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Diagnosing Cognitive Impairments of Cyber Addiction with QEEG and Investigating the Effectiveness of Cognitive Intervention on the Cognitive Functions Involved in the Mental Imagery of Adolescents

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ABSTRACT

Human society faces new challenges, especially the ones damaging the human brain and cognition. The addictive use of cyberspace essentially causes these challenges. This study was a comparative descriptive-analytical study conducted to diagnose cognitive impairments of cyber addiction through a QEEG test and to investigate the effectiveness of cognitive intervention on the cognitive functions involved in the mental imagery of adolescents. The statistical population of the study included 9-12 year-old students who visited Mehraz Andisheh clinic in Shiraz. The available sampling method was used and 40 people with research conditions (including 20 girls and 20 boys) were randomly assigned to two control and experimental groups. This research was conducted in 2023. The study used a mobile-based social network addiction diagnosis questionnaire (Ahmadi et al.; 2015), software (RehaCom et al., IVA-2, Neuroguide), an EEG device, and Kim Carrad visual memory test. After being selected and called to the place of research, people who had the conditions to enter the study first completed the consent form. Then, the EEG recording was conducted for 5 minutes with eyes open and closed. Also, as a pre-test, they performed a visual attention test (IVA-2) for visual memory (Kim Carrad test) and a visual processing test (Captain Log). Then, for ten sessions, the participants in the experimental group received cognitive rehabilitation by RehaCom software, each lasting for 45 minutes with an interval of one day. After the completion of the treatment sessions, the evaluations were repeated. In this research data analysis was done using SPSS software 26 and Analysis of Covariance (ANCOVA). The study findings showed that the cognitive intervention led to a significant difference at the 0.05 level in the pre-test and post-test scores of the experimental group while there was no significant difference between the pre-test and the post-test in the control group. Based on the results, it can be seen that the intervention led to a difference in the pre-test and post-test and a significant difference between the pre-test and post-test groups in the experimental group at the 0.05 level. The study results also showed a significant relationship between the cognitive impairments of cyber addiction and brain wave patterns. These results emphasize that brain signals may be used as an indicator to diagnose cognitive impairment in people with cyber addiction. Also, the results showed that RehaCom software could improve the cognitive functions involved in the mental imagery of teenagers suffering from Internet addiction.

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Introduction

Internet addiction is often called problematic Internet use and Internet use disorder. Recent studies have highlighted the impact of addiction to the Internet and games on teenagers, which can lead to depression, sleep disorders, poor academic performance, psychological disorders, and even biological and physical development. Excessive Internet use has been associated with various negative psychological consequences like mental disorders such as somatization, obsessive-compulsive disorder, anxiety disorders, and depression (Starsviko, 2020). Quantitative Electroencephalography (QEEG) measures the spatial distribution of voltage fields and variation over time and is the most reliable and precise non-invasive laboratory technique for scrutinizing cortical functions (Farrokh Alaee et al., 2020). Research indicates that changes in brain activity occur after forced involvement in traumatic behaviors, similar to drug-related addictions (Grant et al., 2006). Accordingly, similar mechanisms and changes are believed to be involved in internet addiction. Examining brain mapping research in internet addiction can help guide intervention evaluations.

In this regard, CHC[2] and CHT[3] are two critical theories in the field of cognitive assessment that investigate cognitive variables and individual abilities. These two theories differentiate between individual cognitive abilities and their relationship to cognitive functions. The theories of CHC and CHT can help us understand the direct relationship between cyber addiction and the cognitive functions of adolescents (Snyder et al., 2018). By analyzing how cyber addiction affects the cognitive abilities of adolescents, we can identify the different functions related to addiction and how they impact each other. CHC and CHT theories can also help us explore how executive abilities like attention control, time management, and decision-making are affected by cyber addiction (Keith, 2018). While cyberspace is primarily designed for learning, research, and convenience, excessive dependence on it has become a concern due to the growth of technology in our society (Tomchik & Solaki, 2019). Studies have shown that the more time students spend in cyberspace, the worse their academic performance tends to be. With the increased time spent using cyberspace, academic performance decreases drastically. Some also experience the consequences of insomnia.

The result of the digitization of today's society is the increasing prevalence of addiction to social networks among adolescents and adults. Increased cyber addiction may be associated with increased individualism, less sociability, and less acculturation (Lozano-Blasco et al., 2022). Griffiths (1998) stated that cyber addiction is one type of technological addiction and is a subcategory of behavioral addictions (such as compulsive gambling). Kandel (1998) considered cyber addiction a psychological dependence on cyberspace. Abnormal patterns of cyberspace use are a form of behavioral addiction when considered according to these definitions (Chu et al., 1999). In the research background, different terms have been used for cyber addiction. In this article, cyber addiction is used to cover the collective phenomenon. Like many other mental disorders, cyber addiction is also in the group of multifactorial disorders. One of the main challenges in developing the biological-psychological model of cyber addiction is determining which genes and neural mediators are related to the increased likelihood of addiction. In addition, people with cyber addiction showed less efficiency in information processing and lower cognitive control. In the Stroop task, the behavioral results showed that students' cyber addiction was associated with longer reaction time and more response errors in incongruent conditions compared to the control group. The results showed that participants with cyber addiction showed a medial frontal negative bias (MFN) compared to the control group in incongruent conditions. In both behavioral functions, in people with cyber addiction, compared to the regular group, deficits in executive control were observed (Dong et al., 2011).

People with cyber addiction often show defects in the reward system, and the reward system plays an essential role in the development and persistence of drug addiction. One of the critical aspects investigated in cyber addiction studies is the role of active inhibition among internet addicts. People with cyber addiction are mainly involved in habitual behaviors that require active inhibition to reduce these habitual reactions and behavioral problems. This active inhibition can be proposed as a macro strategy to intervene in cyber addiction. In addition, the cognitive loads in internet addicts can severely affect active inhibition ability. For example, performing a large number of simultaneous tasks may cause a violation of active inhibition and lead to engaging in habitual behaviors. This interaction between cognitive loads and active inhibition shows the importance of continuing research in this field and determining effective solutions for managing cyber addiction.

It should be kept in mind that the release of hormones can also have a significant impact on cognitive functions. For example, excessive use of cyberspace and its addiction may hurt various hormones, such as stress

2 Cattell–Horn–Carroll Theory

3 Continuous Hypothesis Test

hormones (such as cortisol) and benign hormones (such as dopamine). Changes in the secretion of these hormones may cause disturbances in cognitive functions, attention disorders, changes in memory, and decision-making. Irregularity in the secretion of hormones may lead to disturbances in cognitive functions. This clutter can cause complications such as reduced attention, a decline in decision-making ability, and changes in memory. These effects may be enhanced by various factors of cyber addiction, including the desire to play games, excessive time spent on the internet, and isolation. By connecting fundamental and higher cognitive theories, brain structure, hormones, and disordered functions, we can provide a broader examination of the impact of cyber addiction on adolescent cognitive functions. This communication helps increase the understanding of the causes and effects of cyber addiction in the secretion of hormones and cognitive functions. In this regard, active memory is the ability to keep the information in the mind to perform complex cognitive operations (Merian et al., 2019). Visual memory is also a type of active memory that is responsible for visual perception and stores visual information for a short time (Amir et al., 2017); it is essential for reasoning, guiding decision-making and behavior (Agahi & Share, 2017), and plays a fundamental role in perception and learning (Bass et al., 2018). *Visual processing* is a basic psychological process that plays a significant role in academic progress and performing independent life skills. This skill plays a fundamental role in understanding arithmetic, mathematics, and numerical cognition (Gray et al., 2000), reading (Baluti et al., 2012; Fakuti et al., 2000), understanding angles, geometric shapes, and the position of numbers, letters, and words relative to each other (Moghadam et al., 2019) and the required writing and handwriting skills (Silverman, 2014). Visual processing affects a child's learning and the ability to think and even perform simple activities such as sorting socks or playing simple games. Visual-spatial processing refers to organizing visual information in meaningful patterns and understanding how they change, move, and rotate in space, according to the cognitive theory of Karl, Horne, and Kettle (CHC visual processing is the ability to use relevant mental images), which is often said in connection with recently perceived images to solve a problem (Flanagan & Harrison, 2012; Schneider & McGrew, 2012). This skill is one of the specialized functions of the right hemisphere. Furthermore, it plays a significant role in the complex skills of human life, among them, we can mention the role of visual functions, memory, and attention.

There is abundant evidence of the brain's plasticity, meaning it can change depending on our work and training (Allavi, 2019). Cognitive empowerment exercises can help overcome brain limitations and weaknesses and improve memory and learning (Shahmohammadi et al., 2018). Nowadays, a new rehabilitation model called computer-based cognitive rehabilitation is gaining popularity. This method uses special software to improve cognitive functions through structured cognitive exercises. These programs can be accessed on computers and other electronic devices such as smartphones, tablets, and gaming systems (Politis & Norman, 2016). RehaCom computer-based cognitive rehabilitation is an excellent functional exercise that strengthens various cognitive domains, including attention to sound, selective attention, divided attention, logical reasoning, verbal memory, and working memory.

Technological advancement is rapidly changing our society, and cyberspace is transforming our way of living. However, this transformation only sometimes improves the quality of human life. Young (1999) argued that studying cyber addiction is challenging due to the technological value in today's societies, the social promotion of people when using cyberspace, and the positive image of cyberspace. Kandel (1998) stated that although exercise positively affects people who need it, excessive exercise may harm human health. Similarly, the impact of cyberspace depends on the amount and type of use. The previous review of studies on cyber addiction can be seen from different perspectives. On the one hand, excessive use or misuse of technology can negatively affect our lives. From another point of view, the existing results lead to the reflection on how to use technology appropriately and safely. As Stern (1999) stated, technologies increase our capacities and abilities; however, they may lead to inconsistent behaviors. Cyberspace has drastically changed our way of life for a long time. However, abnormal use of cyberspace reduces the mental well-being of the individuals, the academic performance, and the people's job performance. Addiction to cyberspace has not yet been officially compiled in the DSM5 psychiatric framework and cyber addiction is considered a severe problem in today's societies in terms of prevalence and public awareness. The similarity between the effects and symptoms of cyber addiction and psychological injuries is observed. Neuroimaging is a non-invasive method to examine the electrical activity of the brain. Since cyber addiction has recently increased, it is essential to investigate this neural infrastructure and how to treat it.

Technological progress has rapidly accelerated the changes in our society. We see cyberspace's immediate and profound impact on our way of life. Research shows that improper use of cyberspace can lead to cognitive and social problems. For example, improper use of

cyberspace can lead to addiction, which may negatively affect mental health and performance. In this context, scientific research is fundamental because it can provide solutions for better and safer use of cyberspace. Also, conducting this research is very important because cyberspace has multiple approaches and many different theories. This issue is related to our society's different temporal and spatial issues and should be addressed promptly. In order to study and better understand these changes and their effects on people's lives, various approaches and theories should be used. For example, neuroimaging as a non-invasive method can help analyze the effects of cyber addiction and individual cognition. In short, the necessity of research in this field to better understand and deal with the new communication and cognitive challenges created by cyberspace is of potential importance. This study aimed to investigate the neural pathway of cyber addiction by brain mapping and also examine the effect of cognitive intervention on improving the mental imagery of adolescents suffering from internet addiction. The study provides a deep and comprehensive analysis of cyber addiction among teenagers. It explored the cognitive, social, and technological factors that influence the behavior and cognitive trends of the digital generation. Also, as deeper understanding of the mental imagery indicators of adolescents, their continued use of cyberspace, and its relationship with their cognitive and developmental reactions is essential, the study analyzed the complex connections between behavioral science and digital technology, promoting a better understanding of the cyber addiction phenomenon based on the CHC and CHT theory. To this end, this study sought to see whether cognitive impairments in cyber addiction can be diagnosed using QEEG, and examine the effectiveness of cognitive interventions in improving cognitive functions related to mental imagery in adolescents.

Method

Design

This study adopted a quasi-experimental approach with pre-test and post-test. The current research is a comparative descriptive-analytical study, which was conducted to diagnose cognitive impairments of cyber addiction with the QEEG test and investigate the effectiveness of cognitive intervention on the cognitive functions involved in the mental imagery of adolescents.

Participants

The statistical population included 9-12-year-old students who visited Mehraz Andisheh clinic. Available sampling method was used, and from among 40 people with research conditions, 20 girls and 20 boys were randomly divided into the control and experimental groups. The criteria for entering this research included cyber addiction, age condition, not having specific medical and psychiatric disorders, and full consent to participate.

Instruments

The social network addiction diagnosis questionnaire is based on mobile phones (Ahmadi et al., 2015). This test has 23 questions, and the questionnaire scoring is on a five-point Likert scale (Completely disagree = 1 and somewhat disagree = 2 and have no opinion = 3 and somewhat agree = 4 and completely agree = 5). Moreover, higher overall scores indicate the respondent's higher addiction to social networks and vice versa. The 24-channel EEG device, which, according to the scoring standard of 10-20 of 19 brainwave channels and from 1 to 30 Hz, was recorded for 5 minutes with eyes open and closed. IVA-2 software (visual attention) is one of the most widely used in measuring visual-auditory attention. This software is designed based on the diagnostic and statistical manual of DSM-V mental disorders. This test can be used to evaluate the performance of people over six years old, and the duration of this test is 20 minutes.

Also, Kim Carrad test (visual memory) was used to estimate visual memory. This test measures three factors: sensory, long-term, and short-term memory. Capitan's Log software (visual processing) was also used as one of the best cognitive software for improving mental performance. This software diagnoses and treats psychological disorders such as memory impairment, visual and auditory perception weaknesses, and other related conditions. Moreover, RehaCom software was used as a comprehensive and advanced software system for computer-assisted cognitive rehabilitation. This practical tool assists the therapist in the cognitive rehabilitation of disorders that affect specific aspects of attention, concentration, memory, perception, activities of daily living, and much more.

Procedure

After selecting the participants, the experimental group went through the specific intervention planned for them while the control group did not receive such treatment. The behavioral data analysis of this research was done in two parts: descriptive and inferential statistics. After presenting the descriptive results, the t-test was used to analyze the data considering the data normality. Also, Cohen's d test was used to check the effect size. The Kolmogorov-Smirnov test was used for the normality of the data, and Levene's test was used for the homogeneity

of variances. Data analysis was done using SPSS version 26 software.

Findings

In this section, first the frequency distribution of demographic variables was examined to see whether they are similar in both the experimental and control groups.

Table 1
The Mean and Standard Deviation of the Analyzed Indicators and the Results of the Shapiro-Wilk Test

Time	Group	Variable	Mean	SD	S.W	sig
Pre test	**Experimental**	Sensory memory	3.241	0.857	0.154	0.095
		short term memory	3.415	1.025	0.078	0.181
		long-term memory	2.987	0.957	0.097	0.231
	Control	Sensory memory	3.341	0.952	0.054	0.154
		short term memory	3.315	0.725	0.121	0.103
		long-term memory	3.084	0.741	0.102	0.112
Post test	**Experimental**	Sensory memory	3.954	0.451	0.098	0.201
		short term memory	4.012	0.984	0.105	0.154
		long-term memory	3.754	0.754	0.124	0.147
	Control	Sensory memory	3.350	0.578	0.113	0.103
		short term memory	3.324	0.855	0.095	0.194
		long-term memory	3.124	0.674	0.201	0.156

According to the findings, the average cognitive function components in the experimental group increased from the pre-test to the post-test while no significant change was observed in the control group. Also, the findings of the Shapiro-Wilks's test showed that the distribution of the investigated data was normal (p-value 0.05).

The results of multivariate covariance analysis or MANCVA to investigate the effect of RehaCom training on memory dimensions are presented in Table 2.

Table 2
Box Test for Default Equality of Covariance

Box's M	9.767
F	1.488
df1	6
df2	10462.189
sig	.178

As can be seen in Table 2, considering the significance level ($P < 0.05$) which is greater than 0.05, it can be said that the assumption of equality of variances has been met, so the MANOVA test can be used.

Table 3
Results of Levene's Test to Measure the Equality of Error Variance of Research Variables

Index of Components	F	DF 1	DF2	sig
Sensory memory	4.503	1	38	.040
short term memory	7.414	1	38	.010
long-term memory	4.933	1	38	.032

According to the Table showing the non-significance of the F value at the error level of 0.5, it can be concluded that the error variance of variables in two groups is equal.

Table 4
Results of Multivariate Covariance Analysis

	Coefficient	F	DF	Error DF	Sig	Effect Size
Pillai's Trace	.417	7.861[b]	3.000	33.000	.000	.417
Wilks' Lambda	.583	7.861[b]	3.000	33.000	.000	.417
Hotelling's Trace	.715	7.861[b]	3.000	33.000	.000	.417
Roy's Largest Root	.715	7.861[b]	3.000	33.000	.000	.417

As Table 4 reveals, the significance levels of Wilks's lambda test indicate that there is a significant difference between the average memory in the studied groups. To understand this difference, the results of the effects between the participants are specified in the table below.

Table 5
The Results of the Effects between the Participants on the Average Prospective and Retrospective Memory Scores

Index of Components	Sum of Squares	DF	Mean of Squares	F	P	Effect size
Sensory Memory	7.460	1	7.460	5.804	.021	.142
Short-Term Memory	26.797	1	26.797	18.861	.000	.350
Long-Term Memory	13.999	1	13.999	6.588	.015	.158

As can be seen in Table 5, F values and significance levels shows that sensory memory (F = 5.804, P = 0.021), short-term memory (F = 18.861, P = 0.000), and long-term memory (F = 13.999, P = 0.015) are significantly different in the studied groups.

Moreover, the difference between the two intervention and control groups before and after the intervention was measured regarding visual attention. The results of the covariance analysis test to investigate the effect of RehaCom training on the visual attention of adolescents with cyberspace addiction are presented in the Table below. In these analyses, the pre-test effects are controlled and the post-test scores are compared in the two groups.

Table 6
Results of Levene's Test to Check the Equality of Variances

F	df1	df2	Sig.
1.872	1	38	.254

Based on the findings of the research, the assumption of equality of variances is confirmed.

Table 7
Results of Univariate Analysis of the Effect of RehaCom Training on Visual Attention

Source Of Changes	Sum of Squares	DF	Mean Square	F	Sig	Effect Size
Pre-Test	1685.922	1	1685.922	20.092	.000	.352
Group	6052.578	1	6052.578	72.133	.000	.661
Error	3104.628	37	83.909			
Total	233177.000	40				

Based on the results obtained in Table 7, the main effect of group was significant ($p<0.001$). In other words, the difference in the average scores of visual attention in the experimental and control groups in the post-test phase is significant ($p<0.001$). Thus, it can be said that RehaCom training had a significant effect on visual attention. The effect of this treatment in the post-test stage on increasing visual attention is 66.1%. The adjusted averages of visual attention scores in the post-test stage in two groups are presented in Table 8.

Table 8
Adjusted Averages

Standard deviation error	Average	group
2.897	24.607*	Experimental
2.897	-24.607*	Control

Furthermore, the difference between the experimental and control groups before and after the intervention regarding visual processing was investigated. The results of the covariance analysis test to investigate the effect of RehaCom training on the visual processing of adolescents with cyberspace addiction are presented in Table 9. In these analyses, the pre-test effects are controlled and the post-test scores are compared in two groups.

Table 9
Results of Levene's Test to Check the Equality of Variances

Sig.	df2	df1	F
.102	38	1	1.993

Based on the findings, the assumption of equality of variances is confirmed.

Table 10
Results of Univariate Analysis of the Effect of RehaCom Training on Visual Processing

Source of Changes	Sum of Squares	DF	Mean Square	F	Sig	Effect Size
Pre-test	1907.818	1	1907.818	67.765	.000	.647
group	664.239	1	664.239	23.593	.000	.389
error	1041.682	37	28.154			
Total	202322.000	40				

Based on the results obtained in Table 10, the main effect of the group is significant ($p<0.001$). In other words, the difference in the mean scores of the two experimental and control groups in the post-test phase is significant ($p<0.001$). Hence, it can be said that RehaCom training had a significant effect on visual processing. The effect of this treatment in the post-test stage is equal to 66.1%.

Table 11
Adjusted Averages

Group	Mean	SD
Experimental	74.580a	1.187
Control	66.420a	1.187

Discussion

In this research, we aimed to investigate the diagnosis of cyber addiction cognitive impairments with the QEEG test and examine the effectiveness of cognitive intervention on the cognitive functions involved in the mental imagery of adolescents. The research results showed a significant positive relationship between the cognitive impairments of cyber addiction and brain wave patterns. These results emphasize that brain mapping may be used as an indicator to diagnose cognitive impairment in people with cyber addiction. Also, the results showed that RehaCom software could improve the cognitive functions involved in the mental imagery of teenagers suffering from Internet addiction. This cognitive intervention improves visual attention and processing and positively affects visual memory (mental image stabilization). Therefore, the results of this research not only confirm the relationship between cognitive impairments and cyber addiction but also provide important information for developing cognitive interventions to improve cognitive functions in people with internet addiction. In this regard, in hypothesis one, there is a significant relationship between cognitive impairments of cyber addiction and brain signals.

Based on the results of this research, it has been determined that there is a significant relationship between the cognitive impairments of cyber addiction and brainwave patterns, and brain signals can be used as useful indicators to diagnose and evaluate cognitive impairments in people with cyber addiction. Cognitive impairments include problems in memory, concentration, attention, critical thinking, and other factors related to people's cognitive performance. These concepts are important for people's mental health and daily functioning. The results are in line with the results of Kornoghabi et al. (2022), Wei et al. (2014), Choi et al. (2014), Kuss et al. (2011), and Weinstein et al. (2010). The waves of great importance in diagnosing cyber addiction include the theta in the frontal region and the decrease of alpha in the occipital region o1 and beta in the frontal region of fz and smr in the central region of c3.

In hypothesis 2, which states that RehaCom software improves the cognitive functions involved in the mental imagery of adolescents suffering from Internet addiction, the effectiveness of RehaCom software in improving the cognitive functions of adolescents suffering from Internet addiction was investigated. This research shows that RehaCom software can improve the mental imagery and cognitive functions of people with cyber addiction. Mental imagery is considered an important element in individual cognitive function, and here, it plays an essential role in cyber addiction. If RehaCom software can improve the mental imagery of teenagers with cyber addiction, it can positively reduce addiction and improve their cognitive performance. This research is important in developing new approaches and interventions for cyber addiction. The results of this hypothesis are in line with the results of Mirzai et al. (1400), Nazari et al. (2015), and Leshniak et al. (2019).

Also, the third hypothesis states that RehaCom software positively affects the visual attention of teenagers suffering from Internet addiction. Studies and research results show that RehaCom software can improve the ability to improve visual attention in people with cyber addiction. Visual attention is one of the important aspects of the cognitive performance of humans and plays a significant role in visual information processing and decision-making. The third hypothesis claims that Rehacom software can improve the visual attention of teenagers with cyber addiction. In this research, the visual attention ability of teenagers has been accurately measured using IVA software, and RehaCom software has been used as a rehabilitation intervention. The explanation of these results is important because it shows that developing rehabilitation software can effectively reduce the negative effects of cyber addiction and improve people's cognitive performance. This issue is of particular importance for professionals or psychologists who work in the field of cyber addiction. The results of this hypothesis are in line with the results of Montag and Rutter (2019), King et al. (2018), Wu et al. (2018), and Blanchino et al. (2017). The fourth hypothesis stated that RehaCom software positively affects the visual processing of adolescents suffering from Internet addiction. Research shows that this software can improve visual processing in cyberspace addicts, and this effectiveness has been carefully considered. Visual processing means the ability of people to interpret and understand visual information and images. This critical skill plays an essential role in solving everyday problems and understanding the content of images and videos in cyberspace. In the research on this hypothesis, adolescents who have a substance use disorder have benefited from RehaCom software as an intervention tool to improve visual processing. The research results show that it is possible to use software-based educational tools to improve visual processing and, as a result, increase the cognitive performance of people with cyber addiction. This hypothesis's results align with the results of Montag and Rutter (2019) and King et al. (2018).

Finally, the fifth hypothesis stated that RehaCom software positively affects the visual memory (mental image stabilization) of teenagers suffering from Internet addiction. Therefore, in this conclusion, the effect of RehaCom software on the visual memory (fixation of mental image) of adolescents suffering from internet addiction has been explained. This research shows that RehaCom software can improve visual memory in people with cyber addiction. This hypothesis deals with the effect of RehaCom software on the visual memory or stabilization of mental images of adolescents with cyber addiction. Visual memory is one of the important cognitive skills that helps people store and reason visual images and information in their minds. In the research related to this hypothesis, adolescents with a cyber addiction have performed exercises using RehaCom software to increase visual memory and stabilize mental images. These results show the importance of developing and improving visual memory, and cognitive-based software can be used as an effective tool to increase visual memory ability in people with cyber addiction. The results of this hypothesis are consistent with the results of Suvo et al. (2018), Anderson et al. (2017), Akbari et al. (2017), Brand et al. (2016), and Montana et al. (2015).

In general, it can be stated that one of the pattern models in the current research is the CHC. As stated, this model is based on the assumption that some components are more critical than others among the essential and influential components in evaluating intelligence. These are more crucial and central components and are considered the core of measurements. In the present research, more crucial and central indicators were selected from the vital indicators affecting the cognitive dimensions of people with cyber addiction. These indicators were measured, and the results showed that three indicators (visual attention, visual memory, and visual processing) had a significant role in the evaluations and that these indicators could meaningfully reveal the cognitive problems associated with addiction. This shows that one should go for more central, original, and comprehensive indicators among the various indicators, as shown in the research results. On the other hand, the CHT theory is a therapeutic intervention theory emphasizing efforts toward theory and practice.

Conclusions

The present study aimed to present and compile an effective and appropriate intervention package to reduce cognitive impairments caused by cyberspace. Influenced by the CHT theory, the current researchers focused on the practical and essential components to solve the problems and issues of people with cyber addiction. This research showed that teenagers addicted to cyberspace may have various cognitive impairments, including problems in perception, memory, concentration and attention, decision-making, reasoning, and controlling negative thoughts. The research results showed that cognitive interventions can significantly improve the cognitive abilities of adolescents with cyber addiction and achieve healthier mental imagery than before.

This research shows that cyber addiction, which negatively affects teenagers' mental health, is a severe problem requiring individual and group interventions in cyber addiction. On the other hand, this research shows that addiction to cyberspace can affect a person's cognitive functions, especially teenagers in an essential period of cognitive development, which can cause destruction and disruption in their cognitive functions. This issue can become a danger to the capabilities and human potentials of the future generation. Interventions and treatments based on mind and cognitive pathology can be used as practical solutions to improve individual cognitive functions and prevent the development of cyber addiction. Consequently, concerns associated with cyber addiction have an impact not just on individuals but also on society at large. It is imperative to give increased consideration to this matter in order to uphold the mental well-being of society and mitigate potential cognitive and psychological harm in the succeeding generations.

A limitation in the existing research lies in the lack of cooperation from certain adolescents. In line with the limitations of the research, it is suggested that due to the positive effect of RehaCom software on improving cognitive functions in adolescents with internet addiction, educational and counseling programs should be developed to intervene and improve the condition of people with cyber addiction in schools. Also, more research should be done on cyber addiction and its effects on cognitive functions with specialized devices such as FMRI. This research can contribute to the treatment and prevention methods for cyber addiction. Finally, it is suggested to design and implement educational and awareness programs for the general society to encourage healthy and responsible use of cyberspace, which can start in schools.

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Conflicts of Interest

No conflicts of interest declared.

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