users control the VR environment when they can identify the differences between the virtual world and the real world, but they lose control with the erosion of this differentiation ability. Sousa et al. (2021) approach VR controllability from a different perspective, using immersion levels to define the concept. According to Sousa et al. (2021), a user cannot control the VR environment in active VR but not in sedentary VR. The two studies base controlled and uncontrolled VR on the user's ability to interact with the virtual environment while maintaining consciousness of the real world.

The remarkable potential of VR in clinical intervention has invited healthcare researchers to explore the concept of controlled and uncontrolled VR. According to Jahn et al. (2021), developing an entirely controlled and secure VR environment creates credible conditions for cognitive rehabilitation among patients enduring neuropsychiatric disorders by enhancing multimodal surroundings that resemble the patients' everyday lives. Jahn et al. (2021) insist that generating a real-life environment demands fully immersive VR, but contemporary literature has only limitedly explored the application of fully immersive VR in cognitive intervention approaches. Arguably, Jahn et al. (2021) defy the reference to fully immersive VR as uncontrollable, supporting any secure and controlled VR environment, including control by external individuals, as controllable. Kim and Lee (2020) lean on the human's ability to manipulate a VR environment and its constituents as the controllability of VR. This approach leads Kim and Lee (2020) to suggest that controlling VR depends on the user's ability to control graphic contents in the virtual environment and express their motion. Reasonably, literature from medical research regarding controllable and uncontrollable VR extensively asserts that the former includes safe and controlled VR environments, while the latter involves any unsafe, unmanageable, and inexpressible VR environments.

Understanding the difference between controlled and uncontrolled VR is essential in exploring the user's sense of agency when assessing the psychophysical responses to VR stimuli. According to Aoyagi et al. (2021), the sense of agency is the person's feeling of supremacy and responsibility for their actions and other happenings in their environment. Aoyagi et al. (2021) claim that the sense of agency has a remarkable influence on several behavioral elements, including consciousness, recognition, and decision-making. Notably, VR causes a coupling of perception and action where the user moves relative to the virtual environment. This coupling generates an optical flow sequence that progressively monitors the user's forces to modulate successive motions in any environment (Keshner and Lamontagne, 2021). A person's perception of environmental information influences their organization and execution of actions, suggesting a powerful relationship between an individual's sense of agency and the VR environment. Aoyagi et al. (2021) claim that a person is likely to take longer before pursuing an action when they feel in control. More recent findings have inspired researchers to elevate their regard for the sense of agency as an awareness complement of motor control to a concept with a direct effect on motor control (Aoyagi et al., 2021). VR creates a digital environment that affects the user's sense of agency, and exploring these two concepts can effectively explain the user's reaction to the VR stimuli.

People have responded directly to the simultaneous ability and inability to control VR, including extensive arguments between its usability and adverse effects. A study by Radianti et al. (2019) depicted that VR has considerable promising potential with widespread ready reception of the technology in several disciplines in higher education. The researchers add that VR has several unexplored elements that can remarkably enhance future applications (Radianti et al., 2019). Shweizer et al. (2018) report that standardized VR enhances the experimental control and modulation of different variables in complex incidents, enhancing clinical interventions. This application has notable limitations due to the uncovered aspects regarding controlled and uncontrolled VR. According to Nelson et al. (2020), philanthropic fundraisers have reported that VR evokes empathy and influences people to engage in pro-environmental habits. Reasonably, VR immerses users in a digital environment, preventing any visual distractions. Nelson et al. (2020) argue that this practice can have both positive and negative effects, and its usage needs further exploration. Moreover, Lavoie et al. (2021) insist that VR applications, including controllable aspects like gameplay, can elicit undesirable emotional reactions among users. Arguably, controlled VR has positive and negative results, while most uncontrollable VR environments pose threats, and both sectors remain underexplored.

Users experience informative psychophysiological reactions to VR stimuli, but many researchers have considerably ignored this topic. According to Marín-Morales et al. (2019), there is existing literature comparing the responses physical environments and their virtual simulations invoke in the users' psychological capabilities, but physiological and behavioral reactions have achieved limited coverage. Marín-Morales et al. (2019) argue that VR is a powerful technology for studying human behavior, but researchers have remarkably overlooked the innovation's ability to arouse physiological and emotional reactions among real-life users. Schweizer et al. (2018) report that VR helps experimental regulation and modulation of different variables in complex circumstances. The current VR application enables the recording of stress reactions in real-time and compares them with people enduring stress. This application enhances ecological credibility since the resultant psychophysiological stress reaction compares to real traumatic stress experiences with reduced intensity (Schweizer et al., 2018). VR stimuli cause users to display various psychophysiological reactions that compare to real-time events, and this concept requires further exploration to verify its environmental dependability.

The user's psychophysiological reactions to VR environments form the foundation of the widespread applicability of the technology, and they vary with the relative environment. Sousa et al. (2021) claim that research from the last two decades has depicted VR technologies, such as active video games, as critical in influencing cognitive and physical performance among users. Despite its insightfulness, this research has only shallowly explored the reasons for varied reactions among different VR environments. Sousa et al. (2021) studied this variance by inducing moderate-to-vigorous physical activity in active VR and sedentary VR and analyzing the results. Notably, active VR involved playing Beat Saber, where participants engaged in whole-body motion, while users in sedentary VR used their fingers to play Thumper while the other body parts remained constant (Sousa et al., 2021). The study showed that active VR users experienced higher heart rates and spent more time in physical activity than sedentary VR participants (Sousa et al., 2021). In addition, active AVR had more imaginative immersion, challenge, and game engagement (Sousa et al., 2021). Gonzalez-Franco and Lanier (2017) report that VR simulation varies, and the external observers use sensors to trail and assess the individual's physical motion and physiological changes. Existing literature proves psychophysiological reactions as critical impacts of VR simulation, and different simulation levels provide varying responses.

Emphasizing the credibility of the VR environment is critical in determining the users' psychophysiological reactions to VR simulations. According to Ruggiero et al. (2021), proxemics researchers argue that VR allows experimenters to modulate the presence and behavior of virtual humans while creating physical alterations that laboratory experiments can hardly support. Marín-Morales et al. (2019) support this argument, arguing that many researchers have developed several computation models in laboratories using controlled stimuli, and the participants' emotional responses vary from real-world scenarios. Ruggiero et al. (2021) add that recent evidence dismisses existing criticism regarding the absence of physical contact. The evidence shows that people treat other individuals in a virtual environment like actual humans (Ruggiero et al., 2021). Moreover, VR provides an ecologically credible and controlled approach to evaluate participants' spatial behavior during social interactivity and validly obtain their psychophysiological responses (Ruggiero et al., 2021). Arguably, VR environmental simulation technologies duplicate the real-world physical environments, overcoming the limitation of lab-controlled stimuli.

Methodology. This study used an experimental design with two experimental groups and one control group. Benedetti, Caponigro, Ardini (2020) define experimental design as a multivariate approach where researchers intend to maximize the ratio between information quality about a specific controlled subject and the effort under scrutiny. Benedetti et al. (2020) add that variables and responses characterize experimental problems. The experimenters can adjust the variables to set values, while the experiment generates the responses as measurable quantities and indicators of its results (Benedetti et al., 2020). The VR stimuli represent the variables in the present study, while the resultant psychophysiological reactions designate the responses. The variable-response nature of this design allows the researcher to establish precise conclusions regarding hypotheses statements, or previous presumptions.

The study is based on the hypothesis that the presence of virtual reality may have an impact on the way people perceive actual reality. Cognitive psychology focuses on understanding how humans represent and process spatial information. While approaching spatial thinking, cognitive psychology considers how people think about space and use space to think. Spatial thinking is a type of mental activity that ensures the creation and manipulation of spatial images while solving practical and theoretical problems. It is important to note that the activity of representation is the principal mechanism of spatial thinking. Two-dimensional (2D) and spatial modeling (3D) tests are designed to measure visual and perceptual abilities together with abstract reasoning. For this purpose, we have used Schulte tables in order to test the speed of the visual search. Two-dimensional (2D) and spatial modeling (3D) tests have been used to measure the ability to reconstruct objects after spending time in virtual reality. The study utilized a standard experimental design with two experimental groups and one control group. Participants spent 30 minutes in virtual reality, and afterwards they were asked to pass the tests to measure their impact.

The study utilized a polygraph to measure various physiological indicators among participants and determine their psychophysiological responses to the respective VR stimuli. Wang (2020) reports that a polygraph uses sensors, converters, and processors to measure these indicators. Modern polygraphs have skin conductance, respiration, blood pressure, pulse, and motion sensors. According to Wang (2020), each sensor collects particular analog signals and delivers them to the converter for purification, magnification, and transformation into digital cues. Skin conductance sensors detect ionic activity on the skin due to changes in sweat gland activity, transmitting positive or negative signals. Differently, respiration sensors measure variations in the individual’s chest movement by detecting minute flow rates about their typical respiratory flow point. Blood pressure and pulse sensors measure their respective elements by detecting a ruminative echo from the fore and back of the blood vessel wall and identifying a pulse wave from a device in contact with the skin, respectively. Motion sensors detect minor movements of the examinee, and the motion’s graphic record depicts its intensity. Wang (2020) adds that these sensors have depicted credible results and participants can uneasily control them. The polygraph’s sensors would detect these changes, and magnifying them would show the participant’s physical and cognitive involvement in the VR environment.

Results. The study involved 140 respondents who were divided into three groups by random sampling. The first experimental group (EG 1) consisted of 44 participants who could control their actions in virtual reality (they could move, jump, and select locations where actions could have been performed while visiting the Grand Canyon), while the second experimental group (EG 2) was formed by 40 respondents, and they could only observe virtual reality without having a possibility to impact an ongoing action (visit to Jurassic Park) (Table 1). The control group (CG) did not experience virtual reality and has only passed the proposed tests.

Table 1

Number of Participants Depending on the Group

Number of participants	Frequency	Percent
Controlled virtual reality (EG 1)	44	31.4
Uncontrolled virtual reality (EG 2)	40	28.6
Control group (CG)	56	40.0
Total	140	100.0

Table 2

Number of Men and Women who Took Part in the Experiment

Number of participants	Frequency	Percent
Men	50	35.7
Women	90	64.3
Total	140	100.0

A polygraph and photoplethysmogram were used to scan the electrodermal activity and heart rate of participants. Electrodermal activity is a bioelectric activity measured on the skin's surface. This information is required for the analysis of human states, emotional processes, and intellectual processes. A photoplethysmogram is a method for recording the optical density of the tissue. Hence, it identifies an entire range of changes in the body caused by emotional stress and serves as a reliable indicator of their magnitude during polygraph tests. It is known that photoplethysmography is used to measure heart rate and oxygen saturation.

In order to compare the first and second experimental groups, an independent-samples t-test was used. We obtained a statistically significant difference in the measurement of electrodermal activity for EG1 (M = 8698.4, SD = 16339.7) and EG2 (M = 599.9, SD = 826.0) (Table 3). According to the t-test, t (42) = 2.2, p = 0.33 (Table 4). Given results suggest that controlled virtual reality affects electrodermal activity: when participants are capable of controlling virtual reality, their electrodermal activity increases.

There was no difference in the measurement of the heart rate photoplethysmogram for EG1 (M = 108.1, SD = 19.0) and EG2 (M = 89.3, SD = 16.6) (Table 3). According to the t-test, t (40) = 3.4, p = 0.001 (Table 4).

Table 3

Comparison between Experimental Groups

Group statistics	Experimental Group	Number	Mean	Std. Deviation	Std. Error Mean
Electrodermal activity	Controlled virtual reality (EG 1)	44	8698.4	16339.7	3335.3
	Uncontrolled virtual reality (EG 2)	40	599.9	826.0	184.7
Heart Rate Photoplethysmogram	Controlled virtual reality (EG 1)	44	108.1	19.0	4.0
	Uncontrolled virtual reality (EG 2)	40	89.3	16.6	3.7

Table 4

Results of Independent Samples Test

Independent Samples Test		Levene's Test for Equality of Variances		T-test for Equality of Means						
		F	Sig.	T	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Electrodermal activity	Equal variances assumed	18.4	.00	2.2	42	.033	8099	3664.8	702.7	15494.3
	Equal variances not assumed			2.4	23.1	.024	8099	3340.4	1190.6	15006.4
Heart rate Photoplethysmogram	Equal variances assumed	.3	.57	3.4	40.0	.002	18.8	5.5	7.6	30.0
	Equal variances not assumed			3.4	40.0	.001	18.8	5.5	7.7	29.9

For the purpose of identifying the presence of statistically substantial differences among experimental and control groups, we used the variance analysis regarding the cognitive performance that was measured by the Schulte table, two-dimensional and spatial modeling tests. Levene's test for equality of means showed that the results of the tests were not identical. We obtained [F (4,136) = 3.443, p = 0.037] for two-dimensional (2D) test results, [F (4,136) = 13.271, p = 0.000] for two-dimensional (2D) test time, [F (4,136) = 9.091, p = 0.000] for Schulte table results, [F (4,136) = 7.428, p = 0.001] for spatial modeling (3D) test results, and [F (4,136) = 21.376, p = 0.000] for spatial modeling (3D) test time (Table 5).

Table 5

Comparison between All Groups

Test of Homogeneity of Variances	Levene Statistic	df1	df2	Sig.
Two-Dimensional (2D) test results	3.443	4	136	.037
Two-Dimensional (2D) test time	13.271	4	136	.000
Schulte table results	9.091	4	136	.000
Spatial modeling (3D) test results	7.428	4	136	.001
Spatial modeling (3D) test time	21.376	4	136	.000

Evidence confirms the fact of the difference between the first experimental group (EG 1), the second experimental group (EG 2), and the control group (CG). That implies a major effect of virtual reality on two-dimensional (2D) test results at the significance level of < .05 for the three conditions: [F (4, 136) = 7.2, p = 0.001], two-dimensional (2D) test time [F (4, 136) = 3,1, p = 0.049], Schulte table time [F (4, 136) = 3.8, p = 0.027], spatial modeling (3D) test results [F (4, 136) = 7.0, p = 0.002], and spatial modeling (3D) test time [F (4, 136) = 14.4, p = 0.000] (Table 6).

Table 6

Results of Analysis of Variance

Analysis of Variance		Sum of Squares	Df	Mean Square	F	Sig.	Effect Size
Two-Dimensional (2D) test results	Between Groups	13.1	4	6.6	7.2	.001	.4329
	Within Groups	69.9	136	.907			
	Total	83.0	140				
Two-Dimensional (2D) test time	Between Groups	411086.9	4	205543.4	3.1	.049	.2848
	Within Groups	5069099.9	136	65832.5			
	Total	5480186.8	140				
Schulte table time	Between Groups	1165.0	4	582.5	3.8	.027	.3143
	Within Groups	11795.8	136	153.2			
	Total	12960.8	140				
Spatial modeling (3D) test results	Between Groups	3774.4	4	1887.2	7.0	.002	.4331
	Within Groups	20119.8	136	268.3			
	Total	23894.2	140				
Spatial modeling (3D) test time	Between Groups	1358402.8	4	679201.4	14.4	.000	.6105
	Within Groups	3644160.0	136	47326.8			
	Total	5002562.8	140				

According to the results, the mean score of the two-dimensional (2D) test results for the first experimental group (M = 2.3, SD = 0.74) and the control group (M = 2.6, SD = 1.1) were significantly different from the second experimental group (M = 1.6, SD = 0.82) (Table 7). Furthermore, we identified that the mean score of the spatial modeling (3D) test results for the EG 1 (M = 47.9, SD = 7.9) and the CG (M = 48.0, SD = 22.3) vary from the second experimental group (M = 32.0, SD = 10.8).

Based on these results, it can be concluded that the absence of the ability to control virtual reality affects spatial thinking. Considering this, when participants were in uncontrolled virtual reality, the outcomes of spatial thinking tests diminished. In contrast, participants who were capable of controlling the virtual reality did not have changes in perceiving space.

Table 7

Comparison between Groups

Descriptive data		**N**	**Mean**	**Std. Deviation**	**Std. Error**	**95% Confidence Interval for Mean**		**Min**	**Max**
						Lower Bound	**Upper Bound**		
Two-Dimensional (2D) test results	EG-1	44	2.3	.74	.15	1.94	2.56	1	3
	EG-2	40	1.6	.82	.18	1.22	1.98	1	3
	CG	56	2.6	1.1	.19	2.23	2.99	0	4
	Total	140	2.3	1.0	.12	2.02	2.48	0	4
Two-Dimensional (2D) test time	EG-1	44	410.1	84.4	17.2	374.5	445.7	238	546
	EG-2	40	402.7	164.9	36.9	255.5	409.9	113	683
	CG	56	507.1	354.1	59.0	387.3	626.9	0	1500
	Total	140	446.8	263.4	29.5	375.8	493.0	0	1500
Schulte table results	EG-1	44	38.0	4.8	.974	35.98	40.02	29	45
	EG-2	40	37.3	12.6	2.82	39.41	51.19	26	66
	CG	56	35.9	15.3	2.56	30.69	41.09	0	61
	Total	140	37.0	12.8	1.43	36.02	41.73	0	66
Spatial modeling (3D) test results	EG-1	44	47.9	7.9	1.62	44.57	51.26	35	60
	EG-2	40	32.0	10.8	2.42	26.94	37.06	15	45
	CG	56	48.0	22.3	3.83	40.15	55.73	5	90
	Total	140	43.9	17.6	2.0	39.87	47.82	5	90
Spatial modeling (3D) test time	EG-1	44	312.4	109.4	22.3	266.2	358.6	130	484
	EG-2	40	305.3	112.8	25.2	192.5	298.1	114	432
	CG	56	350.1	298.9	49.8	437.9	640.2	0	1080
	Total	140	325.5	251.6	28.1	341.6	453.6	0	1080

Discussion. Different researchers have varying opinions regarding controlled and uncontrolled VR, depending on their exploration limits, application areas, and study objectives. Most consider fully immersive VR as uncontrollable, where users cannot differentiate the virtual world from the real world and feel like members of their virtual environment. Its counterpart, controllable VR, has received acclaim as being significantly useful, typically through semi-immersive and non-immersive impact. In this type of VR, users realize that they are interacting with the virtual environment. Rising arguments provide different insights, such as equating controlled VR to safe VR, suggesting further research. The results that have been received in this research confirm the ability of VR to act as a factor that enhances the ability to operate spatial modeling.

Obtained results confirm that controlling virtual reality influences electrodermal activity, as an increase in activity was detected when participants were capable of manipulating virtual reality. However, the rise in electrodermal activity acknowledges experiencing stress. The combination of both factors allows us to state that the ability to control virtual reality causes more stress and forces participants to become more engaged in the activity as such. It might be linked to the necessity of being forcedly included in the virtual environment, which is very similar but not identical to the environment participants used to operate in. That is why we cannot state that participants had an adjustment phase. Even though the first group of participants felt more strained, considering the level of electrodermal activity, tests were accomplished more successfully compared to the other groups. It might show that the ability to control virtual reality does not impact the ability to perform spatial modeling outside of virtual reality. More so, results have shown that the ability to control virtual reality increases the ability to perform spatial modeling, meaning that the active presence in the virtual reality may be used as a training method in cases when it is necessary to learn to operate figures in space.

All respondents completed the Schulte table test without mistakes. According to the results, the experimental groups spent more time finishing this test in comparison to the control group. Accordingly, being present in virtual reality for 30 minutes reduced the ability to perform a fast visual search. Nevertheless, presence in virtual reality had general positive effects on spatial modeling that position VR as an effective method of training skills that are directly or indirectly linked to spatial modeling. Overall, short-term VR sessions do not reduce cognitive abilities. The possibility to manipulate virtual reality allows for enhanced manipulation with two- and three-dimensional objects outside of VR, despite the increased stress of being able to manipulate VR.

Conclusion. The aim of the research was the evaluation of the psychophysical response to the ability to control and manipulate virtual reality. The study presents the model of a classic experiment involving two experimental groups and one control group. While the first experimental group, which included 44 participants, could influence their actions in virtual reality, the second experimental group, which included 40 responders, could only observe virtual reality without being able to change an ongoing action (they could move, jump, and choose locations where actions could have been performed). The control group did not experience virtual reality; they simply passed the specified exams. The cognitive performance that was measured by Schulte table, two-dimensional, and spatial modeling tests. The polygraph was used to measure the psychophysical response. According to the experiment, the possibility of manipulating virtual reality makes the experience more engaging by raising the amount of tension and emotional reaction, while being unable to control it makes it less stressful and less interesting.

The presented research confirmed that presence in virtual reality has general positive effects on spatial modeling and shows that VR is an effective method of training skills that are directly or indirectly linked to spatial modeling. Overall, short-term VR sessions do not reduce cognitive abilities. Despite the fact that manipulating VR increases stress, the ability to manipulate virtual reality allows for better manipulation of two- and three-dimensional objects outside of it.

The study took into consideration short VR sessions and did not focus on long VR sessions (more than 40 minutes). Longer sessions might have had an adverse impact on the cognitive abilities of participant.

REFERENCES

Aoyagi, K., Wen, W., An, Q., Hamasaki, S., Yamakawa, H., Tamura, Y., Yamashita, A., & Asama, H. (2021). Modified sensory feedback enhances the sense of agency during continuous body movements in virtual reality. *Scientific Reports, 11*(2553), 1-10. https://doi.org/10.1038/s41598-021-82154-y

Benedetti, B., Caponigro, V., & Ardini, F. (2020). Experimental design step by step: A practical guide for beginners. *Critical Reviews in Analytical Chemistry*, 1-14. https://doi.org/10.1080/10408347.2020.1848517

Gonzalez-Franco, M., & Lanier, J. (2017). Model of illusions and virtual reality. *Frontiers in Psychology*, *8*(1125), 1-8. https://doi.org/10.3389/fpsyg.2017.01125

Haar, S., Sundar, G., & Faisal, A. (2021). Embodied virtual reality for the study of real-world motor learning. *PLOS ONE*, *16*(1), e0245717. https://doi.org/10.1371/journal.pone.0245717

Jahn, F., Skovbye, M., Obenhausen, K., Jespersen, A., & Miskowiak, K. (2021). Cognitive training with fully immersive virtual reality in patients with neurological and psychiatric disorders: A systematic review of randomized controlled trials. *Psychiatry Research*, *300*, 113928. https://doi.org/10.1016/j.psychres.2021.113928

Keshner, E., & Lamontagne, A. (2021). The untapped potential of virtual reality in rehabilitation of balance and gait in neurological disorders. *Frontiers in Virtual Reality*, *2*, 1-16. https://doi.org/10.3389/frvir.2021.641650

Kim, J., & Lee, J. (2020). Controlling your contents with the breath: Interactive breath interface for VR, games, and animations. *PLOS ONE*, *15*(10), e0241498. https://doi.org/10.1371/journal.pone.0241498

Lavoie, R., Main, K., King, C., & King, D. (2021). Virtual experience, real consequences: the potential negative emotional consequences of virtual reality gameplay. *Virtual Reality*, *25*(1), 69-81. https://doi.org/10.1007/s10055-020-00440-y

Marín-Morales, J., Higuera-Trujillo, J., Greco, A., Guixeres, J., Llinares, C., Gentili, C. Scilingo, E., Alcaniz, M., & Valenza, G. (2019). Real vs. immersive-virtual emotional experience: Analysis of psycho-physiological patterns in a free exploration of an art museum. *PLOS ONE*, *14*(10), e0223881. https://doi.org/10.1371/journal.pone.0223881

Nelson, K., Anggraini, E., & Schlüter, A. (2020). Virtual reality as a tool for environmental conservation and fundraising. *PLOS ONE*, *15*(4), e0223631.https://doi.org/10.1371/journal.pone.0223631

Penn, R., & Hout, M. (2018). Making reality virtual: How VR “tricks” your brain. *Frontiers for Young Minds*, *6*, 1-8. https://doi.org/10.3389/frym.2018.00062

Radianti, J., Majchrzak, T., Fromm, J., & Wohlgenannt, I. (2019). A systematic review of immersive virtual reality applications for higher education: Design elements, lessons learned, and research agenda. *Computers & Education*, *147*, 103778. https://doi.org/10.1016/j.compedu.2019.103778

Ruggiero, G., Rapuano, M., Cartaud, A., Coello, Y., & Iachini, T. (2021). Defensive functions provoke similar psychophysiological reactions in reaching and comfort spaces. *Scientific Reports*, *11*(5170), 1-12. https://doi.org/10.1038/s41598-021-83988-2

Schweizer, T., Renner, F., Sun, D., Kleim, B., Holmes, E., & Tuschen-Caffier, B. (2018). Psychophysiological reactivity, coping behaviour and intrusive memories upon multisensory Virtual Reality and Script-Driven Imagery analogue trauma: A randomised controlled crossover study. *Journal of Anxiety Disorders*, *59*, 42-52. https://doi.org/10.1016/j.janxdis.2018.08.005

Sousa, C., Hwang, J., Cabrera-Perez, R., Fernandez, A., Misawa, A., Newhook, K., & Lu, A. (2021). Active video games in fully immersive virtual reality elicit moderate-to-vigorous physical activity and improve cognitive performance in sedentary college students. *Journal of Sport and Health Science*, *00*, 1-8. https://doi.org/10.1016/j.jshs.2021.05.002

Tanjung, K., Nainggolan, F., Siregar, B., Panjaitan, S., & Fahmi, F. (2020). The use of virtual reality controllers and comparison between Vive, Leap Motion and Senso Gloves applied in the anatomy learning system. *Journal of Physics: Conference Series*, *1542*, 012026. https://doi.org/10.1088/1742-6596/1542/1/012026

Tcha-Tokey, K., Christmann, O., Loup-Escande, E., Loup, G., & Richir, S. (2018). Towards a model of user experience in immersive virtual environments. *Advances in Human-Computer Interaction*, *2018*, 1-10. https://doi.org/10.1155/2018/7827286

Wang, D. (2020). Application of polygraph in concealed information test. *Oalib*, *07*(09), 1-8. https://doi.org/10.4236/oalib.1106804

А. Курапов, О. Дубинський, О. Балашевич, Г. Цурікова

КОНТРОЛЬОВАНА ТА НЕКОНТРОЛЬОВАНА ВІРТУАЛЬНА РЕАЛЬНІСТЬ: ПСИХОФІЗИЧНА РЕАКЦІЯ

Резюме

Віртуальна реальність набуває популярності завдяки широкому спектру застосування, починаючи від розваг і закінчуючи цілою низкою освітніх програм. У неї, безумовно, є свої позитивні сторони і недоліки. ***Мета дослідження*** *полягає у оцінці психофізичної реакції на здатність контролювати та маніпулювати віртуальною реальністю. Воно також фокусується на впливі віртуальної реальності на здатність виконувати просторове моделювання. Вибірка дослідження налічує 140 учасників.* ***Дослідження має форму*** *класичного експерименту із залученням двох експериментальних та однієї контрольної груп. У той час як друга експериментальна група складалася з 40 респондентів і могла лише спостерігати за віртуальною реальністю, не маючи можливості впливати на свої дії у ній, перша експериментальна група складалася з 44 учасників, які могли контролювати свої дії у віртуальній реальності (вони могли рухатися, стрибати та вибирати місця, з яких могли дивитись на природу у віртуальній реальності). Контрольна група лише пройшла запропоновані тести із вимірювання навичок просторового моделювання і не була залучена у віртуальну реальність. Психофізичну реакцію вимірювали за допомогою поліграфу.* ***Результати*** *показують, що здатність контролювати віртуальну реальність робить досвід більш захоплюючим, підвищуючи рівень емоційної реакції та стресу, тоді як нездатність контролювати її викликає менший стрес і залучення.* ***Зроблено висновок****, що короткі сеанси віртуальної реальності позитивно впливають на здатність виконувати завдання з просторового моделювання.*

Ключові слова: *віртуальна реальність; когнітивні процеси; просторове моделювання; психофізична реакція*