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Technology-based ADHD therapies and alternative non-drug options

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Abstract

Since so many studies have been conducted over the past ten years, we now have ample information about the profile and management of ADHD. Children with ADHD frequently struggle in school and with their attitude because of issues with cognitive and metacognitive skills. Due to inadequate management and interventions, it frequently happens that they are marginalized at school or the home. The development of these children's emotional intelligence and abilities like self-awareness, self-regulation, and self-control is crucial for enhancing their life quality and their interactions with adults and peers. Medication, behavior modification, or a combination of the two are typically used to treat ADHD. The efficacy of behavioral therapies is examined in this research, in addition to the use of recent technology for treating ADHD.

Keywords

Attention Deficit Hyperactivity Disorder (ADHD), Social/Emotional Development, Behavior, Technologies, Metacognition, Emotional Intelligence.

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Introduction

According to Drigas & Driga (2019), Attention Deficit Hyperactivity Disorder (ADHD) is a complex neurological disorder, which still lacks scientific data concerning its nature and treatment methods. Some factors, such as the family's socioeconomic status, the existence of a psychiatric disorder in the mother, or smoking and alcohol consumption during pregnancy, have been proved to play an important role. The main symptoms of ADHD are lack of attention and impulsivity, resulting from a malfunction in areas of the brain that control executive functions. These functions, such as memory and attention, lay the foundation for an individual's organizational skills, their ability to focus on tasks, control of emotions, and the ability to self-evaluate.

In order to control the symptoms of ADHD, a therapy based on the development of cognitive and metacognitive skills is required. According to Drigas et al. (2021), cognitive and metacognitive skills evolve progressively via an individual's self-awareness of their strengths and weaknesses, their self-observation, self-regulation, adaptation and flexibility in diverse areas (cognitive, emotional, and behavioral), recognition, discernment and mindfulness. People with high social and emotional intelligence are capable of better self-monitoring, a skill that is necessary to control behavior in children with ADHD (Drigas & Papoutsi 2018). Emotional intelligence focuses also on the individual's character and aspects of self-control, such as regulating impulses, which is one of the predominant difficulties of these children (Matthews et al., 2004). According to the 9-level model (pyramid) of emotional intelligence of Drigas & Papoutsi (2018), a person must go through the following stages to reach the highest level of Emotional Intelligence, which is Emotional Unity:

1) Emotional Stimuli (coding of emotional senses, attention)
2) Emotions' Recognition, Perception/Expression of Emotions (memory, perception, recognition, emotions' identification)
3) Self-knowledge (self-perception, awareness, self-observation)
4) Self-management (self-regulation, flexibility, self-control)
5) Social Awareness, Empathy, Emotion Discernment (awareness, monitoring, social recognition & flexibility)
6) Social skills, Specialization in Emotions (reflection, management of social problems)
7) Universality of Emotions, Self-actualization (self-perfection, self-completion)
8) Transcendence (self-reflection, transcendental knowledge)
9) Emotional Unity (pure consciousness & fullness)

The seventh level, "self-actualization", is at the top of Maslow's hierarchy of needs. In order to achieve this condition of becoming, it is necessary to meet needs at lower levels of the pyramid, such as the need for survival, security, social acceptance, and self-esteem (Maslow 1943, 1987). Only when people with ADHD meet their needs, develop their emotional intelligence and improve their metacognitive skills will they be able to master the appropriate cognitive and socio-emotional skills that will allow them to integrate into the social environment (Drigas & Mitsea 2020; Drigas & Mitsea 2021). Medication is considered a first-choice treatment to reduce the symptoms. However, it has several disadvantages due to the side effects caused and the risk of addiction. On the other hand, intervention tools such as new technologies and behavioral methods have proved to be just as effective.

ADHD and Information & Communication Technologies (ICT)

Powell, Parker, Robertson & Harpin (2017) studied the suitability of mobile applications for children with ADHD. With the advancement of technology, ADHD can be successfully managed using applications especially designed for this population. Previous research by Xu et al. (2002) examined 19 studies evaluating the use of technology in students with ADHD in the age group of 4 to 19 years. The authors concluded that so far there is too little evidence that supports the effectiveness of such interventions. This study aimed to investigate the suitability of 10 applications for children and young people with ADHD, as well as for the doctors who work with them. For this purpose, mobile applications in the Apple iTunes Store and the Android Google Play Store in the United Kingdom were sought, and the top 10 applications, referring to children and young people diagnosed with ADHD, were selected for the study. The selections were made based on the apps' rankings defined by algorithms according to the number of downloads and ratings; the search term used was "ADHD". Five clinicians from a health service that treats children and young people with ADHD and five diagnosed children belonging to the age group from 6 to 17 years, took part in this study. During the study, the youngsters with ADHD used the applications and were then interviewed to share their feedback. Clinicians were also interviewed to share their views on how successful these applications were for this group (Powell et al., 2017).

The clinicians considered that applications could be used to monitor the symptoms of children and adolescents with ADHD and that they have both a positive and a negative impact regarding their relationships with others. They also cared about additional factors, such as accessibility issues, how important it is for applications to take into account ADHD symptoms and the associated difficulties, whether they are appropriate for all ages and whether they have customizable features, so that every user can relate. Also, two youngsters and clinicians noted that the applications weren't always reliable, as oftentimes they did not work properly or disconnected. Two youngsters also considered that having to pay for the applications was an obstacle, as they could not afford online payments. The youngsters and doctors alike, considered that applications should be fun, visually appealing, and use a language and characters to which children can relate, and receive rewards (Powell et al., 2017).

Regarding the symptoms of ADHD, two participants claimed that the applications could be used to relax them (that is, to help their hyperactivity). They also noted that earning an instant reward during the game, such as coins, made them feel happy. Another participant noted that focusing on patterns

made him relax. Likewise, clinicians believed that rewards were essential to attract users. One clinician believed that applications for ADHD have the potential to improve memory and inhibitions, thus aiming to reduce impulsivity. The young people suggested also that applications should be interactive, as they were less impressed and sometimes even frustrated with applications that did not involve interaction but only passive listening or watching. Doctors also suggested that applications could be utilized to track nutrition, mood, and ADHD symptoms, either as reminders or journals (Powell et al., 2017).

Prem, Mohanraj & Samuel (2020) studied the effects that computer interfaces have on the brain of children with ADHD. The Brain-Computer Interface (BCI) is a new technological system of intervention that improves the attention of people with neurological disorders, such as Attention Deficit Hyperactivity Disorder (ADHD). BCI can be used to monitor the brain's activation during an activity, particularly its attention levels, as well as the level of hemispherical balance (Carelli et al., 2017). Using BCI to improve attention in patients with attention disorders is a relatively new approach. BCIs use mathematical algorithms to decipher the neurophysiological signals of the nervous system. Patients can monitor and control the activity of their brain through "neurobio-feedback therapy". BCIs typically use magnetoencephalography (MEG), near-infrared spectroscopy (NIRS), functional magnetic resonance imaging (fMRI), electrocorticography (ECoG), and multi-electrode intracranial implants (Mehdi et al., 2016). A meta-analysis shows that the effects of neurofeedback in children with ADHD increase over time, while the effects of medication decrease, thus indicating the long-term effectiveness of neurofeedback (Van Doren et al., 2018). In this research, there is a critique for applying BCI in attention issues, both for healthy individuals and for individuals with various cognitive disorders, such as Attention Deficit Hyperactivity Disorder (ADHD), Amyotrophic Lateral Sclerosis (ALS), Autism Spectrum Disorder (ASD); post-stroke disabilities, cognitive deficits resulting from brain and spinal cord injuries, and dementia. For this purpose, after sourcing the databases PubMed, Web of Science, and Scopus using the terms "brain", "interface", "computer", "training", and "neurofeedback", 23 surveys were retrieved and studied (Prem, Mohanraj & Samuel, 2020).

The brain-computer interface has been suggested as a neurofeedback therapy for children with ADHD. Jiang et al. (2011) designed a BCI-based 3D-game to improve attention. Specifically, users control the movement of a virtual hand via a 3D animation technique, and the BCI processor tracks their attention levels. Another group of researchers evaluated an intervention program that included sensors and Bluetooth technology with a CogoLand game. After the intervention, parents observed a significant improvement in symptoms in their children with ADHD (Lim et al., 2012). Neuroimaging studies have shown that the brain functions that control selective inhibition in children with ADHD can be normalized with neurofeedback therapy (Beauregard & Levesque, 2006). Munoz et al. (2015) developed a video game using BCI to monitor the neurophysiological signals of children with ADHD. The game's name was "The Harvest Challenge", and the setting was a coffee plantation. Games tend to enhance the abilities of waiting and scheduling and the ability to follow instructions in order to achieve goals. When these skills are improved, impulsivity can be brought under control.

Qian et al. (2018) used the fMRI method to look at changes in brain function when using BCI. After the training, it was observed that the intervention group's inattentiveness symptoms were significantly improved compared to the control group. The researchers observed also an improvement in behavior and an acceleration of brain maturation in children with ADHD. Another study by Sciberras et al. (2014) found that BCI-based attention training programs relieved anxiety and low mood symptoms.

Research by Dentz, Guay, Gauthier, Romo & Parent (2020) studied the effects of the Cogmed educational program on the working memory in children aged 7 to 13 years with ADHD and on medication. Throughout life, ADHD is highly associated with cognitive impairments (Kasper, Alderson, & Hudec, 2012); among them, working memory (WM) difficulties are quite frequent (Martinussen & Major, 2011; Massat et al., 2012). Cogmed is a cognitive training software program that includes exercises to improve verbal and non-verbal memory. The study aimed to determine if the Cogmed program was effective for children with ADHD. For this purpose, participants were divided into an experimental group which used the standard version of the program, and a control group which used a comparative version with a lower level of difficulty. The researchers hypothesized that participants in the experimental group would show a more notable improvement in their verbal and nonverbal memory than those in the control group. The secondary objective was to assess whether the results of the Cogmed program extended to other cognitive functions of the children such as logic, inhibition, or self-regulation, and whether they helped improving ADHD symptoms and school performance with regard to reading comprehension and math (Dentz, Guay, Gauthier, Romo & Parent, 2020).

The study included 36 children aged 7 to 13 years who were diagnosed with a combined type of ADHD with co-existing learning disabilities (LD), or Oppositional Defiant Disorder (ODD) or Tourette Syndrome (TS), and were taking medication that had been stable for at least the last two months. Measurements were taken at three different times: 6 weeks before program start, immediately before program start, and after program completion. Participants completed the training program in five consecutive weeks, with five sessions per week. The assessment tools used were: the Wechsler Intelligence Scale for Children - Fourth Edition (WISC-IV) alphanumerical sequence tests (Wechsler, 2005a) to measure the verbal working memory; the Wechsler non-verbal amplitude test (Wechsler, 2006) for measuring the visual-spatial working memory; BRIEF (Gioia et al., 2000) for working memory and executive functions; Raven's color progressive tables (Raven, Court, & Raven, 1998) for nonverbal reasoning; the Continuous Performance Test (CPT-II) (Conners, 2000) for inhibition and attention; the Conners 3AI Questionnaire (Conners, 2008) for ADHD symptoms; and the comprehension and math reasoning tests by Wechsler Individual Achievement Test, second edition, French Canadian edition (WIAT-II CDN-F) (Wechsler, 2005b).

The results showed that participants who used the standard version of Cogmed did not improve their working memory capacity more than those in the control group. Furthermore, during the entire program from beginning to end none of the two groups showed improvement in there cognitive skills. Qualitatively, the participants stated that they found the program tedious, not very encouraging, and difficult. Having a reward system in place may not be sufficient to maintain motivation of participants and parents (Dentz, Guay, Gauthier, Romo & Parent, 2020). This is a significant issue to consider, given that motivation is crucial to completing the Cogmed program and that ADHD itself is associated with motivation difficulties (Sonuga-Barke, Bitsakou, & Thompson, 2013). In addition, the results of the Cogmed program did not differ for participants with LD, ODD, or TS.

In their literature, Spachos, Chiazzasse, Merlo, Doherty, Chifari & Bamidis (2014) studied the applications for tablets or mobiles that are most often used as interventions for children with ADHD; they also studied the WHAAM mobile application and its usefulness. Mobile health (m-health) has become a critical subset of e-health due to the hardware capacity of smartphones that enables e-health functions in mobile applications (Liu et al., 2011). Of the mobile applications, others function as informational and educational tools, while others help managing and tracking ADHD symptoms or even facilitate diagnosis. The WHAAM application allows behavior monitoring in a SMART way through creating a network of people involved in childcare and enabling data collection. The collected data is then visualized and assessed by the health professionals involved, enabling the planning and scheduling of the intervention. Furthermore, the WHAAM application provides tools for assessing the intervention's effectiveness (Alves et al., 2014).

Many other applications have been developed; the ADHD Treatment Researcher (Vermont Behavioral Solutions, 2011) is an Android application that provides access to recent ADHD faculty developments, including published research, recent clinical trials, books, medical videos, events, forums and more. The "You Can Handle Them All" app (The Master Teacher® (2011) has been designed to help parents or educators manage behavior problems and is available for iPhone, iPad, iPod touch, and Android devices. The iBAA Behavior Assessment App (Future help designs, 2012) is suitable for psychologists allowing them to gather and summarize behavioral information; via iPhone or iPod touch it provides diverse observation methods, such as frequency and intervals of ADHD symptoms. Other applications have been designed by Apple such as "Behavior Assessment Pro" (Marz Consulting, 2011), to provide behavioral analysis through guided questions, and to plan further interventions along with reminders.

Behavioral interventions

The bibliographic review of Moore, Richardson, Jones, Thompson-Coon, Stein, Rogers, et al. (2015) collected findings from four systematic reviews, including 138 studies that focused on non-pharmacological interventions for ADHD in school contexts, examining their effectiveness. According to the researchers, there are four levels of intervention context: the student, the classroom, the school, and the socio-cultural context. There are many ways of intervention that improve the symptoms of ADHD in students, but there are also several diverse factors that may limit their applicability and effectiveness in school. For example, a previous study by Ljusberg (2011, b) argues that interventions designed to help the student's functioning in a regular classroom can further aggravate stigma and marginalization because special treatment of the student may make individual differences more perceptible.

In the present study, three main categories of non-pharmacological school-based interventions for ADHD (Sonuga-Barke et al., 2013) were examined: behavioral education, neurofeedback, and cognitive education. Behavioral interventions rely on social learning. Neurofeedback includes visualization of brain activity to encourage children to improve attention and control behavior. Cognitive interventions include training in cognitive processes related to executive functions (e.g., attention and functional memory). Behavioral interventions and neurofeedback had a positive impact on many symptoms at school, however no beneficial results were observed in cognitive education (Moore et al., 2015).

All cognitive training programs are computer-based. While educators believe that the use of computers is a valuable tool for students with ADHD (Edwards, 2008), in the end, due to the special intervention it may contribute to withdrawal from classroom activities and stigmatization. Some of these possible explanations for the ineffectiveness of cognitive education also apply to neurofeedback, where students with ADHD often have to leave the classroom to attend therapy. Other studies have found that ADHD-related psychoeducation for teachers and students has been effective (Bos et al., 1997; Hong, 2008; Houghton et al., 2006; McNeil, 2005). Behavior change may not be effective in young people aged 11 to 18 years (Partridge, 2009), however interventions regarding study skills may be more effective (Ljusgberg et al., 2011; Wong, 2005).

The review revealed also a lesser effectiveness on social skills building for students with ADHD. First, social skills training may make students with ADHD more aware of their social struggles and this can negatively affect their adaptation at school. Second, social skills training is often provided in small groups (Evans et al., 2011), thus withdrawal from the regular classroom can be perceived negatively and increase stigma (Ljusberg, 2011b). Finally, it was recognized that attitudes towards school, learning, and emotional self-regulation were important for students diagnosed with ADHD and, could therefore be valuable areas of intervention (Moore, 2015).

Albertova (2020) studied how to support the emotional struggles of children with ADHD at school. Interventions in schools are mainly aimed at improving the symptoms of inattention, impulsivity, and/or hyperactivity. More than often, however, there is the aspect of emotional instability that deserves attention too. This study suggests practical interventions suitable for supporting students with ADHD through the collaboration of teachers, school psychologists, and parents.

According to research, well-being plays an essential role in the school context, as it is related not only to academic success but also to social skills, improved relationships with teachers, peers and parents, and the physical health of students (Gilman & Huebner, 2006; Shoshani & Steinmetz, 2013). Therefore, Albertova (2020) proposes the following strategies for schools in order to manage the symptoms of ADHD, including emotional dysfunction in school environments:

1) Organizing teaching and learning: Students with ADHD need regular reminders of classroom and school rules. Also, delegating classroom activities at the beginning of the lesson can be helpful.
2) Strategic praise: strengthening students positively and frequently increases significantly their self-esteem and motivation.
3) Corrective comments: It is important to convey them in a clear and concise way immediately after an unwanted behavior.
4) Individual support in the classroom: Providing each child with a checklist of what needs to be done and to track its progress.
5) Reducing hyperactivity and fatigue: A 5-minute break every 30 minutes of activity, including some short fun activities.
6) Self-esteem: Enhancing the student's individual work, assigning attainable goals, make good use of the student's interests.
7) Social skills: Creating small groups, promoting collaboration, and practicing role-playing games.
8) Emotions and regulation of emotions: Teaching the student and ideally the entire class about emotions and ways to manage them effectively. Create a list with strategies for dealing with negative emotions.
9) Communication between school and parents: The long-term process of support requires an interdisciplinary team within the school, parents, and external mental health professionals.

In one of their studies, Staff, Hoofdakker, Oord, Hornstra, Hoekstra, Twisk, et al. (2021) examined the effectiveness of teachers' behavioral education as a necessary means of intervention in class for children with ADHD. According to previous studies, a teacher's behavioral education is the most effective, non-pharmacological intervention in the classroom to address the symptoms of ADHD and their related behavioral implications (Evans et al., 2011; Fabiano et al., 2003). In addition, it helps lessen the burden on teachers and increasing their levels of self-efficacy (Ross et al., 2012). Therefore, this study aimed at evaluating the techniques of behavioral education of teachers for children with ADHD symptoms. For this purpose, two brief behavioral interventions were developed focusing on either stimulus control or emergency management techniques. Based on previous findings (Gaastra et al., 2016), the researchers hypothesized that both techniques would effectively improve problematic behaviors in children with ADHD, compared to a control group.

The study was conducted in two intervention contexts (stimulus control and emergency management) and in one control context; all three were attended by 30 children aged 6 to 12 years and their teachers. The results were evaluated in all three contexts at three different times: at start, during the week immediately after two intervention sessions, and three weeks after the intervention; the total duration of the study lasted three months. The main inclusion criteria were that the children had been diagnosed with ADHD and had not received any medication for the last month, and that the teachers had not received any behavioral training for the last year. In order to assess the status of symptoms at home parents completed the Strengths and Difficulties Questionnaire (SDQ) (Goodman, 1997). Each teacher attended two individual sessions with a trained psychologist, and after each session the teachers were instructed to apply the techniques in the classroom for four weeks. These interventions were based on documented parent behavior training programs (Van den Hoofdakker et al., 2007), that aim to correct dysfunctional behaviors associated with ADHD, through training on stimulus control and emergency management techniques.

In the stimulus control intervention, the teachers were taught how stimuli cause specific behaviors and how deficits in children with ADHD can lead to difficulties adapting to stimuli. The techniques used in this intervention were: setting clear rules, giving clear instructions, discussing challenging situations with the child upfront, and circumscribe activities within time and space. More specifically, the intervention plan may consist of: (1) the teacher giving appropriate individual instructions to the child, (2) the child having a step-by-step action plan, with illustrations showing how to perform the task and what to do when a question arises, and (3) a timer on the child's desk to show the remaining time.

In the emergency management intervention, the teachers were taught techniques to display specific behaviors, such as praise, reward, ignorance, and negative consequences. The plan of intervention in this case may consist of: (1) the teacher rewarding frequently the child's expected behavior (e.g., praise when the child is working or quiet), (2) the teacher praising other children who are concentrated in their work and (3) the teacher ignoring persisting attention-seeking behaviors (e.g., hand raising, calling the teacher's name) (Staff et al. 2021).

The results showed that both techniques effectively improve ADHD-related problematic behaviors, both in the short and the long run (i.e. up to three months later). Specifically, the teachers in both interventions reported significant improvements in students' problematic behaviors compared to the control group, whilst there were no significant differences in improving the children's s problematic behaviors between the two types of intervention. It was also observed that for younger children, emergency management techniques were more effective than stimulus control techniques, whilst for older children, quite the opposite was true. Furthermore, the effectiveness of the emergency management-based technique increased as the number of students per class decreased, whilst the effectiveness of stimulus control-based techniques did not depend on the size of the class (Staff et al., 2021).

Nasa, Pudjiati & Tjakrawiralaksana (2018) studied the technique of behavior modification and its effects on attention during activities in an 11-year-old boy diagnosed with ADHD. The research examined the boy's ability to listen to a story and

answer comprehension questions. This task was selected because listening to a story increases the attention span in children with ADHD. The inability of children with ADHD to maintain their attention during activities is the primary reason why they face school difficulties and failures (Harpin, 2005). Behavior modification is a widely used and proven effective treatment for children with ADHD, as it has been proved to improve attention during activities (Fabiano & Pelham, 2003). In this method, instructions are given according to each child's individual needs as they learn a skill (Ciccarelli & Meyer, 2006). The prompt itself is a tool or a stimulus used to increase the likelihood of the desired behavior to occur. Once the child has achieved the desired behavior at a particular stage, he/she receives positive reinforcement in the form of fun or praise (Martin & Pear, 2007). The purpose of this study was to examine whether the use of behavior modification techniques can increase the attention span in children with ADHD during activities.

This intervention attempted to increase the boy's attention span during the activity to twelve (12) minutes. This time target was determined based on the estimation that the average range of attention span of a child is their chronological age plus one (Miranda, 2006). The interventions were applied for five consecutive days. Each session lasted about 15-20 minutes. The participant heard a story for approximately 12 minutes that was previously recorded by the researchers. The researchers prepared one story for each session, hence five different stories. During listening, the researcher used a timer to measure the participant's time for as long as he was paying attention. The timer stopped whenever the boy got distracted and started again when he paid attention again. The researcher recorded also the boy's behaviors while he was listening to the story. After listening to the story, the researcher asked five verbal questions and received verbal answers from the boy (Nasa, Pudjiati & Tjakrawiralaksana, 2018).

This program used also instant and positive reinforcement with coins and stickers. The prompts used were verbal, which encouraged the participant to listen carefully to the story. Also, images were used to help illustrate the expected behaviors and those not welcomed during listening to the story. The results showed that the participant increased his attention span during the activity from 2 minutes to 12 minutes. The results also revealed an increased comprehension of the story's content from the first session to the last, based on the participant's increased number of correct answers to questions. The results further showed that the boy could continue to stay attentive during the activity for 10 minutes, without any additional intervention. The participant was also able to share additional information about the story, i.e. beyond the questions, in the fourth and fifth session. The use of positive reinforcement has been proved to be impactful in improving the participant's attention span during an activity. In this study, positive reinforcement was given when the participant gave the appropriate attention to the activity and for a specified duration of time (target). The prompt images also played an essential role in improving the child's attention span, as they were used to facilitate his understanding on the instructions and rules (Nasa, Pudjiati & Tjakrawiralaksana, 2018).

Conclusions

Concluding we have to underline the role of digital technologies in education domain that is very productive and successful, facilitates and improves the assessment, the intervention and the educational procedures via Mobiles [64-69], various ICTs applications [70-98], AI & STEM [99-103], and games [104-108]. Additionally, the combination of ICTs with theories and models of metacognition, mindfulness, meditation and emotional intelligence cultivation [109-135] as well as with environmental factors and nutrition [60-63], accelerates and improves more over the educational practices and results, especially for the students with ADHD.

More specifically the purpose of this academic paper was the literature review of researches on the use of information & communication technologies (ICT) for the treatment of ADHD, as well as the study of the effectiveness of behavioral methods. Children with ADHD exhibit a set of symptoms. The main characteristics of the disorder are inattention, hyperactivity, and impulsivity. To control these symptoms, it is necessary to develop emotional intelligence and to improve the cognitive and metacognitive skills, which are controlled and regulated by various parts of the brain (Drigas & Mitsea, 2021).

Recent research suggests that appropriate mobile applications could be used to relax children with ADHD and to monitor their diet, mood, and symptoms (Powell et al., 2017). According to Spachos et al. (2014), the mobile application WHAAM provides tools for evaluating the intervention's effectiveness. There are many more applications, which act as informative and educational tools, aiming to facilitate the monitoring and management of ADHD symptoms. Also, Prem, Mohanraj & Samuel (2020) concluded that the brain-computer interface (BCI) is a new system of technological intervention that can be recommended as a neurofeedback therapy for ADHD; they observed that inattention symptoms can be significantly limited, behavior can be improved, the brain's maturation can be accelerated, and children's symptoms of anxiety and low mood can be relieved.

In addition, several studies support the use of behavioral interventions in children with ADHD. More specifically, Moore, Richardson, Jones, Thompson-Coon, Stein, Rogers, et al. (2015) concluded that behavioral interventions and neurofeedback significantly improve many ADHD symptoms at school. The same view seems to be shared by Nasa, Pudjiati & Tjakrawiralaksana (2018), who studied behavior modification as a treatment method for children with ADHD and concluded that it might increase attention levels. Also, Staff, Hoofdakker, Oord, Hornstra, Hoekstra, Twisk, et al. (2021) argue that the behavioral education of teachers is the most effective, non-pharmacological intervention to address ADHD symptoms and behavioral problems in the classroom. The opposite view share Brown, Amler, Freeman, Perrin, Stein, Feldman, et al. (2005) who concluded that behavioral interventions alone cannot treat symptoms effectively. The discussion about the methods of treatment of ADHD has occupied the scientific community a lot. Therefore, it is necessary for researchers to constantly strive to find the most appropriate methods that will allow those children to improve their cognitive and metacognitive skills, and thus integrate into the social environment.

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