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Effects of Computer-Based Rehabilitation Therapy on Anxiety and Attention in Children with Specific Learning Disorders

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Abstract

Background: Children with specific learning disorders (SLDs) experience social-academic problems, mainly due to higher behavioral and emotional abnormalities, as compared to normal children. The present study aimed to investigate the effects of computer-based rehabilitation therapy on anxiety and attention in children with SLDs.

Methods: The statistical population included students with SLDs in Dezful (Iran) during the 2021–22 academic year. The convenience sampling technique was employed to select 30 students, who were then equally assigned to an experimental group and a control group (i.e., 15 participants per group). This quasi-experimental research adopted a pretest-posttest control group design. The experimental group received the computer-based cognitive rehabilitation therapy in Captain's Log (two 50-minute weekly sessions), but during this time, the control group received no intervention and was put on the waiting list. The research instruments included the Children's Anxiety Scale and Test of Variables of Attention. Data were analyzed using the analysis of covariance via SPSS-26. The significance level of the study was considered to be α=0.05.

Results: The mean and standard deviation (±SD) of the posttest scores of anxiety and attention were, respectively, 45.13±8.99 and 88.07±9.78 in the experimental group and 72.00±7.15 and 64.67±9.85 in the control group. The results revealed a significant difference between the experimental and control groups (P<0.001). According to the findings, computer-based rehabilitation therapy improved anxiety and attention in children with SLDs.

Conclusion: Hence, this therapy can alleviate anxiety and enhance attention in children with SLDs to help them improve their academic achievement and social relations.

Key Words: Anxiety, Attention, Child, Rehabilitation, Computer-based therapy Specific learning disorders.

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1- INTRODUCTION

Specific learning disorders (SLDs) disrupt one or several major psychological processes, hindering the perception or use of verbal or written language. This disorder may emerge as the inability to hear, think, speak, read, write, spell words, or do mathematical calculations (1). In this case, a learner's academic achievement is much lower than expected regarding age, intelligence quotient, and type of education based on benchmark tests for reading, writing, and calculation (2, 3). Children with SLDs experience various problems in learning and using the abilities to hear, speak, read, write, and do mathematical calculations (4).

Due to their lower levels of abstract thinking, children with SLDs cannot express their emotions and feelings. Suppression and the inability to express emotions, especially negative ones, can jeopardize a child's mental health, causing psychological stress and anxiety and reducing positive emotions and adjustment (5, 6). Although anxiety is slightly necessary for different situations, it can be problematic when people cannot predict the future and their behaviors, see their efforts as futile, and consider everything out of control. Anxiety will lead to tension, stress, and mood disorders in the long run (7). As a result, people will experience further anxiety and make less flexible efforts whenever they fail to solve problems or cope with difficulties. Finally, they will neglect the other possible solutions (8).

The important cognitive problems children with SLDs report include difficulties in executive functions such as paying attention. Attention is closely related to memory. Navarro-Soria et al. (9) reported that people with attention deficiency fail to process a large deal of information; hence, they cannot store and recall information, experiencing memory failures. Defects in these processes affect other cognitive processes, especially learning. The first step in a learning process begins with attention. Learning will be disrupted in the case of insufficient attention (10, 11). The selection process, attention level (concentration), and span of attention to a specific stimulus (attention maintenance) are the components of attention affecting the human "awareness" at any given moment. In this regard, sustained attention is defined as controlled processing while performing a task; therefore, a deficiency in children's sustained attention will deprive them of an opportunity to process, store, and recall information (12). Sustained attention is maintaining a purposive behavior over a continuous activity. In fact, it is activated when a prominent stimulus in a perceptual context can activate the right hemisphere, especially the right prefrontal cortex (13, 14).

Substantial breakthroughs have been made in cognitive sciences over the past two decades. In evaluation and cognition, computer-based tests have gradually replaced paper-based tests. There have also been similar developments in therapies. The computer-based rehabilitation therapy is among the treatment methods adopted in recent years to improve cognitive functions. Computer-based rehabilitation is a terminology employed to treat and rehabilitate cognitive disorders (15). It helps provide therapeutic services to improve traumas and/or replacing new models to compensate for disorders (16). Evidence shows that computer-based cognitive rehabilitation can improve performance in neuropsychological tests. Furthermore, computer-based cognitive rehabilitation programs allow for infinite iterations and gradual changes in exercise difficulty levels. Characterized by self-training, they also store valid records of patient's performance in their databases (17, 18). A computer-based rehabilitation suite aims to positively affect cognitive

functions, especially executive processes. The rehabilitation principles are implemented within a computerized framework via a touchscreen in a computer-based rehabilitation program (19). According to literature, computer-based rehabilitation improves attention, enhances spatial working memory, and alleviates depression symptoms (20-22). Nazarboland et al. (20) reported that computer-based rehabilitation was effective in improving working memory and sustained attention in children with autism spectrum disorders. Niemeijer et al. (21) and Fetta et al. (22) concluded that computer-based interventions seem promising as an approach to improve working memory in individuals with acquired brain injury.

Overall, implementing the computer-based intervention can resolve the discouragement caused by a specific task and bring about satisfaction for children with SLDs during the intervention. In general, there is a lack of studies on the cognitive rehabilitation of children with SLDs; and this study is among the few projects conducted in Iran to analyze the relevant factors. It is essential to accurately identify the factors affecting cognitive performance in children with SLDs and take a major step in implementing cognitive rehabilitation therapies. Accordingly, the present study aimed to investigate the effects of computer-based rehabilitation therapy on anxiety and attention in children with SLDs.

2- MATERIALS AND METHODS

2-1. Design and population

This quasi-experimental research adopted a pretest-posttest control group design. The statistical population included all male and female fourth-graders with SLDs who received education and rehabilitation services from public and private centers for learning disabilities in Dezful, Iran, in 2022.

2-2. Inclusion and exclusion criteria

The inclusion criteria were giving parental consent for children's participation in the study, acquiring scores below average on attention and active memory tests, lacking autism and intellectual disability, and being 10 years old. The exclusion criteria were being absent for more than two therapy sessions, receiving pharmaceutical therapies, having an IQ below 90 based on the Raven IQ test, and having other comorbid disorders such as attention deficit hyperactivity disorder (ADHD) and behavioral disorders.

2-3. Sampling

Based on the inclusion criteria, 30 students were considered eligible and selected as the research sample. They were then randomly assigned to a computer-based rehabilitation group and a control group (i.e., 15 participants per group). The sample size was selected according to G-Power software (test power= 0.95, effect size=1.27, and significance level= 0.05).

2-4. Instruments

a) Children's Anxiety Scale: Designed by Spence (23) to evaluate children's anxiety, the Children's Anxiety Scale includes 45 items and various dimensions: separation anxiety, social anxiety, obsessive-compulsive disorder, agoraphobia, generalized anxiety, and fear of physical harm. This questionnaire is scored on a four-point Likert scale (ranging from 0 for "never" to 3 for "always"). The minimum and maximum total scores are 0 and 132, respectively. The score ranges of 0–44, 44–88, and above 88 indicate low, average, and high levels of children's anxiety, respectively. This scale was completed with the help of parents of children with SLDs. Ghanbari et al. (24) reported the total Cronbach's alpha coefficient of this scale to be 0.84.

b) Test of Variables of Attention: Designed by Rosvold et al., in 1956, the

Test of Variables of Attention (TOVA) was first utilized to evaluate brain injury. It was introduced as a test for evaluating children with ADHD in 1960; however, it is now the most common tool for diagnosing constant attention. This test uses language-independent visual stimuli (e.g., a large rectangle with a square on the top or bottom). It is executed in two conditions: little presentation of a target stimulus or frequent presentation of a target stimulus. In the first half of the test (i.e., little presentation of a target stimulus), the ratio of a target stimulus to a non-target stimulus is 1 to 3.5 (i.e., the target stimulus is presented randomly after the non-target stimulus is presented for 3.5 times on average). Hence, this half is so boring that a participant should pay great attention to correctly detect the less frequently presented stimulus. If the participant fails, he/she will receive an exclusion error which means inattention. In the second half (i.e., frequent presentation of a target stimulus), the ratio of a target stimulus to a non-target stimulus is 3.5 to 1 (i.e., the non-target stimulus is presented only once after the target stimulus is presented 3.5 times). This test is scored on a computer system. The constant attention improvement is indicated by reduced response time, exclusion, and response errors. Two scores of exclusion error and perpetration error were used in this study (25). Hosseini and Talepasand (26) reported the total Cronbach's alpha coefficient of this test to be 0.82.

c) Computer-Based Rehabilitation Therapy: Captain's Log is a computer-based cognitive rehabilitation software suite used as a design component in the cognitive education system. Based on the fundamental information processing system, this software suite gives feedback regarding personal capability, competence, and self-efficacy. Mainly based on active working memory and central processing speed, it was designed for the age group of five years old and above (27). This intervention was implemented in the experimental group for two 50-minute weekly sessions. The intervention program for children with SLDs was carried out by the first author at the counseling center of Dezful City. **Table 1** describes the computer-based rehabilitation therapy sessions.

Table-1: General descriptions of sessions in the computer-based rehabilitation therapy

Session	Games	Cognitive Skill Improvement	Duration (minute)
1	Point match	Attention, response inhibition, processing speed, anxiety alleviation	6
2	Cats game	Response inhibition, general attention, visual perception, visual processing speed, and anxiety alleviation	7
3	Mouse hunt	Anxiety, response inhibition, sustained attention, visual processing speed, anxiety alleviation	5
4	Target practice	Response inhibition, selective attention, sustained attention, visual perception, anxiety alleviation	7
5	Red light, green light	Response inhibition, memory, visual perception, central processing speed, anxiety alleviation	6
6	Select fast.	Response inhibition, generalized attention, visual perception, and anxiety alleviation	6
7	Darts	Response inhibition, generalized attention, visual perception, and anxiety alleviation	6
8	On the road	Response inhibition, generalized attention, visual perception, and anxiety alleviation	7

2-5. Data Analysis

Descriptive statistics (i.e., mean and standard deviation) and inferential statistics (i.e., analysis of covariance) were employed to analyze data obtained from the pretest and posttest stages. Data were analyzed in SPSS version 26.

3- RESULTS

The mean and standard deviation of the children's age in the experimental and control groups were 9.94±2.21 and 10.42±2.08 years, respectively. In the experimental group, there were 7(46.67%) girls and 8(53.33%) boys among the participants. In addition, there were 9(60.00%) girls and 6(40.00%) boys in the control group. Table 2 presents the mean and standard deviation of research variables for the experimental and control groups in the pretest and posttest stages.

Table-2: Means and standard deviations of research variables in experimental and control groups in the pretest and posttest

Variables	Groups	Pretest	Posttest	P
		Mean ± SD	Mean ± SD	
Anxiety	Computer-based rehabilitation therapy	74.93 ± 5.41	45.13 ± 8.99	0.001
	Control	75.07 ± 3.91	72.00 ± 7.15	0.156
Attention	Computer-based rehabilitation therapy	71.00 ± 9.37	88.07 ± 9.78	0.001
	Control	61.47 ± 8.14	64.67 ± 9.85	0.340

The research hypotheses were checked before their data were analyzed to ensure that the research data would meet the ANCOVA hypotheses. To this end, the normality of data was indicated by the non-significance of Z in the Kolmogorov–Smirnov test, which followed normal distributions for anxiety (Z= 0.204, P= 0.093) and attention (Z= 0.184, P= 0.181). Furthermore, Levene's test was conducted to analyze the homogeneity of variances (i.e., equality of variances in the experimental group and the control group) for anxiety (F= 0.338, P= 0.565) and attention (F= 2.143, P= 0.154). According to the results, ANCOVA could be employed.

The multivariate ANCOVA was then utilized to compare the experimental group with the control group in posttest scores after the effects of pretests were controlled to determine the effects of the computer-based rehabilitation therapy on anxiety and attention in children with SLDs. **Table 3** reports the results. As shown in **Table 3**, the multivariate ANCOVA indicated a significant difference between the computer-based rehabilitation therapy and control groups regarding one dependent variable (P<0.001).

Table-3: The results of multivariate ANCOVA on the posttest scores in the experimental and control groups

Variable	Value	df	Error df	F	P	η^2
Pillais Trace	0.79	2	25	47.66	0.001	0.79
Wilks Lambda	0.21	2	25	47.66	0.001	0.79
Hotelling's Trace	3.81	2	25	47.66	0.001	0.79
Roy's Largest Root	3.81	2	25	47.66	0.001	0.79

Table 4 reports the univariate ANCOVA results of the posttest scores on dependent variables. According to the results, the F ratio of the univariate ANCOVA for dependent variables indicated a significant difference between the computer-based rehabilitation therapy and control groups in anxiety and attention (P<0.001). In other words, computer-based rehabilitation therapy mitigated anxiety and improved attention in children.

Table-4: Results of univariate ANCOVA on the research variables in experimental and control groups

Variable	SS	df	MS	F	P	η^2	Power
Anxiety	4071.99	1	4071.99	98.85	0.001	0.79	1.00
Attention	1376.07	1	1376.07	39.15	0.001	0.60	1.00

4- DISCUSSION

This study aimed to investigate the effects of computer-based rehabilitation therapy on anxiety and attention in children with SLDs. According to the findings, computer-based rehabilitation therapy improved anxiety. This finding is consistent with the research results of previous studies (28). In other words, this therapy causes sustained synapse changes in less active cortices through stimulation under the formability and self-recovery principles of the brain. According to the human brain formability theory, such changes cannot be temporary if the less active involved cortices are stimulated properly and regularly. Instead, they will be permanent due to the alterations supposed to have been caused in the structures of neurons (28). In addition, the brain is a flexible organ that can regain its lost function through self-rehabilitation. In the brain rehabilitation process, the other cortices shoulder the responsibilities of the damaged parts gradually; thus, new neural pathways emerge. Cognitive rehabilitation programs mitigate the adverse effects of brain injuries by helping the brain identify and form those alternative pathways (29). In addition, emotional expressions can provide empathy and compassion on the part of others, which can reduce the boredom of long treatment periods and increase children's tolerance (30). At the same time, emphasizing children's strengths and creating positive monologues can help children believe in their problem-solving abilities and show fewer anxious reactions to unpleasant events. Cognitive rehabilitation is the art and science of reconstructing subjective processes and instructing reversible strategies (31). The main principle of computer-based cognitive rehabilitation is to help improve cognitive abilities and necessitate self-control to achieve cognitive achievements. In this regard, computer-based rehabilitation therapy can also be used to alleviate children's anxiety (27).

The research results indicated that computer-based rehabilitation therapy improved attention in children with SLDs. This finding is consistent with the research results of previous studies (20). According to Nazarboland et al. (20), computer-based cognitive rehabilitation therapy enhanced working memory, sustained attention, and mathematical performance in autistic children due to intriguing audiovisual designs and gradually graded difficulty. In other words, selective attention is generally the most widely used and common application of attention. As discussed earlier, it refers to the ability to process relevant data while ignoring irrelevant data, which means processing some data selectively and dismissing others. Conscious concentration is the necessary component of this level of attention. In other words, the brain can pay

attention to only a few topics at a time to concentrate on relevant stimuli (20).

Many pieces of information we constantly deal with require prior selection, without which we would be lost in the abundance of input information and unable to process any of such information effectively, indicating the necessity of information selection. It is fair to infer that the improved performance after the cognitive rehabilitation interventions can indicate changes in the nervous system, which can be explained through the brain formability theory due to neuropsychological exercises (31).

Presumably, the mechanism underlying experience-dependent formation processes can lead to guided improvement through rehabilitation. At this level of attention, confusion occurs when an individual can pay attention to a subject for only a short period and faces difficulty performing the tasks requiring a great deal of attention. The results of this study indicated significant increases in the attention scores of participants in the experimental group on the posttest. To explain this finding, we can cite the principles of neural formation and rehabilitation (22).

In other words, rehabilitation exercises can enhance attention in people with SLDs through hierarchies and multistep programs. Practice means relearning a vital stimulus' subjective processes and actions to form new or effective performance communications in the remaining tissue. Exercising different skills can affect brain flexibility. According to the research literature, the improvement following the rehabilitation caused by flexibility results from training in neuron networks (21).

Since the human brain is highly capable of neuropsychological reorganization, structured stimulation is accompanied by improving the behavioral functions of neurons (32).

4-1. Limitations of the study

The statistical population of this study was limited to Dezful (Iran). Therefore, caution should be considered while generalizing the results to other cities. Another limitation of this study is the lack of control over families' academic, economic, and social levels. The results were also limited to a specific educational grade; hence, they cannot be generalized to higher educational grades. Moreover, the lack of a follow-up stage prevented the generalization of results over time.

5- CONCLUSION

Computer-based rehabilitation therapy improved anxiety and attention in children with SLDs. The results of this study emphasized the importance of using computer-based rehabilitation therapy to alleviate anxiety and improve attention among children with SLDs. Since a major purpose of educating and rehabilitating children with SLDs is to enhance their cognitive skills, computer-based rehabilitation therapy will be useful for improving these children's attention, which is among the major cognitive skills. Hence, it is recommended to inform parents, teachers, trainers, and therapists and provide practical solutions for school officials and the State Welfare Organization of Iran concerning the role and importance of computer-based rehabilitation therapy. As a result, achieving sustainable results in improving the attention of children with SLDs will be possible.

5-1. Ethical considerations

This study was approved by the ethics committee of Islamic Azad University (IR.IAU.AHVAZ.REC.1401.006).
Moreover, for ethical considerations, the overview of the computer-based rehabilitation therapy was implemented on the control group when the training sessions were over, and the posttest was conducted on both groups.

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7- CONFLICTS OF INTEREST

None.

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