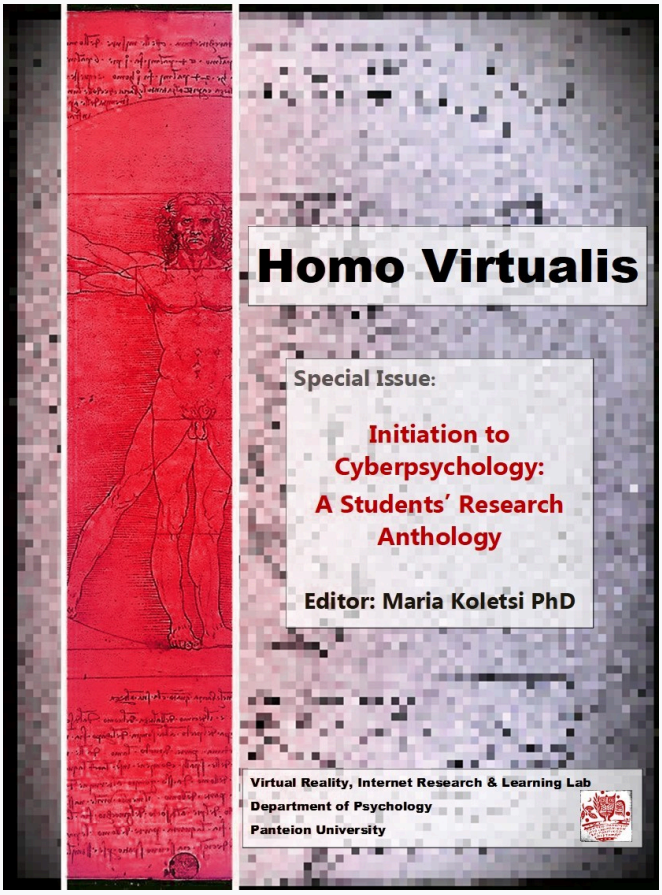
Homo Virtualis

Vol 5, No 1 (2022)

Special Issue: Initiation to Cyberpsychology: A Students' Research Anthology



The Use of Virtual Reality in the Science of Psychology

Nefeli Lampathaki, Maria Evangelou, Margarita Papageorgiou, Artemis Stefanidou Tsiavou, Giasemin Chomko

doi: 10.12681/homvir.30340

To cite this article:

Lampathaki, N., Evangelou, M., Papageorgiou, M., Stefanidou Tsiavou, A., & Chomko , G. . (2022). The Use of Virtual Reality in the Science of Psychology. *Homo Virtualis*, *5*(1), 166–187. https://doi.org/10.12681/homvir.30340

Homo Virtualis 5(1): 166-187, 2022
ISSN 2585-3899 ∫ doi: 10.12681/homvir.30340

The Use of Virtual Reality in the Science of Psychology

Nefeli Lampathaki[1], Maria Evangelou[2], Margarita Papageorgiou[3], Artemis Stefanidou-Tsiavou[4] and Giasemin Chomko [5]

Abstract: With the evolution of technology, digital gaming became a more holistic and realistic experience that engages all senses. This novel capacity was seized by Psychological Science. The aim of this literature review was to describe some of the usages of Virtual Reality (VR), specifically in the domains of Developmental, Clinical, Social, Organizational, Athletic Psychology and Neuropsychology. Some of the findings were that VR can promote children's socialization and self-control in the case of Developmental Psychology. Research on Clinical Psychology has shown that VRT contributes to phobia treatment and can help analyze negative self-image in individuals with eating disorders. In the area of Social Psychology, it can reduce prejudice and enhance prosocial behavior, by providing the ability to manipulate variables and achieving high experimental control and ecological validity. Furthermore, it can enhance employees' productivity and help them cope with stress in Organizational Psychology and boost athletes' motivation and decision making in Athletic Psychology. In Neuropsychology, VR gives the potential of early diagnosis and rehabilitation of neuropsychological complications of Traumatic Brain Injury, Brain Stroke, Parkinson's Disease and facilitates the reduction of Autism Index. Overall, psychological research, diagnosis and treatment via VR seems so far to be a rich and promising field for further investigation that will possibly improve different people's quality of life.

Keywords: Virtual reality, developmental psychology, clinical psychology, social psychology, sports psychology, organizational psychology, neuropsychology

[1] Undergraduate students, Department of Psychology, Panteion University of Social and Political Sciences, nefelidl@yahoo.gr
[2] Undergraduate students, Department of Psychology, Panteion University of Social and Political Sciences, evangeloumary.gr@gmail.com
[3] Undergraduate students, Department of Psychology, Panteion University of Social and Political Sciences, margarita.ppgr@gmail.com
[4] Undergraduate students, Department of Psychology, Panteion University of Social and Political Sciences, artemis.stefanidou@gmail.com
[5] Undergraduate students, Department of Psychology, Panteion University of Social and Political Sciences, jasminecres45@gmail.com

Introduction

Virtual Reality (VR) has to date been utilized in many branches of psychological science. Its contribution to psychology is of great importance, as it has led to the evolution and improvement of existing and the exploration of new psychological theories, the discovery of new research tools and the genesis of innovative methods of psychotherapy. The term "Virtual Reality" is often used to refer to: a) a virtual environment displayed on a screen, b) a room-based system, or c) a head-mounted display unit (HMD; Cruz-Neira et al., 1993; Taylor et al., 2010, as cited in Wilson & Soranzo, 2015). A common element of these systems is the presentation of a stereoscopic depth, which creates the illusion that the viewer sees things in a virtual space. According to Pan & Hamilton (2018), VR is "a computer-generated 3D world that enables the user to interact in an artificial environment using electronic devices". The device that seems to be used the most is the HMD, which has two screens located just in front of the user's eyes. The user sees digital images that are displayed in such a way as to offer the appropriate perspective to each eye. Moreover, it has built-in sensors, which detect and record the orientation, position and movements of the head and adjust the virtual environment accordingly, so that environment navigation is implemented freely. HMD's purpose is to make users' experience as realistic as possible. Some devices also have hand-controllers with sensors for the user's orientation and position, which can be used to interact with digital stimuli (Bird, 2019). VR devices are either portable, standalone or wired. Portable and standalone systems do not have cables, so that they are user-friendly and offer mobility. Wired systems, on the other hand, provide a more complete sense of experience, but are difficult to use in high-mobility situations.

One characteristic of VR, which makes it very useful for the science of psychology, is that it produces an environmental condition that appears and is experienced by the subjects as real (Rosenberg et al., 2013). The strong sense of presence the users experience, by its immersive environments, is essential because the behavior produced in VR reflects real world behavior. In addition, it provides the ability to record the entire physical behavior of the participants as well as to observe non-verbal behavior in a very detailed way (Yaremych & Persky, 2019), which helps draw more reliable conclusions.

The contribution of VR to the study of psychology is salient. Numerous studies have already been conducted in various fields, proving its helpful value in the study of human behavior. The purpose of this literature review was to provide a comprehensive presentation of the ways in which various researchers, in many fields of psychology, have applied VR into their research. Special emphasis was placed on the fields of Developmental, Clinical, Social, Sports, Organizational Psychology and Neuropsychology.

Virtual Reality and Developmental Psychology

Virtual reality has been actively integrated in recent years in several areas of developmental psychology. The creation of a completely simulated environment can contribute in various ways to the discipline and development of children, as it brings them in direct contact with the necessary stimuli. VR can contribute to the socialization of children, as they can learn the concepts of sharing and compliance with social rules. Moreover, its nature can support the educational process by making it more interesting, cultivating children's cognitive skills and problem solving, and promoting their creativity. Finally, its important contribution to children with special needs should not be overlooked.

Virtual Reality and Socialization of Children

Inhibitory Control

The increased realism and visibility of objects through VR may have some effect on children's executive functions (e.g., controlling and suppressing responses), which develop rapidly in childhood. Inhibitory control is a type of executive function related to the regulation of emotions and behavior. The realistic environment generated by VR could determine how children use their cognitive skills to resist, for instance, to a temptation. Based on this, Bailey et al. (2019) wanted to study VR's effects on children's inhibitory control and compare them to those arising from other media (e.g., television). Their research showed that children had difficulty suppressing their responses in the VR condition, even when they did not need to follow a command, a behavior very similar to the physical behavior of the children. These results show the ability of VR to reproduce the physical world and influence children's reactions compared to other media. They also show VR's capability to assess children's abilities and functions.

Social Behavior

Through VR, children can see the virtual world from a first-person perspective and interact with virtual characters (embodied agents; Blascovich et al., 2002), as they would interact with other people in the natural environment. The first-person view creates to the user the illusion that they are physically in the virtual environment and share the same space with the virtual characters. Many researchers support that embodied agents, who can interact both verbally and non-verbally, could influence children's social behaviors in general (Bailey et al., 2019). For example, in Claxton & Ponto's study (2013), children of various ages completed a decision-making task in which they received information from a living person and a built-in 2D screen. Older children used more often the information given to them, by the living person, while the youngest children used information from both agents (living and virtual). In addition, the latter were much more likely to report the feeling that the embodied agent could see them. Their results show that when a TV character is realistically

designed, it can have some effect on children's responses. The way in which children respond to virtual characters could provide an insight into how they apply knowledge gained from others in their daily lives (Bailey et al., 2019). A study by Bailey et al. (2019), which tested children's compliance with an embodied agent (Grover), found that children in the VR condition obeyed Grover's commands more than children in the TV condition, due to the more realistic nature of Grover. It seems, then, that the realism of virtual environments has the potential to provide significant social stimuli, ultimately influencing children's behavior.

Sharing Behaviors

Bailey et al. (2019) also wanted to study the effect of VR on children's sharing behavior, compared to other types of media. To assess children's ability to share, the researchers gave each child ten stickers, telling them they could give Grover as many stickers as they wanted. Their assumption was that children in the VR condition would share more stickers with Grover than children in the TV condition. Their results partially confirmed this hypothesis, again showing the greater impact of the virtual environment on children's social behavior.

VR in the Field of Education

VR and the Educational Process

In a study conducted by Lei et al. (2018), VR was used to examine the effects of VR technology on children's ability to understand concepts from scientific and social studies. They observed ten children playing with VR applications, while simultaneously recording their behavior on video. They evaluated this behavior and consulted education experts on the application of VR in the educational process. The results showed that children, during the use of VR, followed the "Trial and Error" strategy in order to achieve more satisfactory results. This strategy helped them, later, to find a faster solution to similar problems. Some children also interacted on their own with the virtual characters (even when they were not instructed to do so), showing empathy towards them and a creative spirit. Thus, it seems that children respond positively to the virtual environment, expressing positive behaviors.

According to the experts' interviews, VR makes abstract information more understandable. One reason this may happen is because VR supports 3D visualization and presentation of natural phenomena, allowing children to observe objects from different angles and learn from these observations. That means that VR creates highly realistic situations, where children can learn from specific examples, while also having fun. A second advantage of VR, according to experts, is that it can enhance students' efforts to succeed in scientific studies, giving them feedback on complex problems. Lastly, VR sparks children's imagination by providing them with practical and convenient activities. Children like to be active and usually prefer activities that offer

practical experiences and evoke a sense of accomplishment. VR seems to be an essential tool for children's activation.

Learning Different Types of Music

Innocenti et al. (2019), in their research, used an innovative VR application, VR4EDU, to make learning different types of music easier for children. This application exposed children to various musical pieces, allowing them to move alongside the music in the entire virtual environment. Their purpose was to evaluate the effectiveness of VR4EDU in supporting music education, compared to the learning outcomes of traditional lessons. The results showed that there is a statistical difference between the two teams, with the one trained through VR performing better. In this way, their research showed that lessons through VR provide an effective learning experience of music.

VR and Education of Children with Special Needs

Finally, VR seems to be a great tool for teaching children with disabilities. The main sensory output of VR is audio and visual, a condition that can lead to a reduction in information but gives a full description of the virtual environment (Horbova et al., 2020). Through VR, it is easy to modify the features of the virtual environment, to add or subtract objects and present different scenarios, depending on the teaching requirements, regardless of the constraints of the physical world. Thus, VR can be manipulated in such a way as to contribute to the development of skills in children with special needs (e.g., children belonging to the autism spectrum). In this way, the possibility of individualized learning is provided, with a focus on the strengths and weaknesses of each child. At the same time, the educational process becomes easier and more enjoyable for both teachers and children.

Based on that, Horbova et al. (2020) focused on the possibility of exploiting VR in order to solve educational difficulties and improve the quality of education. They suggested that by using a VR system, the lesson in the form of a game could be designed based on the level and social skills of each child. Thus, the child will be able to behave however they want while learning. An example of application of this VR system is teaching children with disabilities to cross the street (Horbova et al., 2020). Before the lesson the child can watch through the system a theoretical scenario of how they should behave in the game. In the practical part, the child can behave as they desire, but if a wrong move is to be made the system will block it. This way children can learn how to behave on the road and overcome their difficulties, while respecting the traffic code. However, researchers suggest that in order for VR learning to be effective, parents should be there for their children and explain to them which option is right and why.

In conclusion, VR seems to have multidimensional benefits for developmental psychology. It offers the possibility of solving many problems of education while at the same time contributes drastically to the learning and healthy development of children. Of course, like any technological medium, VR should be used with moderation and

prudence. It is important to use it in such a way that there is no confusion between the real and virtual world. In order to achieve the best possible results, further research and organization are certainly needed.

Virtual Reality and Clinical Psychology

Apart from developmental psychology, virtual reality appears to be considerably useful for clinical psychology. Clinical psychology is "the branch of psychology that specializes in the research, assessment, diagnosis, evaluation, prevention, and treatment of emotional and behavioral disorders" (APA Dictionary of Psychology, n.d.). One contribution of VR to clinical psychology is the fact that it allows the controlled simulation of complex social phenomena, such as social phobias and psychological disorders. This gives researchers the opportunity to test and put into practice a series of theories in a realistic manner. The new achievements that VR may offer in the field of clinical psychology have begun to emerge in the last twenty years and continue to evolve. These implementations are discussed next.

Virtual Reality and Psychotherapy

VR offers great possibilities for treating people who have serious mental health problems, resulting in them not being functional in their daily lives. Phobias such as agoraphobia, arachnophobia or other anxieties, can be treated by changing a person's way of thinking when encountering a similar stimulus. Through VR, there is an opportunity to change the mindset used to address phobias in real-world conditions, through exposure to controlled and harmless conditions. People can enter simulations of situations that may trouble them and attempt to manage and perhaps, gradually, overcome their problem. At the same time, fertile ground is created for additional study of the various disorders and theories.

Another positive feature of VR is the ability to stop and repeat virtual trials at any time (e.g., in case of a patient feeling ill or threatened). In addition, if the patient chooses VR as an alternative way of treatment, they will be able to practice at home easily and with a small amount of equipment. Generally, there is a lot of research supporting the usefulness of VR in the therapeutic process. However, Carvalho et al. (2010) suggest conducting more research in controlled environments to explore all aspects of this topic.

Virtual Reality and Social Anxiety

Dechant et al. (2017) conducted research attempting to evaluate the application of VR as a diagnostic tool for social anxiety, by using two different situational scenarios. In the first scenario, a train dock was presented, in which participants were asked to contact the station attendant and perform some calculations. In the second scenario, a waiting room in a doctor's office was presented, in which the participants had to ask to take someone's place, but their request was denied. The aim was to examine the differences between high and low levels of social anxiety through careful observation of eye movements and skin conductance responses. The results showed that eye

contact had a greater effect on social anxiety than physiological responses. Based on this, visual behavior, through VR, can be used as a diagnostic tool for social anxiety, showing VR's ability to support the diagnostic process.

Virtual Reality and Eating Disorders

Moving on to another category of disorders, Riva (2011) examined the potential contribution of VR to the treatment of eating disorders. He focused on an "allocentric negative body image", which does not change regardless of changes in the body. With the term "allocentric negative body image" the researcher refers to the image that a person has formed of their body, which is based on the view of others. What he proposed was the addition to the treatment of eating disorders of a 10- session body image reconstruction protocol (Riva et al., 1998a; Riva et al., 1998b). This protocol is based on VR technology and can be used to improve the long-term results of regular treatments. Riva suggested that VR is useful, because it provides the possibility of systematic and controlled exposure therapy, safely and without restrictions.

More specifically, Riva (2011) refers to experiential cognitive therapy, a type of therapy that focuses on individual discovery and empowerment and the negative emotions associated with food and the body. As part of this treatment, the therapist uses the "20/20/20 rule". The first 20 minutes are similar to the procedures of classical cognitive behavioral therapy. At this stage, the therapist lets the patient speak while he directs the conversation with specific questions. The next 20 minutes are for VR therapy. During this part, the patient experiences a critical situation in the virtual environment, which may unfold in places that cause particular stress to people with eating disorders, such as pools, beaches, restaurants or supermarkets. The aim is to help the patient to develop strategies, in order to deal with the situation. The last 20 minutes examine the patient's understanding of the virtual experience, as well as their reactions to the various situations they experienced during the procedure.

This study has been repeated 2 more times (Riva et al., 2003; Riva et al., 2006 as cited in Riva, 2011) with the contribution of VR and has helped to deepen the understanding and analysis of the aforementioned allocentric negative body image, advocating the supportive role of VR in the healing process.

Virtual Reality and Psychotic Disorders

According to Freeman et al.'s (2017) systematic review, 44 studies have been conducted on the use of VR for schizophrenia and other related problems. In most studies VR has been used to evaluate and understand the causes of psychosis. The results are generally quite heterogeneous, reflecting the complexity and severity of the subject. Confirmed results have emerged mainly from research based on the relation between VR and paranoia (e.g., Freeman et al., 2014; Valmaggia et al., 2015, as cited in Freeman et al., 2017). These results show that in the virtual environment similar behaviors to those of the physical world are produced (i.e., appearance of paranoid thoughts in the virtual environment). Regarding the therapeutic utility of VR for

psychosis, studies are limited in number but they are very promising, so further research on this subject is needed.

VR and Obsessive-Compulsive Disorder

The use of VR in obsessive-compulsive disorder (OCD) studies is a relatively recent argument. Most studies addressing this issue focus primarily on three types of OCD: control behavior, fear of infection, and slowness associated with doubt and perfectionism (Bouchard et al., 2019). The first research on OCD and VR (Kim et al., 2008, as cited in Bouchard et al., 2019) aimed to observe whether people with OCD would behave in the virtual environment the same way they behave in the real world. Their results showed that OCD patients performed many control behaviors and had high levels of stress in VR corresponding with real world clinical data. Similar research has been conducted on other aspects of OCD (e.g., Laforest et al., 2016; O'Connor et al., 2011; Roh et al., 2010, as cited in Bouchard et al., 2019), confirming the ability of VR to produce coercive behaviors, as they appear in the real world. It is clear that VR may be useful for cognitive behavioral therapy, as part of the process of extensive exposure to stressful stimuli due to the high levels of stress it causes (Bouchard et al., 2019). However, in all studies, VR was used more as a diagnostic tool and less as a therapeutic tool. More research is therefore needed on this subject to determine the contribution of VR to OCD.

Virtual Reality and Substance Use Disorder

Simulation of stimuli related to problematic behaviors, such as substance use and abuse, is possible thanks to VR (Freeman et al., 2017), without the dangers that would arise with true stimuli. Several studies have been conducted on VR and substance use, most of which focus on the assessment of the disorder. Most of the studies have shown that some VR environments can induce a strong desire for various stimuli (e.g., for cigarettes; Pericot-Valverde et al., 2016, as cited in Freeman et al., 2017). Research on the therapeutic use of VR for substance use is minimal. However, the results of the therapeutic application of VR in other types of disorders, create an optimistic framework for the extension of the results to the substance use disorder (Bordnick & Washburn, 2019). Inducing cravings means that virtual reality can be used successfully in therapy, although this has not been yet confirmed (Freeman et al., 2017).

In conclusion VR could significantly increase access to psychological therapies and the enrichment of existing therapies. The approach of psychotherapeutic techniques using VR could be an innovative and promising method aimed at better and more holistic understanding, management and treatment of mental disorders. A basic condition, of course, for any new perspective, is further research.

Virtual Reality and Social Psychology

The Branch of Social Psychology

Social psychology is the branch of psychology, which focuses on "how the thoughts, feelings and behaviors of individuals are influenced by the actual or implied presence of others" (Allport, 1954a, p.5, as cited in Hogg & Vaughan, 2010, p.2). So, the main focus is on observable and discrete situations and behaviors, which acquire social meaning because the individual is influenced by other individuals.

Unfortunately, in social psychology the concepts that researchers attempt to study are so complex and subtle that, in some cases it is impossible to meet the necessary conditions for conducting research. For instance, in order for an experiment to be successful, strict experimental control must be achieved, a requirement hard to fulfill. At the same time, although an experimental design may have a significant degree of internal validity, the findings of such a process are more difficult to generalize to real life, because the experimental conditions differ from the real ones. Therefore, procedures based on experimental designs lack external and ecological validity (Schmuckler, 2001, as cited in Rovira et al., 2009). In contrast, in field studies the ecological validity is strong, however experimental control cannot be ensured in any way (Yaremych & Persky, 2019). In addition, many social psychology studies are difficult to replicate by other researchers at other times. A typical example is Stanley Milgram's experiment on obedience. His experiment, although important in understanding obedience to an authoritarian figure, was described by many as problematic and immoral, and therefore considered impossible to be repeated by another researcher.

The ability to replicate research together with the need for validity, are necessary factors for confirmation of findings and theories. Although each researcher tries to achieve different goals through their research, they must take into account the issues of repeatability, experimental control and validity, in order to avoid problems of reliability and interpretation of the results.

Use of Virtual Reality

One way in which the above problems can be addressed is by using virtual reality. The reason why its use is suggested in social psychology is because people tend to respond realistically to virtually generated worlds and situations (Rovira et al., 2009), while experiencing all the psychological symptoms that accompany these situations (Rosenberg et al, 2013). In other words, people respond exactly as they would in a real situation. Therefore, the measurement of behavior is real (observed in immediate time) and not hypothetical (i.e., what the participant would do in a situation), as is mainly the case with self-report questionnaires or experimental laboratories.

One way VR can contribute to the improvement of social psychology research, and especially experimental design, is through manipulation of any desired variable with full control (Pan & Hamilton, 2018). In doing so, the researcher can ensure the

necessary experimental control (de la Rosa & Breidt, 2018). For example, the concept of social identity cannot be easily manipulated, as the characteristics of ethnicity, race or appearance are stable and non-manipulative. With VR, however, the researcher acquires the ability to exploit and determine, as he wants, these characteristics. Taking advantage of this feature, Peck et al. (2013) attempted to study whether having dark skin by light-skinned participants reduces their indirect bias. Through VR they manipulated their basic color variable and the participants' reflections on a virtual mirror. Their research practically showed that VR allows the design of experiments with variables that cannot be controlled directly in the real world.

VR also improves the ecological validity and mundane realism of a study (Blascovich et al., 2002), as the virtual environment is set to resemble as closely as possible the real world. That means that it improves the degree to which an experiment resembles a situation someone encounters in the real world (Aronson & Carlsmith, 1969, as cited in Blascovich et al., 2002). An example of this is the research of Slater et al. (2013), who studied the conditions under which a passer-by intervenes in violent attacks in order to protect the victim. VR produces an ecologically valid environment, because it relies on events that have already happened in the real world (e.g., violent bar behaviors; Rovira et al., 2009). The difference is that in the virtual environment the researcher can study dangerous situations, without the real risk variable. In this way, ethical issues are ensured, which protect the participants from harm.

An additional contribution of VR to social psychology is the opportunity to repeat a study. Due to the software used, researchers are required to accurately define the research process they have followed, something that is not always possible with non-virtual research. Among other things, it allows the reproduction of experiments that for ethical reasons cannot be performed in a laboratory environment. Again, the most typical example is Milgram's obedience experiment. Slater et al. (2006), replicating Milgram's experiment in a virtual environment, explored not the very concept of obedience but whether participants would react to the situation they were subjected to as real, knowing that it was not. The basic experimental design was the same, but the two studies differed ethically, as Slater et al. informed the participants about the research objectives and did not cause emotional distress. An important observation, however, was that humans responded realistically to their interactions with virtual characters, despite their knowledge of their unreal nature.

Finally, virtual reality is particularly useful for exploring pioneering scientific questions (de la Rosa & Breidt, 2018; Pan & Hamilton, 2018). For example, Rosenberg et al. (2013) knew from the research of Gentile et al. (2009, as cited in Rosenberg et al., 2013) that prosocial video games can enhance players' prosocial behavior in the real world. Given this information, but also the fact that experiences in the VR world are felt as real, they attempted to show that prosocial behavior can be enhanced by exposing an individual to a virtual environment. Their research was pioneering not only because it first studied the effect of VR on behavior, after exposure to the virtual world, but also because for

the first-time incarnation of the concept of "superhero" (and not just the idea of incarnation; Nelson & Norton, 2005, as cited in Rosenberg et al., 2013) was possible, thus allowing the demonstration of real behavior. Accordingly, Banakou et al. (2016), based on the research of Peck et al. (2013) for indirect prejudice, tried to study whether the reduction of prejudice lasted even after the experience of VR. This research was pioneering because the researchers studied the effect of VR over time (specifically one week), while previous research had been limited to studying the effect immediately after exposure to the virtual environment. Through these studies, the use of VR as a means for the improvement of people's social behavior also emerges.

In conclusion, the use of VR in the field of social psychology seems to have many advantages, enabling researchers to combat the problems of ecological validity and experimental control. This does not mean, however, that VR has no limitations or problems with its application. After all, it is a technological tool. Most importantly, in order for research to be conducted in the virtual world, the theory being tested must be accurate and well-defined in terms of the psychological processes under consideration (Pan & Hamilton, 2018). Therefore, good organization is the key to the successful application of VR in the studies of social psychology.

Virtual Reality and Sports Psychology

Sports psychology is another field that virtual reality has contributed to. Below some studies are mentioned, highlighting how VR is related to sports psychology.

Initially, Stinson and Bowman (2014) studied whether a virtual goalkeeper could help athletes develop better strategies for controlling their emotions under stressful circumstances, in which they should perform as best as they can. In their research, users had to take a penalty. The independent variables used by the researchers were some known stress stimuli, the reference field (the degree in which the screen includes the player in space) and the simulation fidelity. Eventually, this study showed that athletes can experience stress in VR environments. Their study also refers to the term "competitive stress". Obviously, it is useful for the athletes to experience stress because it gives them energy, but competitive stress makes them unable to take the right decisions during high-pressure conditions. Training in such conditions seems to offer good results. For example, VR can also help in creating large virtual audiences and specific contexts in which users can learn to manage their stress (Stinson & Bowman, 2014).

Other researchers (e.g., Zinchenko et al., 2011) report that VR helps athletes make decisions more easily using their body movements, in contrast to other exercises in which they are required to be static. Through VR, an athlete can be exposed to a variety of stimuli, moving or static, and to unusual conditions that may arise, and train for real competition. Such systems include both visual, tactile and auditory stimuli, and in the future also olfactory stimuli will be available. In other words, VR can very closely imitate real environments.

VR can also help the athletes to enhance the cognitive functions that are essential for athletic performance. Athletes need to be able to make quick decisions effectively, for example to think about their opponent's next move and cope with stressful situations, such as competition. Another application of VR is the examination of differences between male and female athletes in terms of orientation in the field. According to studies, women orient themselves by remarkable visual objects, while men also take into account the geometry of space (Zinchenko et al., 2011).

Communication is another area in which VR can be used. Using avatars, athletes can practice both verbal and non-verbal communication. This helps athletes to better understand their perceptual skills. According to studies that used VR, cognitive and motor activities seem to be represented by different normal brain structures. On the other hand, other studies showed that these brain areas (dorsal and abdominal) interact and complement each other. A key point is that the optical system is generally defined by plasticity and adaptability (Zinchenko et al., 2011). Experiments in which the subject walks through a 3D maze and must perform a complex task (e.g., find a hidden object) help in studying the interactions between cognitive functions (e.g., perception, memory, thought) and behavioral actions. They also provide information for the degree and structure of kinetic and cognitive cooperation in various practical activities. Another contribution is the study of specific characteristics of brain function and the germinal nervous system regarding intentional actions (Zinchenko et al., 2011).

In addition, Bird (2019) notes that training athletes with VR devices reduces the chances of accidents. He also notes that athletes are exposed to many stressors (i.e., opponents, teammates, superiors, the pressure of performing well) and so they should develop stress management strategies. An important strategy is relaxation. A possible task could be thinking of a real or imaginary location, which causes feelings of relaxation. Some videos depicting natural landscapes, such as mountains or beaches, appear to be effective in reducing stress, as they seem to reduce heart rate and blood pressure (Gerber et al., 2017, as cited in Bird, 2019). Another way is to listen to music with healing properties or to practice breathing exercises (Karageorghis et al., 2018, as cited in Bird, 2019). VR devices can be used for this type of exercises, as they offer a variety of such tasks and provide biofeedback to the user.

Lastly, VR appears to be able to help with the recovery of athletes after an injury. Initially, it can be used when athletes are injured so that they can stay in touch with the field and their team and avoid feeling isolated. In addition, it can help with rehabilitation exercises. Bird (2019) suggests that a digital assistant can be used, in order to give feedback to the person and encourage them.

To summarize, VR already offers a lot in the field of sports psychology and in the future it can offer even more. As discussed above, virtual reality helps athletes to improve their performance, manage competition and other stressful stimuli, and enhance their cognitive functions. In addition, it offers relaxation exercises and helps in recovery after injury so that the athlete does not lose touch with sports. A major problem though is

the effective representation of sport conditions. Generally, there is limited literature that studies the relationship between VR and sports psychology. For this reason, further research in this area is highly recommended.

Virtual Reality and Organizational Psychology

Organizational psychology focuses on the health and efficiency of each employee individually and the work community as a whole. Two fields that organizational psychology concentrates on are skill development and reduction of stress, which according to research, is the second main reason for performance decrease at work (World Health Organization, as cited in De Carlo et al., 2020). Another factor that affects workers seems to be the conflicts between them. Therefore, virtual reality can be used to enhance work productivity (De Carlo et al., 2020). Most of the information below comes from De Carlo et al.'s (2020) literature review.

Firstly, VR is used to help employees learn relaxation techniques. One technique that is particularly helpful in reducing stress is depiction of naturalistic environments, such as a beach or a mountain. The use of natural sounds seems to be quite helpful. The presence of a voice which welcomes the participant also seems to help them relax and remove any negative thoughts. Additionally, VR is used to train professionals to face stressful situations (Tichon & Mavin, 2016 as cited in De Carlo et al., 2020).

Another contribution of VR in organizational psychology is that it helps with the development of personal resources, something really important for workers (De Carlo et al., 2020). Employees can be trained through interactive environments, where their behaviors are recorded and evaluated, to take initiatives. Another trait that can be developed with the help of virtual reality is leadership, a very important trait for workplaces, especially for those who are at high-responsibility positions. Furthermore, resilience, which is the ability to deal with difficult life situations from a positive perspective, is another trait that can be developed through VR. VR can prepare someone for stressful situations and can reduce the likelihood of developing post-traumatic stress disorder (Rizzo et al., 2013, as cited in De Carlo et al., 2020). It can also help in boosting individual optimism and self-efficacy because it can offer active learning and enables active user participation, which enhances the users to create and innovate in their field of work (Botella et al., 2012; Nissim & Weissblueth, 2017, as cited in De Carlo et al., 2020).

VR is widely used in anxiety treatment and depression, mainly through the treatment of exposure to stressful stimuli. In the field of organizational psychology, exposure therapy can help someone to address social phobia and exposure anxiety in public, for example public speaking, a skill that employees need to develop.

In conclusion, organizational psychology is another field of psychology that can use VR as a means of both performance improvement and employee stress management.

However, more data collecting would be helpful in order for a better picture of the usage of VR in this field to be created.

Virtual Reality and Neuropsychology

Neuropsychology involves the study of the psychological consequences of brain complications in humans. Virtual reality contributes to the systematic and meticulous investigation of cognitive functions (e.g., Schultheis & Rizzo, 2001, as cited in Banville et al., 2019). It offers sophisticated diagnostic abilities and enhances the effectiveness of conventional psychometric tools, fostering the rehabilitation of individuals with neurological disorders.

VR and Brain Stroke

A brain stroke is an incident of abrupt loss of brain activity, mostly caused by lack of oxygen or bleeding around the brain tissue. Both of previous circumstances are life threatening since they can damage a significant amount of neural areas. The location of brain damage defines its future extent and severity. Most stroke survivors experience negative life consequences (Williams et al. 1999, as cited in Nolin et al., 2019), some of which are paralysis, hemiplegia and other cognitive dysfunctions. Rehabilitation is regarded as necessary for the return to normality.

VR offers diagnostic properties of impairment in different cognitive functions, such as in spatial abilities (Baheux et al., 2004), route representation (Carelli et al., 2011), memory (Brooks et al., 2004) and executive functions (e.g., Jovanovski et al., 2012; Nir-Hadad et al., 2017). It seems that VR trials are sensitive to small distinctions in the performance of brain stroke patients that cannot be easily detected by other typical psychometric tools. Moreover, VR can assist the therapeutic process of patients who struggle with post stroke ramifications (Kim et al., 2007). In fact, research has shown that patients' mnemonic (e.g., Cameirão et al., 2016; Gamito et al., 2017) and higher cognitive functions (e.g., Faria et al., 2016) can be improved by training in basic everyday skills (e.g., crossing the street or shopping) in VR environments.

Virtual Reality and Traumatic Brain Injury

Traumatic Brain Injury (TBI) "leads to death and disability in millions of individuals around the world each year" (Flanagan et al., 2008, as cited in Banville et al., 2019, p. 327). It is provoked by an external factor that leads to permanent or temporary loss or distraction of consciousness. The cognitive problems caused to all patients with TBI, renders the sufficient diagnosis of cognitive dysfunctions vital (Fay et al., 2009, as cited in Banville et al., 2019). Complications and progress must be recorded at each stage of rehabilitation in order for the detection of permanent impairment to be possible.

In the case of children and adolescents who suffer from TBI, VR can detect executive dysfunctions (e.g., Erez et al., 2013), attention deficits and behavioral peculiarities (e.g., disturbance or hyperactivity). Children with brain trauma seem to make more mistakes

in the trials and need more time to complete the required task they are given compared to children without brain trauma.

Likewise, adults with craniocerebral trauma are less efficient and slower in VR memory function tasks and their performance is similar to that of older participants (Arvind Pala et al., 2014). According to Slobounov et al. (2010, as cited in Banville et al., 2019) these individuals present a different brain activation pattern located primarily in the frontal and lateral regions of the brain. VR can detect spatial and precursor memory problems (e.g., Livingstone & Skelton, 2007; Renison et al., 2012, as cited in Banville et al., 2019), difficulty in performing multiple tasks (e.g., Besnard et al., 2016), as well as problems with logical reasoning, processing and speed of thought (Zhang et al., 2001).

Virtual Reality and Parkinson's Disease

Cognitive impairment is very common in Parkinson's disease (PD) and mental functions such as memory, language, executive functions and visual-spatial abilities are affected. Similar to motor symptoms, cognitive impairment in PD varies from person to person in terms of onset and rate of onset (Verleden et al., 2007). Cognitive deficits are related to patients' disability and psychological burden of caregivers, they reduce the quality of life of both sides and have a major economic and health impact (Serino et al., 2014). The superior executive functions are those that suffer the greatest neuropsychological effect from PD (e.g., Ceravolo et al., 2012) and its early diagnosis and rehabilitation is of great importance.

As PD progresses, a significant number of patients develop dementia (e.g., Hely et al., 2008). The term "mild cognitive impairment" in PD is used to describe non-age-specific cognitive apoptosis that does not severely impair individuals' daily activities but appears to predict the onset of dementia (Janvin et al., 2006, as cited in Serino et al., 2014). Serino et al. (2014) report that the Virtual Multiple Errands Test (VMET) can overcome the weaknesses of conventional executive function testing in patients with mild cognitive impairment due to PD. VMET is a VR psychometric tool of executive functions, which presents a functional virtual supermarket in a mall. It consists of four tests, which include the purchasing of items, information about them, writing a shopping list and answering relevant questions after the assignment. VMET allows the evaluation of executive dysfunctions in Parkinson's patients which cannot be fully spotted in everyday life. It also assesses the ability of patients to develop, organize and control all the necessary goals and objectives in order to meet the requirements of everyday life. Early diagnosis of executive function deficits given by VMET can prevent the onset of PD, as early intervention can improve patients' quality of life.

Virtual Reality and Autism Spectrum Disorders

Autism Spectrum Disorders (ASD) are one of the most common neurodevelopmental disorders. A group of symptoms usually occurs between the ages of 12 and 14 months, some of which are difficulties in social interaction, communication, and stereotypical

repetitive behaviors (Gillberg & Coleman, 2001, as cited in De Luca et al., 2021). People with ASD have atypical cognitive profiles, such as problematic social cognition, perception, executive functions and information coding, which is associated with attention problems (Mayes & Calhoun, 2007, as cited in De Luca et al., 2021). ASD has a negative impact on the lives of those diagnosed and their families.

The main therapeutic approach in ASD is Cognitive Behavioral Therapy (CBT), which focuses on minimizing cognitive and behavioral problems through targeted exercises (Anderson & Morris, 2006). De Luca et al. (2021) applied BTS-Nirvana (BTS-N), an innovative VR device, in a case study of children with ASD. In the experiment, participants use a screen to perform various activities (e.g., identifying and moving objects). The above intervention seemed to improve the child's attention span, reduce their stereotypical behaviors, showed better therapeutic compliance and reduced the overall autism index.

This improvement may have occurred because cognitive training in a context of virtual reality activates mechanisms involved in neuroplasticity and neurorehabilitation (e.g., the dopaminergic and serotonergic systems; Liu et al., 2017, as cited in De Luca et al., 2021). Unlike other therapies, children with autism can experience and improve upon realistic experiences in a controlled environment. Exercises in a VR scenario help patients perceive the impact of their actions and their performance, enhancing the educational process and rehabilitation. VR tools, being structured and individualized, have the ability to attract and retain the attention of children with neurodevelopmental disorders by entertaining them, detecting their weaknesses and enhancing their potential (Parsons et al., 2007 as cited in De Luca et al., 2021).

In conclusion, the use of VR tools seems to be quite useful in neuropsychological disorders. Their use can improve the quality of life of people suffering from these disorders, through the diagnosis and rehabilitation of the cognitive deficits they face. It is interesting to note the potential extent to which the use of VR for the diagnosis and rehabilitation of other neuropsychological disorders, such as dementia and Alzheimer's, may take place. Of course, its weaknesses must be taken into account in order to be addressed and be used effectively.

Conclusions

Virtual reality is an innovative and revolutionary technological achievement, as it challenges the boundaries between reality and fantasy. According to studies, virtual experiences do not differ much from realistic responses of individuals in real life conditions (Rosenberg et al., 2013). Its development has expanded into various scientific fields, including psychology, increasing their capabilities and prospects.

In the field of developmental psychology, it seems to be able to promote the development of children with multiple means. Children’s interaction with virtual characters can contribute to their socialization, rule compliance, self-control and sharing. In the field of education, it seems to help children in understanding complex

concepts, in problem solving and mathematical thinking. The nature of VR seems to coincide with children's preferences for action and crafts, increasing their creative expression and eagerness to learn. Furthermore, it promotes the adaptation of children with special needs to the social and school context and can be used as a means of learning musical instruments and other skills. Therefore, it is understood that it can aid the educational process, achieving optimal results.

In the field of clinical psychology, VR can be used to treat numerous types of phobias and trauma-related anxieties through contact with the emotionally charged stimulus. Simulations in a safe environment and the ability to pause and practice at home offer patients the ability to actively manage their problem. It can also help to understand the negative allocentric body image that people with eating disorders have, through their exposure to stressful social environments, for them (e.g., swimming pools, restaurants, etc.). In terms of substance abuse, virtual environments can induce the desire for a substance and the conditions for the user to manage that desire. Research about the usage of VR on other psychological disorders as well, such as depression, would be very beneficial and make a significant contribution to their understanding, explanation and management.

In social psychology, VR devices can exceed methodological deficiencies related to experimental control, ecological validity, and repeatability. They enable the manipulation of variables that under real conditions would be impossible, for instance the socio-psychological identity of the participant through avatars or the formation of dangerous situations with the absence of real threat. Researchers can also measure individuals' attitudes, design programs to reduce prejudice and increase prosocial behaviors.

In sports psychology, athletes can improve their emotional control strategies under stress, in virtual environments that mimic the athletic stadiums. They can also be trained in quick decision making, communication, perception, stress management strategies and accident reduction. In addition, VR helps rehabilitate injured athletes by helping them keep in touch with the pitch and their team, thus reducing the feeling of isolation they may experience. Finally, a digital assistant can provide them with the necessary psychological support they need by coaching and animating them.

In organizational psychology, VR can increase employee productivity. It cultivates skills and strategies and promotes cooperation between employees and initiatives by them. Moreover, it strengthens the mental resilience of employees by helping them manage stressful situations in a better manner, as well as it promotes their creativity and optimism.

In neuropsychology, VR improves the diagnosis of cognitive deficits (e.g. spatial capacity, executive or memory functions) which arise due to a neuropsychological disorder, and facilitates their rehabilitation. In brain injury, it can detect attention problems and behavioral peculiarities in children or difficulties in multi-tasking or

logical reasoning in adults. It also gives the chance of early diagnosis and intervention in Parkinson's disease which are crucial for its progression. At last, it provides the opportunity of teaching skills and dealing with behavioral issues in children with Autism Spectrum Disorders, significantly reducing their autistic index.

Alongside VR's advantages, there are also some essential disadvantages. For example, its high cost and complexity of use are factors that make scientists reluctant to conduct research based on it. VR devices may not be compatible for everyone, for some they may cause nausea or others might not perceive the virtual environment realistic enough or feel present in it (Pan & Hamilton, 2018). The fact that participants know that what they are experiencing is artificial affects their behavior and can lead to false interpretations. Further research with VR is surely necessary, since in many surveys sample size was rather small, in order for its contribution in the science of psychology to be more understood and applicable in everyday life.

References

Anderson, S., & Morris, J. (2006). Cognitive behaviour therapy for people with Asperger syndrome. *Behavioural and Cognitive Psychotherapy, 34*(3), 293-303. https://doi.org/10.1017/S1352465805002651

American Psychological Association. (n.d.). Clinical Psychology. In *APA dictionary of psychology*. Retrieved May 15, 2022, from https://dictionary.apa.org/clinical-psychology

Arvind Pala, P., N'Kaoua, B., Mazaux, J. M., Simion, A., Lozes, S., Sorita, E., & Sauzéon, H. (2014). Everyday-like memory and its cognitive correlates in healthy older adults and in young patients with traumatic brain injury: A pilot study based on virtual reality. Disability and Rehabilitation. *Assistive Technology, 9*(6), 463–473. https://doi.org/10.3109/17483107.2014.941952

Baheux, K., Yoshikawa, M., Tanaka, A., Seki, K., & Handa, Y. (2004). Diagnosis and rehabilitation of patients with hemispatial neglect using virtual reality technology. IEEE Engineering in Medicine and Biology Society. Annual Conference, 2004, 4908–4911. https://doi.org/10.1109/IEMBS.2004.1404357

Bailey, J. O., Bailenson, J. N., Obradović, J., & Aguiar, N. R. (2019). Virtual reality's effect on children's inhibitory control, social compliance, and sharing. *Journal of Applied Developmental Psychology, 64,* Article 101052. https://doi.org/10.1016/j.appdev.2019.101052

Banakou, D., Hanumanthu, P. D., & Slater, M. (2016). Virtual embodiment of white people in a black virtual body leads to a sustained reduction in their implicit racial bias. *Frontiers in Human Neuroscience, 10.* https://doi.org/10.3389/fnhum.2016.00601

Banville, F., Nolin, P., Rosinvil, T., Verhulst, E., & Allain, P. (2019). Assessment and rehabilitation after traumatic brain injury using virtual reality: A systematic review and discussion concerning human-computer interactions. In A. "S." Rizzo & S. Bouchard

(Eds.), *Virtual Reality for Psychological and Neurocognitive Interventions* (pp. 327–360). Springer. https://doi.org/10.1007/978-1-4939-9482-3_15

Besnard, J., Richard, P., Banville, F., Nolin, P., Aubin, G., Le Gall, D., Richard, I., & Allain, P. (2016). Virtual reality and neuropsychological assessment: The reliability of a virtual kitchen to assess daily-life activities in victims of traumatic brain injury. *Applied Neuropsychology. Adult*, 23(3), 223–235. https://doi.org/10.1080/23279095.2015.1048514

Bird, J. M. (2019). The use of virtual reality head-mounted displays within applied sport psychology. *Journal of Sport Psychology in Action, 11*(2), 115-128. https://doi.org/10.1080/21520704.2018.1563573

Blascovich, J., Loomis, J., Beall, A. C., Swinth, K. R., Hoyt, C. L., & Bailenson, J. N. (2002). Immersive virtual environment technology as a methodological tool for social psychology. *Psychological Inquiry, 13*(2), 103–124. https://doi.org/10.1207/S15327965PLI1302_01

Bordnick, P. S., & Washburn, M. (2019). Virtual environments for substance abuse assessment and treatment. In A. "S." Rizzo & S. Bouchard (Eds.), *Virtual reality for psychological and neurocognitive interventions* (pp. 131–161). Springer. https://doi.org/10.1007/978-1-4939-9482-3_6

Bouchard S., Laforest M., Gamito P., Cardenas-Lopez G. (2019) Using VR for obsessive-compulsive and eelated disorders. In A. "S." Rizzo & S. Bouchard (Eds*.), Virtual reality for psychological and neurocognitive interventions* (pp. 307–326). Springer. https://doi.org/10.1007/978-1-4939-9482-3_5

Brooks, B. M., Rose, F. D., Potter, J., Jayawardena, S., & Morling, A. (2004). Assessing stroke patients' prospective memory using virtual reality. *Brain Injury, 18*(4), 391–401. https://doi.org/10.1080/02699050310001619855

Cameirão, M. S., Faria, A. L., Paulino, T., Alves, J., & Bermúdez I Badia, S. (2016). The impact of positive, negative and neutral stimuli in a virtual reality cognitive-motor rehabilitation task: a pilot study with stroke patients. *Journal of Neuroengineering and Rehabilitation, 13*(1), 70. https://doi.org/10.1186/s12984-016-0175-0

Carelli, L., Rusconi, M. L., Scarabelli, C., Stampatori, C., Mattioli, F., & Riva, G. (2011). The transfer from survey (map-like) to route representations into Virtual Reality Mazes: Effect of age and cerebral lesion. *Journal Of Neuroengineering And Rehabilitation, 8*(1). https://doi.org/10.1186/1743-0003-8-6

Carvalho, M. R. D., Freire, R. C., & Nardi, A. E. (2010). Virtual reality as a mechanism for exposure therapy. *The World Journal of Biological Psychiatry, 11*(2 Pt 2), 220–230. https://doi.org/10.3109/15622970802575985

Ceravolo, R., Pagni, C., Tognoni, G., & Bonuccelli, U. (2012). The epidemiology and clinical manifestations of dysexecutive syndrome in Parkinson's disease. *Frontiers in Neurology, 3,* 159. https://doi.org/10.3389/fneur.2012.00159

Claxton, L. J., & Ponto, K. C. (2013). Understanding the properties of interactive televised characters. *Journal of Applied Developmental Psychology, 34*(2), 57–62. https://doi.org/10.1016/j.appdev.2012.11.007

De Carlo, A., Carluccio, F., Rapisarda, S., Mora, D., & Ometto, I. (2020). Three uses of virtual reality in work and organizational psychology interventions. A dialogue between virtual reality and organizational well-being: Relaxation techniques, personal resources, and anxiety/depression treatments. *TPM: Testing, Psychometrics, Methodology in Applied Psychology, 27*(1). https://doi.org/10.4473/TPM27.1.8

de la Rosa, S., & Breidt, M. (2018). Virtual reality: A new track in psychological research. *British Journal of Psychology, 109*(3), 427–430. https://doi.org/10.1111/bjop.12302

De Luca, R., Leonardi, S., Portaro, S., Le Cause, M., De Domenico, C., Colucci, P. V., Pranio, F., Bramanti, P., & Calabrò, R. S. (2021). Innovative use of virtual reality in autism spectrum disorder: A case-study. *Applied Neuropsychology. Child, 10*(1), 90–100. https://doi.org/10.1080/21622965.2019.1610964

Dechant, M., Trimpl, S., Wolff, C., Mühlberger, A., & Shiban, Y. (2017). Potential of virtual reality as a diagnostic tool for social anxiety: A pilot study. *Computers in Human Behavior, 76,* 128-134. https://doi.org/10.1016/j.chb.2017.07.005

Erez, N., Weiss, P. L., Kizony, R., & Rand, D. (2013). Comparing performance within a virtual supermarket of children with traumatic brain injury to typically developing children: a pilot study. *OTJR: Occupation, Participation and Health, 33*(4), 218–227. https://doi.org/10.3928/15394492-20130912-04

Faria, A. L., Andrade, A., Soares, L., & I Badia, S. B. (2016). Benefits of virtual reality based cognitive rehabilitation through simulated activities of daily living: a randomized controlled trial with stroke patients. *Journal of Neuroengineering and Rehabilitation, 13*(1), 96. https://doi.org/10.1186/s12984-016-0204-z

Freeman, D., Reeve, S., Robinson, A., Ehlers, A., Clark, D., Spanlang, B., & Slater, M. (2017). Virtual reality in the assessment, understanding, and treatment of mental health disorders. *Psychological Medicine, 47*(14), 2393–2400. https://doi.org/10.1017/S003329171700040X

Gamito, P., Oliveira, J., Coelho, C., Morais, D., Lopes, P., Pacheco, J., Brito, R., Soares, F., Santos, N., & Barata, A. F. (2017). Cognitive training on stroke patients via virtual reality-based serious games. *Disability and Rehabilitation, 39*(4), 385–388. https://doi.org/10.3109/09638288.2014.934925

Hely, M. A., Reid, W. G., Adena, M. A., Halliday, G. M., & Morris, J. G. (2008). The Sydney multicenter study of Parkinson's disease: The inevitability of dementia at 20 years. *Movement Disorders: Official Journal of the Movement Disorder Society, 23*(6), 837–844. https://doi.org/10.1002/mds.21956

Hogg, M. & Vaughan, G. (2010). *Social psychology* (5th ed.). Pearson Education Limited.

Horbova, M., Andrunyk, V., & Chyrun, L. (2020). Virtual reality platform for teaching children with special needs. Computational Linguistics and Intelligent Systems: Proceedings of the 4nd International Conference (2), 2020, 170-177 http://ena.lp.edu.ua:8080/handle/ntb/52129

Innocenti, E. D., Geronazzo, M., Vescovi, D., Nordahl, R., Serafin, S., Ludovico, L. A., & Avanzini, F. (2019). Mobile virtual reality for musical genre learning in primary education. *Computers & Education, 139,* 102-117. https://doi.org/10.1016/j.compedu.2019.04.010

Jovanovski, D., Zakzanis, K., Ruttan, L., Campbell, Z., Erb, S., & Nussbaum, D. (2012). Ecologically valid assessment of executive dysfunction using a novel virtual reality task in patients with acquired brain injury. *Applied Neuropsychology Adult, 19*(3), 207–220. https://doi.org/10.1080/09084282.2011.643956

Kim, J., Kim, K., Kim, D. Y., Chang, W. H., Park, C. I., Ohn, S. H., Han, K., Ku, J., Nam, S. W., Kim, I. Y., & Kim, S. I. (2007). Virtual environment training system for rehabilitation of stroke patients with unilateral neglect: crossing the virtual street. *Cyberpsychology & Behavior: The Impact of the Internet, Multimedia and Virtual Reality on Behavior and Society, 10*(1), 7–15. https://doi.org/10.1089/cpb.2006.9998

Lei X., Zhang A., Wang B., Rau PL.P. (2018). Can virtual reality help children learn mathematics better? The application of VR headset in children's discipline education. In PL. P. Rau (Ed.), *Cross-cultural design. Applications in cultural heritage, creativity and social development* (1st ed.). Springer. https://doi.org/10.1007/978-3-319-92252-2_5

Nir-Hadad, S. Y., Weiss, P. L., Waizman, A., Schwartz, N., & Kizony, R. (2017). A virtual shopping task for the assessment of executive functions: Validity for people with stroke. *Neuropsychological Rehabilitation, 27*(5), 808–833. https://doi.org/10.1080/09602011.2015.1109523

Nolin, P., Besnard, J., Allain, P., & Banville, F. (2019). Assessment and rehabilitation using virtual reality after stroke: A literature review. In A. "S." Rizzo & S. Bouchard (Eds.), *Virtual reality for psychological and neurocognitive interventions* (pp. 307–326). Springer. https://doi.org/10.1007/978-1-4939-9482-3_14

Pan, X., & Hamilton, A. (2018). Why and how to use virtual reality to study human social interaction: The challenges of exploring a new research landscape. *British Journal of Psychology, 109*(3), 395-417. https://doi.org/10.1111/bjop.12290

Peck, T. C., Seinfeld, S., Aglioti, S. M., & Slater, M. (2013). Putting yourself in the skin of a black avatar reduces implicit racial bias. *Consciousness and Cognition, 22*(3), 779-787. https://doi.org/10.1016/j.concog.2013.04.016

Riva, G. (2011). The key to unlocking the virtual body: Virtual reality in the treatment of obesity and eating disorders. *Journal of Diabetes Science and Technology, 5*(2), 283-292. https://doi.org/10.1177/193229681100500213

Riva, G., Bacchetta, M., Baruffi, M., Rinaldi, S., & Molinari, E. (1998a). Experiential cognitive therapy: A VR based approach for the assessment and treatment of eating disorders. In G. Riva, B. K. Wiederhold, & E. Molinari (Eds.), *Virtual environments in clinical psychology and neuroscience: Methods and techniques in advanced patient–therapist interaction* (pp. 120–135). IOS Press.

Riva, G., Bacchetta, M., Baruffi, M., Rinaldi, S., & Molinari, E. (1998b). Experiential cognitive therapy in anorexia nervosa. *Eating and Weight Disorders, 3*(3), 141–150. https://doi.org/10.1007/BF03340002

Rosenberg, R. S., Baughman, S. L., & Bailenson, J. N. (2013). Virtual superheroes: Using superpowers in virtual reality to encourage prosocial behavior. *PLos ONE, 8*(1), Article e55003. https://doi.org/10.1371/journal.pone.0055003

Rovira, A., Swapp, D., Spanlang, B., & Slater, M. (2009). The use of virtual reality in the study of people's responses to violent incidents. *Frontiers in Behavioral Neuroscience, 3*(59). https://doi.org/10.3389/neuro.08.059.2009

Serino, S., Pedroli, E., Cipresso, P., Pallavicini, F., Albani, G., Mauro, A., & Riva, G. (2014). The role of virtual reality in neuropsychology: The virtual multiple errands test for the assessment of executive functions in Parkinson's disease. In Ma M., Jain L. & Anderson P. (eds), *Virtual, augmented reality and serious games for healthcare 1*. Springer. https://doi.org/10.1007/978-3-642-54816-1_14

Slater, M., Antley, A., Davison, A., Swapp, D., Guger, C., Barker, C., Pistrang, N., & Sanchez-Vives, M. V. (2006). A virtual reprise of the Stanley Milgram obedience experiments. *PLoS ONE, 1*(1), Article e39. https://doi.org/10.1371/journal.pone.0000039

Slater, M., Rovira, A., Southern, R., Swapp, D., Zhang, J. J., Campbell, C., & Levine, M. (2013). Bystander responses to a violent incident in an immersive virtual environment. *PLoS ONE, 8*(1), Article e52766. https://doi.org/10.1371/journal.pone.0052766

Stinson, C., & Bowman, D. A. (2014). Feasibility of training athletes for high-pressure situations using virtual reality. *IEEE Transactions on Visualization and Computer Graphics, 20*(4), 606–615. https://doi.org/10.1109/TVCG.2014.23

VandenBos, G. R. (Ed.). (2007). *APA Dictionary of Psychology*. American Psychological Association.

Verleden, S., Vingerhoets, G., & Santens, P. (2007). Heterogeneity of cognitive dysfunction in Parkinson's disease: a cohort study. *European Neurology, 58*(1), 34–40. https://doi.org/10.1159/000102164

Wilson, C. J., & Soranzo, A. (2015). The use of virtual reality in psychology: A case study in visual perception. *Computational and Mathematical Methods in Medicine, 2015*, Article 151702. https://doi.org/10.1155/2015/151702

Yaremych, H. E., & Persky, S. (2019). Tracing physical behavior in virtual reality: A narrative review of applications to social psychology. *Journal of Experimental Social Psychology, 85,* Article 103845. https://doi.org/10.1016/j.jesp.2019.103845

Zhang, L., Abreu, B. C., Masel, B., Scheibel, R. S., Christiansen, C. H., Huddleston, N., & Ottenbacher, K. J. (2001). Virtual reality in the assessment of selected cognitive function after brain injury. *American Journal of Physical Medicine & Rehabilitation, 80*(8), 597–605. https://doi.org/10.1097/00002060-200108000-00010

Zinchenko, Y. P., Menshikova, G. Y., Chernorizov, A. M., & Voyskunskiy, A. E. (2011). Technologies of virtual reality in psychology of sports of great advance: Theory, practice and perspectives. *Psychology in Russia: State of the Art, 4*(1), 129-154. https://doi.org/10.11621/pir.2011.0008