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USE OF VIRTUAL REALITY TECHNOLOGY FOR REHABILITATION OF DRUG ADDICTION

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Objective: The aim of this review is to investigate applications of virtual reality technology on substance/drug addiction rehabilitation and to evaluate its results as good and best practices of methodologies

Method: A comprehensive literature review was conducted at the Science of Direct, Pubmed and Google Scholar. The search criteria were “virtual reality” “exposure therapy” “substance use” “drug” “addiction” keywords. Studies that were not written in English were not included in the review.

Discussion: Seven studies were reached. Publications which have been researched for this review cover the studies conducted between 2001-2010. The substances included in the studies were cannabis, heroin, cocaine, and methamphetamine.

Conclusion: Although use of virtual reality in treatment and rehabilitation of substance use disorders is an open area to improvement, there is a need for studies on drug addiction rehabilitation by using virtual reality technology.

Keywords: addiction, drug, cue exposure therapy, substance use, virtual reality

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1. INTRODUCTION

Virtual reality(VR) is a method of transporting a person to a reality that he/she feels as though he/she is not physically present(Rebelo et al., 2012). Virtual reality allows practitioners to design environments and conditions for a study that will be difficult to practice in real-world(Tal&Wansink, 2011). It is a new exposure tool that uses three-dimensional computer-graphic-based technologies to mislead one's senses and make them feel physically in a virtual environment(Ticknor&Tillinghest, 2011). In virtual reality applications, a head-mounted display, head monitoring devices, sound, vibrotactile and odor stimulators can be used(Bordnick et al., 2009).

To the best of our knowledge, the idea to use VR technology emerged at first to combat psychological disorders in November 1992 at Clark Atlanta University(North et al., 1997). VR has been applied successfully in behavioral science research and treatment since 1995 (Bordnick et al., 2011).

VR technology is used in treatment of many disorders in psychiatry. It is used as an exposure technique in treatment of anxiety disorder. Usage of VR has proven to be effective in treatment of body dysmorphic disorder, panic disorder, agoraphobia, acrophobia, flying phobia, spider phobia and binge eating disorder(Riva, 2003). It is also used in treatment of post-traumatic stress disorder and sexual disorders(Botella et al., 2004).

There are studies on use of VR in treatment of substance use disorders and smoking and alcohol dependence. Related to smoking addiction; VR cue exposure reveals more craving indication compared to conventional devices(Lee et al., 2004; Traylor et al., 2009), VR leads to a reduction in nicotine dependence(Girard et al., 2009) and VR provides strong evidence that could be used as a useful tool for social workers and clinicians(Bordnick et al., 2013). Regarding alcohol addiction; it has been found that increases validity of Cue Exposure Treatment(CET) and leads to a reduction in craving(Lee et al., 2007), VR is a useful method in addition to treatment of alcohol dependence(Lee et al. 2009), and an effective approach to educating young people about dangers of alcoholic driving(Montgomery et al., 2006).

1.1. Use of Virtual Reality in Substance Addiction Rehabilitation

Drug addiction is a public health problem of increasing importance worldwide. The number of people diagnosed with substance use disorder exceeds 15 million worldwide (World Health Organization, 2014). Technology-based treatment is reported to be an effective and low-cost intervention in treatment of addictive disorders such as alcohol, smoking, and drug (Newman et al., 2011). Addictive behavior emerged scenario is repeated through using VR and meanwhile counselor has opportunity to observe those behaviors and reacts of clients. The observations of the counselor assist in preparing the appropriate treatment plan for the client (Srivastava et al., 2014). VR use in substance use disorders has the potential to contribute to the development of exposure-based behavioral therapies (Saladin et al., 2006). VR has led to changes in cognitive-behavioral intervention and cue exposure (Bordnick et al., 2011).

Cue exposure is a potentially effective tool in treatment of addictive behaviors (Conklin & Tiffany 2002). In general, cue exposure therapy involves repeated exposure of an addictive person to stimuli previously associated with drug use to eliminate conditional responses to such cues (Conklin & Tiffany 2002). Use of VR allows creation of realistic and high-risk situations to reduce craving (Ticknor & Tillinghast, 2011).

Craving is accepted as an important diagnostic criterion and predictable relapse factor in substance use disorders. Individuals diagnosed with substance use disorder are vulnerable to social and environmental cues related to substance abuse, especially during recovery. In particular, substance-related environments and social relationships can trigger a craving. Existing behavioral therapies for substance use disorders use a cue exposure approach to reduce the effectiveness of social and environmental conditions that may trigger a craving. However, in real social and environmental conditions, craving outweighs behavior training. Here comes the importance of using virtual reality (Hone-Blanchet et al., 2014).

Previous studies have shown that use of VR is more effective or equal than cue exposure paradigms that reveal craving in adults. VR has become increasingly used as a cue exposure paradigm for substance users (Hersh, 2014). In addition, VR standouts in the acquisition of new skills in treatment (Hone-Blanchet et al., 2014).

Repeated exposure to drug cues during withdrawal has been proposed to reduce drug-related cue reactivity and thus reduce drug-seeking behavior in treatment modality using VR technology (Martin et al., 2010).

1.2. Use of Virtual Reality in Special Populations

Therapies using virtual reality are successfully used in treatment of specific diseases such as anxiety, post-traumatic stress disorder, and substance use. Substance use is a serious problem in offenders under the control of the criminal justice system and beyond the offenders under probation supervision, substance use is much higher than in the normal population. The use of virtual reality therapy, which works together with psychotherapeutic approaches, has been reported to be effective in the treatment of most of the offender-related diseases. The use of VR allows criminals to acquire skills and practice in a safe environment without having to be in high-risk environments. Offenders could be given therapeutic techniques such as aversion, exposure and cognitive behavioral therapy (Ticknor & Tillinghast, 2011).

The aim of this review is to investigate the applications of VR technology in the treatment and rehabilitation of substance use. First of all, the method of the study, how the published studies were selected and the criteria for which they were included were explained. The results of the studies included in the review were then evaluated. Finally, with the suggestions to be made for future studies, the study was finalized.

2. METHOD

After searching Pubmed, Science Direct, Proquest and EBSCOhost and Google Scholar databases in detail database searches were limited to years 2001-2010 and human studies published in English. Studies that were not written in English were not included in the review. Between 2001 and 2010, only 7 studies which include using VR technology in drug addiction treatment were reached. During the research on databases; “exposure therapy”, “virtual reality”, “substance use”, “drug” and “addiction” keywords were used.

3. DISCUSSION

The aim of this study is to review published studies, to analyze applications which include usage of VR technology in treatment of drug addiction and to make recommendations for future studies.

In the present study, each research is briefly summarized on the Table 1 and it represents studies that were using VR treatment and rehabilitation for people who were using cannabis, alcohol, nicotine, heroin, cocaine and methamphetamine. Information about which substance was studied, treatment conditions and the number of sessions, main findings, and limitations of the studies were given in the Table 1. The main purpose of this review is to focus on studies about VR technology for treatment and rehabilitation of substance/drug users such as cannabis, heroin, cocaine, methamphetamine, alcohol and/or cigarette etc..

When the results were examined it was observed that cannabis, alcohol, nicotine, heroin, cocaine, and methamphetamine were studied with virtual reality therapy and 7 studies were conducted with small or very small sample sizes, there were no studies with more than 22 participants, sessions were 1-time or 1-day treatment, Nicotine Cue Reactivity Assessment System(NCRAS) and Cue Exposure Treatment(CET) methodologies were used in addition to virtual reality in one study.

Results of a study suggest that a standardized and rich virtual reality environment significantly increases craving and physiological reactivity(Saladin et al., 2006). Virtual reality can have some ethical concerns such as cue exposure tends to increase craving as well as a television commercial for drug use and to minimize these risks they used cognitive therapy and progressive muscle relaxation technique(Kuntze et al., 2001). According to the study of Culbertson et al., (2010), during VR therapy, low craving participants exhibited lower cardiovascular activity while higher heart rate was measured on high craving participants. Physiological differences between the two groups of participants show online virtual reality cue models provide a new method that can increase craving in a laboratory(Culbertson et al., 2010). In the last study, it was stated that VR cannabis cue reactivity may be a new technology-based method in the development of addiction research and treatment(Bordnick et al., 2009).

Virtual reality therapy is a valuable tool for substance use disorders. On the other hand; the most important point of attention during the literature review is that there are very few studies on substance addiction treatment and rehabilitation by using virtual reality. 7 studies have been reached on the treatment and rehabilitation of substance use but most of the studies in the field of addiction are directed towards VR applications used in the treatment and rehabilitation of cigarette and alcohol addiction. The small number of studies reveals need for research in this field. In general, the limited number of samples is one of the most important limitations of the studies. Conducting researches to study larger sample groups in the future will provide statistically more significant results in field of virtual reality for substance use disorder and treatment/rehabilitation models by using virtual reality. The number of treatment/rehabilitation sessions may be considered as insufficient and it could be another important issue as a limitation. In order to be able to refer more accurate data about the effectiveness of VR use, the number of sessions can be increased and it is also very important to conduct follow-up studies to measure long-term effectiveness and observing patients' basic skills, social adaptation etc..

4. CONCLUSION

Treatment and rehabilitation models which include virtual reality technology should be studied more with interdisciplinary approach in different fields such as medical treatment, psychology,



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psychiatry, neurophysiology, toxicology and social work in the future, therefore effectiveness of virtual reality on rehabilitating people who have substance use disorder can be understandable and foreseen in long terms by follow- up study models. Although there is evidence that use of virtual reality is useful in treatment and rehabilitation of substance use disorders, it is still an open area to improvement. There is a need more focus on substance addiction by using virtual reality technology.

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ABBREVIATIONS

CET: Cue Exposure Treatment

IVR: Immersive Virtual Reality

NCRAS: Nicotine Cue Reactivity Assessment System

VR: Virtual Reality

VRT: Virtual Reality Technology

Table-1: Search Results of Virtual Reality Methodology for Substance Use Disorder

Authors	Substance/ Drug	Number of Sessions	Number of Participants (N)	Treatment Conditions	Main Findings	Limitations
Kuntze et al. (2001)	Heroin	1 – time	15	CET/IVR	Immersive Virtual Reality (IVR) is as good or even better in eliciting subjective and physiological classical devices	Small sample size No follow up
Saladin et al. (2006)	Cocaine	1- day session	12	VR	Virtual Reality Therapy has potential utility in exposure – based behavioral and pharmacological interventions	Small sample size

Bordnick et al. (2006)	Cannabis	1 session	20	VR	Offers a new technology – based method to advance addiction research and treatment	Small sample size
Bordnick et al. (2008)	Alcohol	1- day session	40	VR	“VR-ACRAS(Virtual Reality-Alcohol Cue Reactivity Assessment System) system increases in subjective alcohol craving when drinkers are exposed to VR alcohol cues compared to neutral VR cues”	The potential cost to set up and operate a system

Carter et al. (2008)	Nicotine	1 - day session	22	VR	“Multidimensional scaling models shows that smokers’ experience of craving is qualitatively, structurally different under VR smoking cue conditions versus neutral conditions.”	Small sample size The sample consists of only adult smokers
Traylor et al. (2008)	Nicotine	1- day Session	20	VR- NCRAS	“This study shows that young adults who smoke respond to increased	Small sample size
Culbertson et al. (2010)	Methamphetamine	1- day session	17	VR	Effective of a novel VR drug cue model created within an online virtual world	Small sample size No follow up

BIBLIOGRAPHY

Behavioral Interventions: Theory & Practice in Residential & Community Based Clinical Programs, 22(2), 121-135

Bordnick, P. S., Traylor, A., Copp, H. L., Graap, K. M., Carter, B., Ferrer, M., & Walton, A. P. (2008). Assessing reactivity to virtual reality alcohol based cues. *Addictive Behaviors*, 33(6), 743-756.

Bordnick, P. S., Copp, H. L., Traylor, A., Graap, K. M., Carter, B. L., Walton, A., & Ferrer, M. (2009). Reactivity to cannabis cues in virtual reality environments. *Journal of psychoactive drugs*, 41(2), 105-112.

Bordnick, P. S., Carter, B. L., & Traylor, A. C. (2011). What virtual reality research in addictions can tell us about the future of obesity assessment and treatment.

Bordnick, P. S., Yoon, J. H., Kaganoff, E., & Carter, B. (2013). Virtual reality cue reactivity assessment: A comparison of treatment-vs. nontreatment-seeking smokers. *Research on Social Work Practice*, 23(4), 419-425.

Botella, C., Quero, S., Baños, R. M., Perpiña, C., Garcia-Palacios, A., & Riva, G. (2004). Virtual reality and psychotherapy. *Cybertherapy*, 99, 37-52.

Carter, B. L., Bordnick, P., Traylor, A., Day, S. X., & Paris, M. (2008). Location and longing: The nicotine craving experience in virtual reality. *Drug and Alcohol Dependence*, 95, 73–80.

Conklin, C. A., & Tiffany, S. T. (2002). Applying extinction research and theory to cue- exposure addiction treatments. *Addiction*, 97(2), 155-167.

Culbertson, C., Nicolas, S., Zaharovits, I., London, E. D., Richard De La Garza, I. I., Brody, A. L., & Newton, T. F. (2010). Methamphetamine craving induced in an online virtual reality environment. *Pharmacology Biochemistry and Behavior*, 96(4), 454-460.

de Quirós Aragón, M. B., Labrador, F. J., & de Arce, F. (2005). Evaluation of a group cue-exposure treatment for opiate addicts. *The Spanish journal of psychology*, 8(2), 229-237.

Girard, B., Turcotte, V., Bouchard, S., & Girard, B. (2009). Crushing virtual cigarettes reduces tobacco addiction and treatment discontinuation. *CyberPsychology & Behavior*, 12(5), 477-483.

Havermans, R. C., Mulkens, S., Nederkoorn, C., & Jansen, A. (2007). The efficacy of cue exposure with response prevention in extinguishing drug and alcohol cue reactivity.

Hersh, J. R. (2014). *Can Computers Assist Treatment? Virtual Reality as a Possible Cue Exposure Technique With Adolescent Substance Abusers* (Doctoral dissertation, Duke University).

Hone-Blanchet, A., Wensing, T., & Fecteau, S. (2014). The use of virtual reality in craving assessment and cue-exposure therapy in substance use disorders. *Frontiers in human neuroscience*, 8, 844

Kuntze, M. F., Stoermer, R., Mager, R., Roessler, A., Mueller-Spahn, F., & Bullinger, A. H. (2001). Immersive virtual environments in cue exposure. *Cyberpsychology & behavior*, 4(4), 497-501.

Lee, J. H., Ku, J., Kim, K., Kim, B., Kim, I. Y., Yang, B. H., ... & Lim, Y. (2004). Experimental application of virtual reality for nicotine craving through cue exposure. *CyberPsychology & Behavior*, 6(3), 275-280.

Lee, J. H., Kwon, H., Choi, J., & Yang, B. H. (2007). Cue-exposure therapy to decrease alcohol craving in virtual environment. *CyberPsychology & Behavior*, 10(5), 617-623.

Lee, S. H., Han, D. H., Oh, S., Lyoo, I. K., Lee, Y. S., Renshaw, P. F., & Lukas, S. E. (2009). Quantitative electroencephalographic (qEEG) correlates of craving during virtual reality therapy in alcohol-dependent patients. *Pharmacology Biochemistry and Behavior*, 91(3), 393-397.

Marissen, M. A., Franken, I. H., Blanken, P., van den Brink, W., & Hendriks, V. M. (2007). Cue exposure therapy for treatment of opiate addiction: results of a randomized controlled clinical trial. *Psychotherapy and psychosomatics*, 76(2), 97-105.

Martin, T., LaRowe, S. D., & Malcolm, R. (2010). Progress in cue exposure therapy for the treatment of addictive disorders: a review update. *The Open Addiction Journal*, 3(1).

Montgomery, F. H., Leu, M. C., Montgomery, R. L., Nelson, M. D., & Sirdeshmukh, M. (2006). Use of a virtual reality driving simulator as an alcohol abuse prevention approach with college students. *Journal of Alcohol and Drug Education*, 50(3), 31.

Newman, M. G., Szkodny, L. E., Llera, S. J., & Przeworski, A. (2011). A review of technology-assisted self-help and minimal contact therapies for drug and alcohol abuse and smoking addiction: is human contact necessary for therapeutic efficacy?. *Clinical psychology review*, 31(1), 178-186.

North, M. M., North, S. M., & Coble, J. R. (1997). Virtual Reality Therapy: An Effective Treatment for Psychological. *Virtual reality in neuro-psycho-physiology: Cognitive, clinical and methodological issues in assessment and rehabilitation*, 44, 59.

Rebelo, F., Noriega, P., Duarte, E., & Soares, M. (2012). Using virtual reality to assess user experience. *Human Factors*, 54(6), 964-982.

Riva, G. (2003). Applications of virtual environments in medicine. *Methods of information in medicine*, 42(05), 524-534.

Srivastava, K., Das, R. C., & Chaudhury, S. (2014). Virtual reality applications in mental health: Challenges and perspectives. *Industrial psychiatry journal*, 23(2), 83.

Tal, A., & Wansink, B. (2011). Turning virtual reality into reality: a checklist to ensure virtual reality studies of eating behavior and physical activity parallel the real world.

Ticknor, B., & Tillinghast, S. (2011). Virtual reality and the criminal justice system: new possibilities for research, training, and rehabilitation. *Journal For Virtual Worlds Research*, 4(2).

Traylor, A. C., Bordnick, P. S., & Carter, B. L. (2008). Assessing craving in young adult smokers using virtual reality. *American Journal on Addictions*, 17(5), 436-440.

Traylor, A. C., Bordnick, P. S., & Carter, B. L. (2009). Using virtual reality to assess young adult smokers' attention to cues. *CyberPsychology & Behavior*, 12(4), 373-378.