Therapeutic Efficacy of RehaCom in Children (8-12 Years Old) with attention deficit hyperactivity disorder

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ABSTRACT

Attention deficit disorder is a psychiatric condition in children that impairs attention, response control, emotional regulation, and other cognitive functions. On the other hand, RehaCom is a cognitive rehabilitation software that has therapeutic effects on cognitive impairments in various conditions such as stroke, multiple sclerosis, and schizophrenia. The aim of this study was to investigate the effectiveness of RehaCom on auditory and visual response control, as well as auditory and visual attention in children with attention deficit disorder. Twenty children aged 8 to 12 were selected (10 in the experimental group and 10 in the control group). Brain Mapping(QEEG) and the IVA2 test were conducted for all participants, while only individuals in the experimental group received twenty 45-minute sessions of RehaCom training, three sessions per week. The results showed that RehaCom therapy significantly improved auditory and visual response control in children with ADHD. Therefore, RehaCom may have the potential to alter the structural and functional brain characteristics related to response control."

Keywords: ADHD, RehaCom, IVA2, Attention Deficit

1. INTRODUCTION

Attention Deficit Hyperactivity Disorder (ADHD) is one of the most common developmental disorders in children, characterized by symptoms such as inattention, hyperactivity, and impulsivity. This disorder can significantly impact children's academic, social, and emotional functioning"[1].

ADHD is a prevalent disorder, affecting approximately 5% of school-aged children and 2.5% of adults [2]. It has been reported that 45 to 84% of children with ADHD also have Oppositional Defiant Disorder (ODD), and around one-third of children have comorbid mood or anxiety disorders [3]. ADHD disrupts attention, response control, and emotional regulation [4]. Motor hyperactivity, impulsivity, and disruptions in behavioral inhibition and sustained attention are commonly observed in individuals with ADHD [5], [6]. It has been shown that core deficits in inhibitory control are associated with multiple executive function impairments in ADHD [7]. Individuals with ADHD may also experience psychological symptoms such as depression, anxiety, and issues related to self-esteem and self-confidence [8]. Neuroimaging studies have suggested a critical role of subcortical regions such as the striatum and amygdala in ADHD [4]. Previous studies have demonstrated altered microstructural white matter integrity in widespread fiber tracts and increased gray matter volume in bilateral frontal regions in children with ADHD [9]. Left pallidum/putamen activity and left inferior frontal gyrus function are also altered in individuals with ADHD [10]. Furthermore, disruptions in neural networks associated with attention and cognitive control processes have been reported in individuals with ADHD, especially in those older than 8 years [11], [12]. Proposed treatments for individuals with ADHD include pharmacological and behavioral interventions, parent training, cognitive training, and physical exercise interventions [13]. Psychostimulant medications have been reported to have numerous side effects and may be ineffective or intolerable in approximately 30% of individuals with ADHD [14]. Additionally, computer-based cognitive training programs may be effective in treating ADHD. For example, a previous study has shown that treatment with an attention processing training program for three months (one-hour sessions twice a week) has therapeutic effects on individuals with ADHD, although the effect size is not substantial [15]. Furthermore,

training with a computerized attention and activity test can be effective in decision-making in children and adolescents suspected of having ADHD [16]. However, some studies have reported that computer-based training may not be effective for individuals with ADHD [17].

Rehacom is a neurofeedback device specifically designed for children with ADHD. This device helps children regulate their brainwave activity within the desired range using computer games. RehaCom improves attention, response control, and activities of daily living in patients with chronic stroke [19]. Moreover, previous studies have demonstrated the improvement effect of RehaCom on working memory, processing speed, executive functions, semantic cognition, and visuospatial skills in patients with Multiple Sclerosis (MS) [20], [21]. RehaCom also leads to significant rehabilitation in patients with schizophrenia [22], [23]. However, there are conflicting results regarding the effectiveness of RehaCom in patients with schizophrenia [24]. Another study has also reported that treatment with RehaCom significantly (in 100% of patients) improves cognitive function in patients with acquired brain injury [25]. To date, the potential therapeutic effect of RehaCom on individuals with ADHD has not been investigated. Although, as mentioned, some studies have reported the effectiveness of computer-based rehabilitation programs in ADHD.

2 RESEARCH METHOD

This study employs a single-case design using an A-B-A design. In Phase A, the child's symptoms are assessed before the intervention with RehaCom using brain mapping and the IVA 2 test. In Phase B, the child undergoes an 8-week treatment with RehaCom. In Phase A, the child's symptoms are reassessed after the intervention with RehaCom using brain mapping and the IVA 2 test.

2.1. Experimental Designs

2.1.1. RehaCom Software

This software is a cognitive rehabilitation package developed in the early 1990s to restore cognitive abilities in individuals with brain damage. RehaCom software includes activation and stimulation of several cognitive domains such as attention, memory, visuospatial processes, and executive function. This program consists of several modules with varying levels of difficulty, and it automatically adjusts the difficulty level of the task successfully executed as the subject completes simple tasks and records the number of errors and completion time for all patients in a file. Attention allocation, concentration, reaction time, verbal memory, verbal fluency, and spatial memory are subsets of this software. RehaCom program has enough flexibility, simplicity, accessibility, dynamics, and objectivity to assist clinical functions. Its interactive features and multimedia nature provide the opportunity for the treatment of numerous patients and maintaining their motivation, regardless of their multiple impairments and sensory deficits. The use of this software enables more precise recording of patient results and enhances the quality of stimulation [25].

2.1.2. Integrated Visual and Auditory Test 2 (IVA-2)

This test was developed by Sandford and Turner in 1994 based on the Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition. The IVA-2 test is a 20-minute visual and auditory test that assesses two primary factors: response control and attention. The execution of the IVA-2 test consists of four stages: (Stage 1) warming up, (Stage 2) training, (Stage 3) main test, and (Stage 4) cooling down. The warming-up stage is divided into two separate periods: one minute for visual warming-up and one minute for auditory warming-up. The next stage, the training stage, begins, where visual and auditory objectives and errors are presented in combination. This stage takes time [26].

The main test is conducted after the training stage, where visual and auditory objectives are presented in combination. It takes approximately 13 minutes. The last two minutes of the test are for evaluating the test's validity, called cooling down. In the main test, five hundred visual and auditory stimuli are presented. The task of the test is to respond or not respond (response control) to the five hundred visual and auditory stimuli. Each stimulus is presented for only one and a half seconds.

Therefore, good performance requires continuous and sustained attention. During the test, the individual is instructed to press a key upon hearing or seeing a number one. If the individual presses the key after hearing or seeing the number two (which is not the target), it indicates impulsivity, and if the individual responds less after hearing or seeing the number one, it indicates inattention. This test is suitable for individuals over 6 years old and adults.

2.1.3. Brain Mapping

A 19-channel EEG Mitsar system with NeuroGuide software was used to record QEEG. This system has a fixed connection to the HBI database [27].

Each recording lasted 45 to 60 minutes. Initially, the head size of each participant was measured to determine the required sensor cap size. After successful sizing and montage of the sensor caps, electrodes were placed according to the international 10-20 system. Figure 1 illustrates the location of each sensor. Once the electrodes were in place, the sensor cap was connected to a 32-channel Mitsar amplifier. The sensor cap was then disconnected from the power source to eliminate the risk of electrical shock to the participants. The participant remained calm and undisturbed before turning on the power supply. EEG signals were recorded for 3 minutes with eyes closed, 3 minutes with eyes open, and 20 minutes during the computer-based attention test. EEG signals from the eyes-closed and eyes-open states were included in the statistical analysis. The results of EEG recordings during the task condition are not reported in this article [28].

3.Findings:

Children in the age range of 8 to 10 years were examined, with 20 subjects diagnosed with attention deficit hyperactivity disorder (ADHD) divided into two groups of ten, experimental and control. The research participants were homogeneous, and neither the Chi-square test nor the independent t-test found any differences in demographic variables for both groups ($p > 0.05$). Before the intervention began, both experimental and control groups underwent a pre-test phase. After the intervention sessions in the experimental group, both groups participated in a post-test phase. Mean and standard deviation (SD) were separately presented for both experimental and control groups. The pre-test and post-test findings for the control group did not change ($p > 0.05$), while the post-test mean for the experimental group increased ($p < 0.001$). Therefore, cognitive rehabilitation training resulted in a reduction in attention deficit hyperactivity disorder symptoms in children aged 8 to 10.

Here is the table presenting the test scores for auditory and visual attention measures in both the experimental and control groups, including pre-test and post-test scores:

Table 1. *IVA 2 Test Before and After Examination for the Control and Experimental Groups*

Measure	Test Type	Group	Mean	Standard Deviation
Auditory focus attention	Pre-test	Experimental	46	2.8139
		Control	53	2.7386
	Post-test	Experimental	106	5.8251
		Control	54	2.5475
Visual focus attention	Pre-test	Experimental	30	2.6010
		Control	28	3.4405
	Post-test	Experimental	99	5.6754
		Control	27	2.8613
Auditory selective attention	Pre-test	Experimental	54	2.8139
		Control	58	2.7386
	Post-test	Experimental	91	5.7311
		Control	60	2.6076
Visual selective attention	Pre-test	Experimental	32	2.7659
		Control	46	3.7386
	Post-test	Experimental	88	5.4320
		Control	47	3.5475
Auditory sustained attention	Pre-test	Experimental	38	3.8139
		Control	32	3.1386
	Post-test	Experimental	94	4.9838
		Control	33	3.0213
Visual sustained attention	Pre-test	Experimental	61	2.8139
		Control	55	2.4376
	Post-test	Experimental	103	6.1218
		Control	57	2.5475
	Pre-test	Experimental	43	2.8139

Measure	Test Type	Group	Mean	Standard Deviation
Auditory alternating attention	Post-test	Control	41	2.7386
		Experimental	101	5.7268
Visual alternating attention	Pre-test	Control	38	2.5475
		Experimental	56	2.8139
	Post-test	Control	52	2.7386
		Experimental	91	5.8252
Auditory divided attention	Pre-test	Control	50	2.6875
		Experimental	67	2.8139
	Post-test	Control	67	2.7986
		Experimental	104	5.9145
Visual divided attention	Pre-test	Control	65	2.5975
		Experimental	78	2.8139
	Post-test	Control	79	2.6586
		Experimental	101	5.3375
		Control	80	2.6175

These scores represent the performance of both groups in various auditory and visual attention measures before and after the intervention.

4.Discussion:

The findings demonstrate that cognitive rehabilitation training improves attention in children (aged 8-10) with ADHD. According to the results, cognitive rehabilitation training enhances attentional deficits by improving the function of affected brain regions through strategic training or repetition and practice. However, the cost-effectiveness of sessions and working with children (aged 8-10) diagnosed with ADHD remains one of the challenges of this research.

5.Conclusion:

In conclusion, cognitive rehabilitation training appears to be an effective intervention for improving attention in children with ADHD. By targeting specific cognitive processes and utilizing strategic training methods, this approach shows promise in addressing attentional deficits associated with ADHD. Nonetheless, further research is needed to explore the long-term effects and cost-effectiveness of such interventions.

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