Original Article

Comparison of the Effectiveness of Virtual Reality with Medication on the Memory of Attention Deficit Hyperactivity Disorder Students

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Abstract

Aims: The purpose of this study was to compare the effectiveness of virtual reality (VR) with medication on the memory of attention deficit hyperactivity disorder (ADHD) students. **Materials and Methods:** The research method was quasi-experimental with pretest, posttest, control and follow-up design. The statistical population consisted of 7–12-year-old elementary school students with ADHD in Isfahan city in the school year of 2018–2019 which 48 of them were selected through purposive sampling. Data were collected using the Swanson Parent Form SNAP-4, Memory Subscale of Wechsler's Intelligence Quotient (IQ), and Raven's Colored IQ Test. The VR group received ten sessions of intervention and the medication group received medicines. Then, posttest and follow-up were performed for all the three groups. Multivariate tests were used to analyze the scores. **Results:** The results showed that there was a significant difference in memory variables in the posttest stage between the control and VR groups ($P < 0.001$) and the control and medication groups ($P < 0.05$). **Conclusions:** In a general conclusion, it seems that VR therapy and medication have been effective in improving the memory of elementary ADHD students and the effects of these treatments remain in the follow-up stage, but the therapeutic approach of VR has been more effective than medication in both the posttest and follow-up stages.

Keywords: Attention deficit hyperactivity disorder, medication, memory, students, virtual reality

Introduction

Childhood development has certain stages and characteristics throughout life, and each stage has specific expectations and developmental tasks for them. Some children are not able to go through these stages and meet expectations and developmental tasks for various reasons. They are, therefore, distant from the majority of their peers and unable to exhibit behaviors appropriate to their level of development and face serious problems in social, educational, and adaptive behaviors. One of the disorders is attention deficit hyperactivity disorder (ADHD). It begins in childhood and its symptoms are inappropriate with the level of developmental evolution.[1]

Received: 25-Oct-2019 **Revised:** 03-Nov-2019
Accepted: 16-Nov-2019 **Published:** 17-Feb-2020

Access this article online

Quick Response Code:

Website: http://iahs.kaums.ac.ir

DOI: 10.4103/iahs.iahs_66_19

Children with ADHD have major functional problems in educational, family, and social settings. Adolescents with this disorder are at high risk of academic failure due to learning or language problems. Hyperactivity can lead to inferiority complexes, personality disorders, interpersonal problems, and even antisocial behaviors. According to the types of symptoms seen in ADHD, there are three types of ADHD manifestations: (1) frequently inattentive, (2) frequently impulsive, and (3) combined type.[2]

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How to cite this article: Tabrizi M, Manshaee G, Ghamarani A, Rasti J. Comparison of the effectiveness of virtual reality with medication on the memory of attention deficit hyperactivity disorder students. Int Arch Health Sci 2020;7:37-42.

Memory is one of the talents for recording and storing information when needed, but most of the time, things are not remembered when needed, and people forget. Memory, as the recording of information in the mind, forms the basis of learning. If we remove memory from human life, it will not be able to do anything, even daily behaviors, such as eating, dressing, talking, and the like. Memory is an action that encompasses past experiences. Memory holds current events and recalls past.[3] One of the major problems with ADHD children is their memory. They are often missing out on essentials and are known for being forgetful and unable to transfer information from short-term to long-term memory, thereby causing problems for themselves and others. The impairment of working memory also results in these children being weak in storing and retrieving information related to social functions and lacking the ability to efficiently process social cues.[4] These children generally have problems with spatial visualization, attention, expressive language, language comprehension, learning, speaking, reading, and writing.[5] Working memory deficits are associated with a range of adverse outcomes in children with ADHD, including learning and language impairment, impaired academic performance, learning disabilities, inattention to speech, and impaired social interactions.[6] Memory deficits are more common in hyperactive children.[7]

Numerous therapeutic approaches have been used to treat the disorder, including neurofeedback and medication. Although these methods have had some successes in treatment, there are major deficiencies. The use of neurofeedback may cause headaches and dizziness in the first few sessions of treatment, and it cannot be said to be a definitive method of treatment for ADHD. On the other hand, it is a method that requires a great deal of time and cost.[8] The results of a cross-sectional single-blind study that examined the effect of neurofeedback on ADHD showed that previous studies have failed to conclusively establish the effect of neurofeedback on ADHD.[1] Medication effects are temporary and only limited to the short time the medicine is used, especially when it is used for children during school hours. In addition, the dangerous physical side effects of medicines result in families and physicians not being overly happy with medication.[9,10]

About three decades ago, a person named Jaron Lanier introduced virtual reality (VR) into the field of treatment.[11] The use of VR for the treatment of various psychiatric disorders and its effectiveness in various researches has been confirmed.[12] VR is a complex user encounter that involves real-time simulation by multiple sensory channels. VR puts the user in a computer-generated three-dimensional environment in which real-life experiences are simulated and the user can communicate with the virtual world through their senses as if one is truly in this virtual world.[13,14] Researches published over the past few years on VR have been studied, and it has been found that 24 studies have confirmed the efficacy of this method in the treatment of mental disorders.[15,16] VR technology provides new opportunities for expanding new clinical research, evaluation, and interventional tools. Implementation of tests, training, teaching, and treatment of VR, which are difficult but not impossible, are expanding and evolving along with traditional and classical methods.[17] A number of studies have examined social anxiety, school refusal, hyperactivity, and autism, and numerous studies have proven the effectiveness of VR as a treatment.[12]

This method has many benefits, including the possibility of structured treatment such as a special and supportive position, the creation of a fear-free activity, the use of role-play, handling one's own fears and overcoming the real world, the possibility of providing education, making it possible to go beyond reality, therapist's mastery at any point of time to the subjects' observations, assistance to solve the problem of subjects' aversion to dealing with the created environment, the possibility of better participation and more inclusive learning, the possibility of the subjects' integrated assessment, and helping to rehabilitate their cognitive abilities.[18]

The research gap is that in our country, VR therapy has not been used to treat ADHD and improve memory. Given the side effects of some therapies in children with ADHD, as well as issues and problems caused by hyperactivity in individuals, families, and society, it seems that VR can be used to treat this group of people free of any side effects. Based on searches conducted by the researcher so far in Iran, the effect of VR and its comparison with other treatments on symptoms of ADHD has not been investigated; thus, the purpose of this study was to investigate the effect of VR on the memory of children with ADHD compared to medication. Research questions are as follows: (1) Does VR therapy have a significant effect on the memory of children with ADHD? (2) Does medication have a significant effect on the memory of children with ADHD? (3) Is there a significant difference between the effectiveness of VR therapy and medication on memory in children with ADHD?

Materials and Methods

This is a quasi-experimental study with pretest, posttest, control group and 2-month follow-up. Independent variables included VR therapy and medication, and the dependent variable was memory impairment. The statistical population of the study included all male and female students of an elementary school in Isfahan city who were referred to educational counseling centers for the treatment of ADHD in the academic year 2018–2019. The sample consisted of 48 people who had diagnosed as ADHD by psychiatrists and had intellectual ability with 81 or higher intelligent quotient (IQ), no vision and hearing impairments, and no medication taking for 3 weeks before starting the study, according to the inclusion criteria. They were randomly selected and assigned into three groups of 16 (VR as the first experiment group, medication as the second experiment group, and the control group). Their parents had signed a consent form to participate their children in the study. This research has the ethics code number IR IAU.KHUISF.REC.1398.012 from Islamic Azad University, Isfahan (Khorasgan) branch.

The SNAP-4 questionnaire parent form was used to measure ADHD and completed by the parents. This scale can provide three types of hyperactivity: inattentive type with a cutoff point of 1.78, impulsive type with a cutoff point of 1.44, and combined type with a cutoff point of 1.67. This test has 18 questions and has appropriate validity and stability such that Cronbach's alpha was reported 0.94 for combined, 0.90 for inattentive, and 0.79 for impulsivity types.[19] The validity coefficient of this test has been reported by means of test–retest 0.86, Cronbach's alpha coefficient of 0.90 and split-half coefficient of 0.76.[20] In this study, Cronbach's alpha was 0.79.

The digit span subscale that measures short-term memory is a subset of the verbal scale of Wechsler Children's Intelligence Test.[21] Its split-half reliability was 0.42–0.98 and test–retest reliability was 0.44–0.94. The concurrent validity of this scale was reported to be 0.74. Correlation coefficients of verbal, performance, and total IQs were reported to be 0.84, 0.86, and 0.80, respectively.[22] The reliability coefficient was 0.85 in the present study.

The Raven's Progressive Matrices Test is one of the nonverbal intelligence tests to test children aged 5–11 years and mentally retarded adults.[23] Internal consistency for children 6–11 years ranged from 0.76 to 0.88 and the split-half reliability coefficients of 0.81–0.90.[24] This test was used to match hyperactive children's IQ above 81. In this study, the reliability coefficient was 0.89.

VR therapy software is a software that uses the 360° Samsung VR camera to build it.[25] At the end of each session, students in the class were asked to respond to the target image. During offering different stimuli, audio-visual intruders entered the scene once every few seconds and could distract the students' concentration. Ten sessions of 3-min filming were made, from very easy to very difficult. The software was stored in the memory of the VR Box camera. In this study, the content validity ratio[26] of this software was 0.99.

A copy of the tests was stored inside the Acer laptop so that the students could immerse in virtual classroom environments and respond individually to stimuli while watching through the camera by pressing the space bar button on the laptop system. Intrusive stimuli were also introduced during the test to enhance their concentration and attention. As the number of sessions increased, the difficulty increased, and the number of intrusive stimuli increased and intensified. Table 1 provides a summary of VR therapy sessions.

The medication experiment group received treatment with medicines such as Ritalin, atomoxetine, and dexamphetamine, while the control group did not receive any intervention. At the end of the intervention, posttest, and 2 months later, follow-up was performed for all three groups. Data were analyzed using descriptive statistics, mean, standard deviation (SD), and inferential level by covariance analysis.

Results

The range of education level of students was 2–6 (mean = 3.46, SD = 1.688) with Grades 2 (age 8, 18.75%), 3 (age 9, 18.75%), 4 (age 10, 25%), 5 (age 11, 25%), and 6 (age 12, 12.5%). The age range was 8–12 years (mean = 9.58 years, SD = 1.8). Of 48 students, 32 (66.7%) were boy. The number of IQ score levels for below average was 11 (22.91%), average 22 (45.85%), above average 13 (27.08%), and superior 2 (4.16%). In Table 2, the descriptive findings including mean and standard deviations of VR, medication and control groups are listed. The mean memory scores in the intervention groups were significantly higher in the posttest and follow-up than in the control group.

The results of the implementation of the Kolmogorov–Smirnov test of the presumption regarding the scores of the research variables showed that the null hypothesis that implies the normality of distribution of the scores in the research variables in all three stages of pretest, posttest, and follow-up in all three groups is normal (all levels were significantly higher than 0.05). The results of Levene's test of homogeneity of variances showed that in the memory variable in the pretest stage (sig = 0.538, $F = 0.628$), in the posttest stage (sig = 0.223, $F = 1.49$), and also in the follow-up stage (sig = 0.717,

Table 1: A summary of virtual reality therapy sessions

Session	Description
1. Very easy	Teaching very easy tasks along with one target and some intruder stimuli
2. Very easy	Teaching very easy tasks along with one target and some intruder stimuli
3. Easy	Teaching easy tasks along with one target and some intruder stimuli
4. Easy	Teaching easy tasks along with one target and some intruder stimuli
5. Medium	Teaching medium tasks along with one target and some intruder stimuli
6. Medium	Teaching medium tasks along with one target and some intruder stimuli
7. Difficult	Teaching difficult tasks along with one target and some intruder stimuli
8. Difficult	Teaching difficult tasks along with one target and some intruder stimuli
9. Very difficult	Teaching very difficult tasks along with two targets and some intruder stimuli
10. Very difficult	Teaching very difficult tasks along with two targets and some intruder stimuli

Table 2: Descriptive findings of memory variable in three groups and three stages of research

Group	Mean±SD		
	Pretest	Posttest	Follow-up
Virtual reality	7.94 (2.4)	11.19 (1.72)	10.38 (1.96)
Medication	7.38 (2.77)	8.06 (3.02)	7.88 (2.89)
Control	6.06 (1.77)	5.94 (1.39)	6.13 (1.45)

SD: Standard deviation

$F = 0.335$), homogeneity of variances was obtained and the sum of the results shows that the presumption is confirmed in all three stages.

The results of the Box test were obtained to examine the homogeneity of the variance-covariance matrices in the memory variable (Mbox = 25.63, $F = 1.92$, sig = 0.053), which confirms the presumption in the memory variable. Mauchly's test results were also obtained to test the uniformity of covariance in groups for this variable (Mauchly's $W = 0.889$, $\chi^2 = 5.05$, sig = 0.08) indicating no confirmation of this presumption in the memory variable. To investigate the role of demographic characteristics for control in the research variables, the results of correlation analysis between memory and age (sig = 0.896, $r = 0.017$) and IQ (sig = 0.033, $r = 0.26$) were obtained. It was shown that the relationship between memory and IQ was significant but was not significant between memory and age.

The results of Table 3 show that multivariate analysis for the memory variable is not significant for the effect of time and interaction of time and IQ ($P > 0.05$) but is significant for time interaction and group membership ($P < 0.001$). In other words, the difference between the pretest, posttest, and follow-up stages in general and the effect of IQ on them were not significant. However, the process of research stages, i.e., pretest, posttest, and follow-up or time effect, was different in the three groups ($P < 0.001$).

According to the findings in Table 4, the mean scores of memory in the experiment (VR and medication) and control groups were significantly different ($P < 0.001$). The results showed that 36.4% of the individual differences in the memory variable were related to the differences between the three groups.

The results of Table 5 show that there is no significant difference between the mean of memory scores in the pretest, posttest, and follow-up stages and the effect of IQ was not significant ($P > 0.05$). However, the interaction of time effect and group membership was significant in this variable ($P < 0.001$). In other words, the difference in the memory scores of the research stages in the three groups was significant, indicating that the process of changing the scores in the research stages in the three groups was different. The difference is 0.397. That is, 39.7% of the variance or individual differences in memory variables were related to the differences between the three test stages and group membership. It can be concluded that the effects of VR and medication may be different in improving the memory of ADHD students.

The results in Table 6 show that there was no significant difference between the mean scores of memory in all three groups in the pretest stage. However, the results showed that there was a significant difference between the control group and the VR group ($P < 0.05$) and medication ($P < 0.05$) in both

Table 3: Results of multivariate analysis of memory scores

Variable	Value	*F*	Hypothesis df	Error df	Significant	Partial η^2	Observed power
Time effect							
Pillai's trace	0.038	0.854	2	43	0.433	0.038	0.187
Wilks' lambda	0.962	0.854	2	43	0.433	0.038	0.187
Time effect × IQ							
Pillai's trace	0.013	0.298	2	43	0.75	0.013	0.093
Wilks' lambda	0.987	0.289	2	43	0.75	0.013	0.093
Time effect × group							
Pillai's trace	0.568	8.72	4	88	0.001	0.284	1.000
Wilks' lambda	0.434	11.15	4	86	0.001	0.341	1.000

IQ: Intelligent quotient

Table 4: Results of the analysis of between subject effects for memory variables

Source	Sum of squares	df	Mean squares	*F*	Significant	Partial η^2	Observed power
IQ	20.16	1	20.16	1.54	0.22	0.034	0.229
Group	328.52	2	164.26	12.58	0.001	0.364	0.994
Error	574.232	44	13.051				

IQ: Intelligent quotient

Table 5: Results of the analysis of the within-subject effects in the research stages and interaction of the stages and groups

Source	Sum of squares	df	Mean squares	*F*	Significant	Partial η^2	Observed power
Time effect	1.303	2	0.652	0.713	0.493	0.016	0.167
Time effect × IQ	0.37	2	0.185	0.202	0.817	0.005	0.081
Time effect × group	52.99	4	13.25	14.49	0.001	0.397	1.000

IQ: Intelligent quotient

Table 6: Results of parameter estimation for comparison of three groups in three stages of research

Stage	Comparison	*B*	Standard deviation error	*t*	Significant	Partial η^2	Observed power
Pretest	Virtual reality with control	1.55	0.832	1.88	0.057	0.095	0.556
	Medication with group	1.302	0.828	1.57	0.123	0.053	0.336
	Virtual reality with medication	0.458	0.831	−0.584	0.562	0.008	0.088
Posttest	Virtual reality with control	5.18	0.768	6.75	0.001	0.509	1.000
	Medication with group	2.11	0.765	2.77	0.008	0.148	0.772
	Virtual reality with medication	−3.068	0.767	−3.99	0.001	0.267	0.974
Follow-up	Virtual reality with control	4.16	0.77	5.404	0.001	0.399	1.000
	Medication with group	1.74	0.776	2.27	0.028	0.105	0.71
	Virtual reality with medication	−2.42	0.77	−3.14	0.003	0.184	0.899

the posttest and follow-up stages. The effect of VR therapy and medication on memory improvement in posttest was 50.9% and 14.8%, respectively, and the effect of these treatments in follow-up was 39.9% and 10.5%, respectively. Based on the results of the memory variable in both the posttest and follow-up stages, the difference between the VR and medication groups was significant ($P < 0.05$). In both the posttest and follow-up stages, VR and medication had significantly different effects on memory improvement.

Discussion

The results showed that VR therapy similar to medication improved memory in children with ADHD in both the posttest and follow-up stages. VR therapy has shown efficacy in the treatment of ADHD.[12,15] The findings of the present study are in line with the findings of Krokos *et al*.[27] who showed that VR can provide remarkable recall abilities in people with ADHD, as well as with Guazzaroni[28] and Bréchet[29] who believed that delayed retrieval could be accelerated by immersion in virtual scenes.

VR can be a substitute for methods such as medication, neurofeedback, and cognitive-behavioral interventions, with low cost and no side effects. It means that VR system can be used instead of drugs, neurofeedback, and cognitive behavioral therapy. C reating a happy and relaxed environment for hyperactive children while immersed in a situation that does not pose a threat to them is another advantage of the VR approach. The mechanism of performance of VR resembles that of the brain itself, that is, simulated immersion. This means that the human brain, in order to better control and regulate the body, creates a simulated immersion of the body into the real world.[15] VR can turn an inactive learning experience into an active performance. The goal of using VR in the treatment of children with ADHD is to engage students fully in the learning experience by immersing them in the learning experience, increasing their attention and concentration, while also enhancing their memory. VR captures and sustains attention. VR simulations create the full concept of presence, so the ADHD child enters the simulated world, not merely observing it. The use of VR in the treatment of ADHD allows the child to evaluate his or her practical skills and will enjoy it as he or she learns.

Conclusions

In this study, subjects created a sense of interaction between themselves and the virtual world. That is, they felt that they could communicate with the world around them. Another feature of the study was the combination of a sense of immersion and a sense of interaction between the child and the virtual world. This feeling makes all these children's attention focused on the virtual world and unaware of what is happening to them in the real world at that moment. It means that the immersion of children in the virtual world makes them not to consider the real world and not to worry about it. During the VR process, the intrusive stimuli that enter the scene during the sessions are well controlled by the learners and learn how to focus their attention only on lessons and instruction.

In a general conclusion, both VR therapy and medication seem to have a significant effect on memory improvement in students with ADHD, and this effect remains at follow-up, but the effectiveness of VR on memory was higher than medication at both stages. It means that VR therapy was more effective than using medication. Given that the study was conducted on a small sample, one should be very cautious about generalizing it to the whole community. One of the limitations of this study is that this study was conducted on primary school students with ADHD aged 7–12 years in Isfahan city, so generalization of the results to other age groups and other cities should be refused. This study was conducted on students with ADHD and should not be generalized to other childhood disorders. It is better for future researchers to generalize the findings to the larger community by selecting larger sample sizes. It is recommended that further research be conducted on adolescents and adults with ADHD. Similar research is also suggested in other parts of the country. Given that no such research has been done in our country, we can hope to cure this disorder in the near future. According to the results of this study, it can be concluded that VR can be used as an alternative and complementary method to improve memory performance of children with ADHD.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

References

1. Cortese S, Panei P, Arcieri R, Germinario EA, Capuano A, Margari L, *et al*. Safety of methylphenidate and atomoxetine in children with attention-deficit/hyperactivity disorder (ADHD): data from the Italian national ADHD registry. CNS Drugs 2015;29:865-77.
2. Butcher J, Mineka S, Hooly J. Psychopathology. Volume 1, Translated by Seyed Mohammadi Y. Tehran: Arasbaran Publication 2018.
3. Ganji H. General Psychology. 2nd ed. Tehran: Savalan Publishing; 2017.
4. Phillips KL, Schieve LA, Visser S, Boulet S, Sharma AJ, Kogan MD, *et al*. Prevalence and impact of unhealthy weight in a national sample of US adolescents with autism and other learning and behavioral disabilities. Matern Child Health J 2014;18:1964-75.
5. Baghdasarian A, Golshani F, Qashqaee M. Comparison of perceptual error and children's intelligence profile. J Psychol Res 2014;6:49-64.
6. Alloway TP, Cockcroft K. Working memory in ADHD: A comparison of British and South African children. J Atten Disord 2014;18:286-93.
7. Castellanos FX, Sonuga-Barke EJ, Milham MP, Tannock R. Characterizing cognition in ADHD: Beyond executive dysfunction. Trends Cogn Sci 2006;10:117-23.
8. van Doren J, Arns M, Heinrich H, Vollebregt MA, Strehl U, Loo KS. Sustained effects of neurofeedback in ADHD: A systematic review and meta-analysis. Eur Child Adolesc Psychiatry 2019;28:293-305.
9. Blum NJ, Shults J, Harstad E, Wiley S, Augustyn M, Meinzen-Derr JK, *et al*. Common use of stimulants and alpha-2 agonists to treat preschool attention-deficit hyperactivity disorder: A DBPNet study. J Dev Behav Pediatr 2018;39:531-7.
10. Collingwood J. Side Effects of ADHD Medications. Psych Central; 2016. Available from: https://psychcentral.com/lib/side-effects-of-adhd-medications. [Last retrieved on 2017 May 28].
11. Rosenberg S. Dreaming in Code: Two Dozen Programmers, Three Years, 4,732 Bugs, and One Quest for Transcendent Software. Hardcover. New York: Crown Publishing Group, a Division of Random House, Inc.; 2007.
12. Bioulac S, de Sevin E, Sagaspe P, Claret A, Philip P, Micoulaud-Franchi JA, *et al*. What do virtual reality tools bring to child and adolescent psychiatry? Encephale 2018;44:280-5.
13. Manshaee Gh, Eslami P, Haj Ebrahimi Z. The effectiveness of virtual reality exposure therapy on reducing anxiety in people with flight phobia. J Clin Pers Psychol 2018;17:191-99.
14. Garrett B, Taverner T, Gromala D, Tao G, Cordingley E, Sun C. Virtual reality clinical research: Promises and challenges. JMIR Serious Games 2018;6:e10839.
15. Riva G, Wiederhold BK, Mantovani F. Neuroscience of virtual reality: From virtual exposure to embodied medicine. Cyberpsychol Behav Soc Netw 2019;22:82-96.
16. Nolin P, Stipanicic A, Henry M, Lachapelle Y, Lussier-Desrochers D, Allain P, *et al*. Classroom-CPT: A virtual reality tool for assessing attention and inhibition in children and adolescents. Comput Human Behav 2016;59:327-33.
17. Rizzo AS, Sebastian Thomas Koenig ST, Talbot TB. Clinical Virtual Reality: Emerging Opportunities for Psychiatry; 2018.
18. Botella C, Quero S, Baños RM, Perpiñá C, García Palacios A, Riva G. Virtual reality and psychotherapy. Stud Health Technol Inform 2004;99:37-54.
19. Bussing R, Fernandez M, Harwood M, Wei Hou, Garvan CW, Eyberg SM, *et al*. Parent and teacher SNAP-4 ratings of attention deficit hyperactivity disorder symptoms: Psychometric properties and normative ratings from a school district sample. Assessment 2008;15:317-28.
20. Sadr al-Sadat SJ, Hoshyari Z, Zamani R, Sadr al-Sadat L. Determining the psychometric properties of SNAP-4 parent scale. Rehabilitation 2007;8:59-65.
21. Pasha Sharifi H. Theory and Application of Intelligence and Personality Tests. Tehran: Sokhan; 2016.
22. Shahim S. Standardization of Wechsler Intelligence Scale for children in Shiraz. Shiraz Univ J Soc Human Sci 1992;14:123-54.
23. Anastasia A. Psychometric. Translated by Mohammad Naghi Barahani. Tehran: Tehran University Press; 2008.
24. Cotton SM, Kiely PM, Crewther DP, Thomson B, Laycock R, Crewther SG. A normative and reliability study for the raven's colored progressive matrices for primary school aged children from Victoria, Australia. Pers Individ Dif 2005;39:647-59.
25. Rasti J, Manshaee Gh, Eslami P. Construction and validation of virtual reality software for flight phobia treatment. Sci Res Appl Psychol 2018;19:27-35.
26. Mohseni Ezhiyeh A, Ghamrani A. Psychometric characteristics of the persian version of multidimensional state of boredom scale (PV-MSBS) in mothers of children with autism spectrum disorder. J Rafsanjan Univ Med Sci 2016;15:821-34.
27. Krokos E, Plaisant C, Varshney A. Virtual memory palaces: Immersion aids recall. Virtual reality 2019;23:1-15.
28. Guazzaroni G. Autism Spectrum Disorder (ASD) and Attention-Deficit/Hyperactivity Disorder (ADHD) Children: From users to creators of virtual reality learning content. In Virtual and Augmented Reality in Mental Health Treatment. IGI Global; 1 ed. 2019. p. 176-98.
29. Bréchet L, Mange R, Herbelin B, Theillaud Q, Gauthier B, Serino A, *et al*. First-person view of one's body in immersive virtual reality: Influence on episodic memory. PLoS One 2019;14:e0197763.