

*Original Article*

# The Effectiveness of Computer Games Rehabilitation and Cognitive Play Therapy Rehabilitation on the Risk-Taking of Children with Attention Deficit Hyperactivity Disorder

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## Abstract

**Background and Aim:** Attention Deficit Hyperactivity Disorder (ADHD) is one of the most prevalent disorders of childhood with several consequences. This study aimed to compare the effectiveness of cognitive computer games rehabilitation and play therapy based on cognitive rehabilitation on the risk-taking of children with attention deficit hyperactivity disorder.

**Materials and Methods:** The research method was semi-experimental with a pretest-posttest, a waiting list, and a one-month follow-up design. The statistical population included all children aged 7 to 12 with attention deficit hyperactivity disorder in Karaj City. The participants, 24 children referred to the Razi counseling center in 2020-2021, were selected by the convenience sampling method and were randomly assigned to cognitive computer games (8 children), cognitive play therapy (8 children), and control (8 children) groups. The experimental groups received the interventions, while the control group stayed on the waiting list and received no treatment during research. The balloon analog risk task (BIS) was used to collect data. Analysis of variance with repeated measures and Bonferroni's post hoc tests were used for data analysis.

**Results:** The findings showed that cognitive computer games and play therapy based on cognitive rehabilitation are effective in the risk-taking of children with attention deficit hyperactivity disorder ( $P < 0.05$ ). Also, the findings showed a significant difference between the effectiveness of the two interventions in risk-taking.

**Conclusion:** Play therapy based on cognitive rehabilitation was more effective than cognitive computer games in reducing risk-taking.

**Keywords:** Cognitive computer games, Play therapy, Cognitive rehabilitation, Risk-taking, Attention deficit hyperactivity disorder

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## Introduction

Attention deficit hyperactivity disorder (ADHD) is a neurodevelopment disorder characterized by a persistent pattern of inattentive, hyperactive, and impulsive behavior (1). One problem of hyperactive children is risk-taking, i.e. they easily put themselves in danger. Risk-taking is engaging in behaviors associated with potentially dangerous, unpleasant, destructive physical, psychological, and social outcomes (2). They show uncontrollable and sudden reactions to a stimulus, which can be risky in many situations (3). Risk-taking is usually associated with reduced function in cognitive regulation structures, including the lateral prefrontal cortex (4).

Evidence suggests that ADHD is often associated with increased participation in risky behaviors, including smoking, substance abuse, gambling, and unprotected sex (5). Multifactorial aspects of ADHD, such as deficits in behavioral inhibition, impulsivity, and executive control, have been hypothesized as the main reason for increased vulnerability in these children (6). The cognitive process is more influential among the factors influencing risk-taking and risky decision-making. A decision-maker with a defect in attention and memory capacity cannot remember all available decision-making options at the time. Also, to choose the right decision, selective attention is required, and the capacity of attention to consider different subsets of information plays an essential role in decision-making. Therefore, executive functions are one of the main factors influencing the decision-making defects of ADHD cases (7).

Many interventions were carried out to reduce children's cognitive problems, among which the cognitive rehabilitation approach is shown to be more helpful in rehabilitating and strengthening cognitive components by using exercises and cognitive tasks to improve functions. According to the brain plasticity hypothesis, cognitive rehabilitation focuses on improving executive function indicators. It is safe and does not have complications of medication with long-term effects (8). One of the main factors that play an essential role in the decision-making and risk-taking of people with ADHD is the defect in executive function involved in cognitive regions of the brain.

Accordingly, the researchers selected two interventions focused on cognitive rehabilitation in this study. Play-related cognitive and social skills are necessary for success in school, and cognitive-based games increase cognition more than other activities (9). However, in previous studies that have dealt with the effectiveness of play therapy or game therapy, most interventions have not been based on cognitive rehabilitation.

Computerized cognitive rehabilitation programs use a model adapted to brain nature (the difficulty of the activity increases or decreases depending on the student's performance). These programs have shown performance gains in various cognitive tasks (10). In computerized cognitive rehabilitation, the treatment program is supported by the therapist, which significantly reduces the therapist's time and effort compared to play therapy. Computer-assisted cognitive rehabilitation is a strategy that can make treatment widely available, reduce costs, and provide learning experiences and data-tracking capabilities (11). Studies have shown the effectiveness of computer game therapy for children; for example, one study found that computer-based cognitive training was effective on the working memory of children with ADHD (12). In a study, Nejati reported the effectiveness of cognitive rehabilitation through computer games has improved inhibition in children with ADHD (13). Ayouzi, Yazdanbakhsh, and Moradi (14) concluded in their research that computer-based cognitive rehabilitation has improved executive function and response inhibition in children with ADHD. However, in the study of Arshadhi and colleagues (15), no difference was observed between the two experimental groups of cognitive rehabilitation of inhibitory control, electrical stimulation of the brain, and the combination of rehabilitation of inhibitory control and electrical stimulation of the brain.

According to the relevant literature, due to the presence of executive dysfunction and impulsive behaviors that increase risk-taking in children with ADHD, they face many problems in various social and educational areas; therefore, the importance of effective intervention for these children is emphasized. Also, the theoretical foundations mentioned in both cognitive rehabilitation interventions (play therapy based on cognitive rehabilitation and computerized game cognitive rehabilitation) show the effect of both types of

interventions on the cognitive system. Although these two methods have differences in implementation and the amount and type of effectiveness, there is no information in this area. Therefore, in the present study, the question is whether play therapy based on cognitive rehabilitation and computerized cognitive rehabilitation are effective in risk-taking in children with ADHD. Given that no study has yet compared these two methods of intervention, and given the importance of finding the most effective method for the cognitive rehabilitation of children with ADHD, the main question is whether there is a difference between these two methods of intervention.

## Methods

A pretest-posttest design, waiting list, and one-month follow-up were used in this semi-experimental study. The statistical population of the current study consisted of all children aged 7 to 12 years with attention deficit hyperactivity disorder who were referred to Razi Karaj Counseling Center in 2020 and 2021. After obtaining the necessary permissions from the university, the researcher referred to the Razi Counseling Center (Karaj City), and the children with ADHD were identified and re-examined by a psychologist. A clinical interview was performed with the child and parents to confirm the diagnosis by a psychiatrist. Children who met the criteria selected. Inclusion criteria were: age between 7 and 12 years, living with both parents, diagnosed with ADHD, having an IQ of 90 and above (according to the Children's Raven IQ Test), the child's interest or cooperation, and obtaining written consent from the child's parents to participate in the research. Exclusion criteria included physical disability, concurrent use of cognitive interventions such as neurofeedback and medications, coexistence of other psychiatric disorders based on clinical interviews, and absenteeism. The participants were matched through IQ tests and randomly divided into three groups (8 people in each group). The first group received cognitive computer games intervention, the second group received play therapy based on cognitive rehabilitation, and the third group was on the waiting list. A pretest was administered to all participants using the Bart Test (BIS). One week after the

completion of the sessions, a posttest was administered to the participants, and a feedback session was held with the parents. A similar questionnaire was distributed one month later. To observe ethical considerations, participants were informed of the purpose of the research, the confidentiality of their information, and the freedom to withdraw from the study. Also, a written consent form was obtained from the student's parents.

## Materials

### Raven IQ Test

The Raven IQ Test was developed and revised by Raven in 1956 to measure children's IQ. It contains 36 geometric shapes with three sets and six shapes under each geometric shape. The minimum score is zero, and the maximum score is 36. According to the report of Cotton et al., the reliability coefficient of this test is 0.86 to 0.92 for the age group of 6 to 14 years (16). In an Iranian study, the test-retest reliability and validity coefficients of Raven's test for children were 0.62 and 0.41, respectively (17).

### Bart test (BIS)

The Bart Balloon Analog Risk Task Test is used to measure risk-taking decisions. One of the advantages of this test is that it is not culture-dependent. It was developed on a neurological basis. In this test, the picture of a balloon appears on the screen; below each balloon, there is a button to inflate and two boxes, one a temporary box and the other a permanent box. The subject starts to inflate the balloon by pressing the button. More money appears in the temporary fund as more balloons are inflated. Instead of inflating more balloons, the subject can press the button to collect money, and then a new balloon will appear, and the permanent fund receives the money from inflating the previous balloon. If the balloon bursts, the money in the temporary fund will decrease. Balloons burst at an unspecified point, so a person loses money from the temporary fund by inflating it too much and bursting, and if it does not burst and replace the new balloon, the money from the temporary fund is transferred to the permanent fund; in this way, it is possible to measure high-risk or risk-taking decisions. People with higher risk tolerance tend to ignore the bursting of the balloon in favor of increasing the money in the temporary fund. Cronbach's alpha of this test was 80% (7).

The intervention program of cognitive computer games and play therapy based on cognitive rehabilitation was conducted by the researcher at Razi Clinic in 12 sessions (45 minutes). During the training sessions, no intervention was performed for the waiting list. An attempt was made to ensure that the environmental conditions were the same for both experimental groups. For cognitive computer games, two software were used, my Brain and Training to Improve Active Memory by Turkel Klingberg et al. at Karolinska Institute (2007). This collection includes 20 different games. Each game is designed to strengthen one or more areas of the brain. In all games, the results of various stages can be saved and compared. Memory training researchers such as

Klingberg and his colleagues at the Karolinska Institute and Stanford University have studied working memory and ways to improve it for several years. To train working memory, they used computer software called "RoboMemo." It can be used to strengthen the memory of children and adults by training forward, backward, and consolidation memory. This program, modified and revised for the last time in 2018, resulted from years of research and programming. The play therapy package based on cognitive rehabilitation consists of twelve 45-minute sessions carried out twice a week. It is a researcher-made package adapted from reliable research sources (18, 19). Five experts in the field confirmed its face and content validity.

**Table 1.** Content of play therapy sessions based on cognitive rehabilitation

Session	Task
1	Pre-test and initial familiarization, including getting to know the children + preparing the environment for the intervention + introducing the method and duration of the sessions
2	Sharp-eyed game + pen and paper game + finding the differences
3	Hub game + pen and paper game + writing words without dots among the words provided
4	Puzzle game + pen and paper game + training cards
5	Sit and walk with ball and basket code, pen and paper game
6	Memory game (look and say)
7	Moving objects in the room
8	Story (question about the content of the story)
9	The game of placing objects under the glass + using sentences or short text without letters
10	Defining the story of the lying shepherd without using the next word
11	Identifying the heard codes of the story
12	Making colored cubes with pattern + post-test

## Results

In this study, the number of girls and boys was equal (12 girls and 12 boys). The average age of the participants was 8.29, with a standard deviation of 2.18. In the descriptive part, analysis was conducted using frequency, percentage, mean, and standard deviation. Covariance analysis was used to analyze the data after observing all assumptions, including Kolmogorov-Smirnov, test M-box, regression slope, and Levin's test, through SPSS version 26 software. The obtained results show that the total average risk-taking in the computer games group was 38.84 in the pre-test and 63.79 in the post-test, which showed some reduction, and this average reduction was almost

present in the follow-up phase. In the cognitive rehabilitation group, the average total risk-taking was associated with a relatively significant decrease in the post-test, which was also true in the follow-up stage (Table 2). Covariance analysis was used to compare the effectiveness of the two treatment methods, controlling for the groups' pretest scores.

Table 3 shows that the effectiveness of the two therapeutic methods, cognitive computer games and play therapy based on cognitive rehabilitation, on total risk-taking and the burst balloon component were significantly different. Based on the adjusted means, it can be concluded that the play therapy intervention based on cognitive rehabilitation is significantly more effective than cognitive computer games ( $P < 0.05$ ).

Table 4 shows the adjusted means. Examining the adjusted means (Table 4) showed that in the play therapy based on cognitive rehabilitation, the mean difference of the total risk-taking was 3.10,

and the mean of the burst balloon component was 1.35 higher than in the cognitive computer games group ( $P>0.05$ ).

**Table 2.** The average and standard deviation of risk-taking and its components in groups

Variable	Time	Computerized game therapy		Play therapy		Waiting list	
Inflated balloon	Pre-test	30.88	1.46	32.25	1.49	33	1.6
	Post-test	29.25	1.28	28.13	0.84	35	2.39
	Follow up	29.88	1.13	28.5	1.2	35.13	2.03
Non-Inflated balloon	Pre-test	4.5	0.54	4.63	0.52	5	0.76
	Post-test	4.25	0.46	3.88	0.64	4.88	0.35
	Follow up	4.38	0.52	3.88	0.64	5.13	0.84
Score	Pre-test	21.75	0.89	22.25	0.89	21.36	0.74
	Post-test	19.88	1.46	19.38	1.19	23.5	1.77
	Follow up	20	1.77	19.25	1.39	22.25	1.91
Max pumps	Pre-test	27.25	0.71	27.5	0.93	28.00	1.07
	Post-test	26.25	1.49	25.63	1.41	27.5	2.56
	Follow up	26.5	1.51	25.63	1.6	28.25	2.32
Risk-taking	Pre-test	84.38	2.07	86.62	1.6	87.63	2.13
	Post-test	79.63	1.6	77	1.85	90.88	4.85
	Follow up	80.75	1.49	77.25	2.38	90.75	3.85

**Table 3.** Covariance analysis test to check the effectiveness of treatment methods on risk-taking

Variable	source	Mean square	df	F	P	eta
Inflated balloon	Group(intervention)	5.84	1	4.89	0.046	0.273
Non-inflated balloon	Group(intervention)	0.615	1	1.87	0.195	0.126
Score	Group(intervention)	1.28	1	0.68	0.424	0.05
Max pumps	Group(intervention)	2.55	1	1.37	0.263	0.095
Risk-taking	Group(intervention)	27.03	1	8.84	0.011	0.405

**Table 4.** Comparison of means with the Bonferroni test

Variable	Computer game	Play therapy	Mean diff	Standard error`	P
Inflated balloon	29.36	28.01	1.35	0.061	0.04
Non-inflated balloon	4.26	3.86	0.40	0.28	0.19
Score	19.92	19.33	0.059	0.715	0.424
Max pumps	26.34	5.53	0.81	0.691	0.263
Risk-taking	79.86	76.76	3.1	0.68	0.011

## Discussion

This study aimed to determine the difference between the effectiveness of cognitive computer games and play therapy based on cognitive rehabilitation on the risk-taking of children with attention deficit hyperactivity disorder. The results showed that both methods were effective in reducing risk-taking, and these two interventions had a significant difference in terms of effectiveness on risk-taking. Also, in the follow-up stage, play therapy based on cognitive rehabilitation had a lasting effect on risk-taking. No study directly examined the difference between these

two interventions in reducing risk-taking in children with attention deficit hyperactivity disorder; however, the research results of Olderati et al. (20) and Aloni et al. (21) are close to the results of the present study. In explaining this finding, we can say that the difficulty in regulating emotions and risky behaviors in attention deficit hyperactivity disorder may be caused in part by problems in ignoring irrelevant emotional stimuli. It may be the result of incomplete executive control, which is consistently reported in children with attention deficit hyperactivity disorder. Therefore, difficulties in suppressing attention to irrelevant emotional stimuli in the environment may exacerbate primary attention deficits (often reported in people with attention deficit

hyperactivity disorder). As a result, the defect in emotional regulation to maintain and sustain attention can be a crucial factor in the psychopathology of attention deficit hyperactivity disorder. It means that attention deficit inhibition in attention deficit hyperactivity disorder is not only indicative of cognitive deficits but also appears to be enhanced under conditions of emotional distraction (22); therefore, in this case, interventions that target executive functions reduce risky behaviors in these children.

Generally, playing is a good solution for teaching educational issues related to impulsivity, such as taking turns and being patient. Play strengthens the child's muscular system and sensory-motor development, which impacts highly the child's intelligence. By playing, the child's attention increases in performing reflective behaviors before the operation. In other words, according to the knowledge and needs of the child, the therapist, in the form of a play, teaches educational issues related to impulsivity, such as taking turns and patience with the child. Play therapy allows the child to express conflicting feelings, thoughts, and paradoxical beliefs. It is very effective in role-playing and exploring thoughts and feelings. It also gives the children an opportunity to express their feelings, concerns, and creative ideas and express things that, for any reason, they may not be able to express in a normal situation.

Play therapy intervention based on cognitive rehabilitation focuses on communication between the therapist and the child, and play is administered based on communication. The major part of the clinical interpretation comes from the way the child communicates with the therapist. During activities, therapists also use behavior modification and change strategies to positively reinforce adaptive behaviors or use play situations to teach structural problem-solving skills or coping skills so that the child accepts them during interpersonal interactions. The child experiences emotional discharge, reduction of painful effects, reorientation of impulses, and corrected emotional experience. In fact, it can be concluded that playing is in accordance with the developmental conditions and the inner desires and needs of the child. In addition, in this method, the child contributed to the play process. This can justify the long-lasting effect of

play therapy based on cognitive rehabilitation on reducing the risk of ADHD children.

Children in the intervention groups in the post-test and follow-up phases were able to solve their problems by having the opportunity to increase their concentration and attention to mastering skills so that they could express and expose their distressing feelings and gain self-control skills, resulting in a reduction in risk-taking. As mentioned above, the effectiveness of play therapy based on cognitive rehabilitation on risk-taking was long-lasting, while the effect of cognitive computer games was not long-lasting; in this context, we can point out that risk-taking stems from the impulsivity of children with attention deficit hyperactivity disorder. To recover, one needs therapeutic and educational sessions with the interaction and intervention of a therapist. Play therapy based on cognitive rehabilitation was shown to be more effective in reducing risk through the formation of interpersonal interactions and the intervention of a psychotherapist based on the child's needs.

## Conclusion

This research involved some limitations. In this research, we attempted to control the effect of intervening factors on the results by random replacement in 3 groups (two experimental groups and one waiting list) and matching based on IQ scores. Although we attempted to control for confounding factors with these methods, due to limited access to the sample, it was not possible to control for factors affecting the participants, such as family and economic factors, and to determine the subtype of attention deficit hyperactivity disorder, which may affect the generalizability of the results. In addition, most children today have experience using computer games, and the children who participated in this study are no exception, which may limit the generalizability of the research findings. Therefore, we suggest that intervening variables, such as the influence of family, social and economic conditions, and the effect of previous use of computer games, should also be considered in future research. We suggest that the interventions used in this research (play therapy based on cognitive rehabilitation and cognitive computer games) be considered and used by child psychologists and counselors in child mental

health clinics and centers because of their effectiveness in improving working memory and reducing risk in children with deficit hyperactivity disorder.

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## Conflict of Interest

The authors declare that they have no conflict of interest.

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