Solutions for improving the symptomatology of the child with attention-deficit/hyperactivity disorder (ADHD)

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Abstract

Attention- deficit/hyperactivity disorder (ADHD) is one of the most common developmental disorders experienced in childhood and can persist into adulthood. The disorder has an early onset and is characterized by a combination of overactive, poorly modulated behavior with marked inattention. In the long term it can impair academic performance, vocational success and social-emotional development. On the other hand, child with ADHD has been included among those with special support needs and special educational needs in the USA since 1990. In this case, the intervention program was built for those students in the school environment. The objective of this study is to find the effectiveness of a problem solving intervention program on the frequency of symptoms of hyperactivity and attention deficit, visuomotor precision, visuomotor integration (which includes visuospatial abilities, such as estimating distances between objects, line orientation, angularity, and fine motor coordination) and emotional regulation of students with ADHD. Also, this study aimed to verify if emotional regulation had an effect on two relationships between: problem solving ability and visuomotor integration of students with ADHD, problem solving ability and visuomotor precision of students with ADHD. A problem solving intervention program consisting of 120 activities was carried out for 6 months with 30 elementary school students (grades 0-4) diagnosed with ADHD and integrated in normal school. TRS-P was used to evaluate changes in the frequency of symptoms of hyperactivity and attention deficit in students with ADHD, an image system was developed for this study to identify difficulties of emotional regulation and NEPSY was used to evaluate changes in the neuropsychological functioning in three domains: Attention/Executive functioning, Visuospatial and Sensorimotor. The program has been identified to have a positive effect on the frequency of symptoms of hyperactivity and attention deficit, visuomotor precision, visuomotor integration (which includes visuospatial abilities, such as estimating distances between objects, line orientation, angularity, and fine motor coordination) and emotional regulation of students with ADHD. Also, in this study it was demonstrated emotional regulation had an effect on two relationships between: problem solving ability and visuomotor integration of students with

ADHD, problem solving ability and visuomotor precision of students with ADHD. The problem solving intervention program designed in this research can be utilized in the classroom.

Keywords: *ADHD, emotional regulation, visuomotor integration, visuomotor precision, intervention.*

I. INTRODUCTION

Attention Deficit/Hyperactivity Disorder (ADHD) in the child is characterized by a complex symptomatology. For this reason, a considerable number of articles appeared in the literature on genetics, psychology and the science of education. Among the reference authors who studied Attention Deficit/Hyperactivity Disorder (ADHD), we mention: Barkley (2012); Greene (2016); Becker, Froehlich, Epstein (2016); Barkley, Peters (2012); Bonvicini, Faraone and Scassellati (2016); Greene and Chee (2001).

ADHD, on the other hand, was known until 1775 under the following names: Minimal Cerebral Deficit, Minimal Cerebral Dysfunction, Hyperkinetic Childhood Disorder, Attention Deficit Disorder with/without Hyperactivity, and, since 1987, attention deficit/hyperactivity disorder (Antshel and Barkley, 2011; Berkley and Peters, 2012; Sparrow and Erhardt, 2014). The first scientist who gave a definition of Attention Deficit/Hyperactivity Disorder (ADHD) was George Still (1902), a British physician whose description was published more than a hundred years ago. He explained the conditions in which there is a moral control defect. This suggested that patients had insufficient moral control to manage their focus (Barkley, 1997a).

This disorder is a neuro-behavioral development characterized by an early onset (usually in the first five years of life) (Barkley, 1997a). Children with ADHD are often reckless and impulsive, predisposed to accidents, and have discipline problems due to violation of the rules, but without being a deliberate defiance. Also, their relationships with other children and adults are often disinhibited, predominantly lack of normal care and caution. Thus, they can be isolated from others. Impairment of cognitive functions is common, and specific delays in motor and linguistic development are common. Secondary complications include dissocial behavior and low self-esteem (Tannock, 1998).

ADHD is characterized by attention deficit and/or hyperactivity disorder. There are three categories of ADHD: predominantly inattentive, predominantly hyperactive/impulsive and

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mixed (American Psychiatric Association, 2013). In the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition, the symptoms occurred in ADHD were limited to those associated with cognitive (attention deficit) and behavioral (hyperactivity/impulsivity) deficits, while deficient emotional self-regulation, a relevant source of morbidity, was left out.

Approximately 80% of school-enrolled children in the first grade were diagnosed with attention deficit/hyperactivity disorder in the US in 2002, and between 30 and 65% were supposed to be having behavioral disorders in adolescence. ADHD is a neuro-mental disorder of developing self-control capacity that interferes with normal development and affects daily activities. This disorder affects all aspects of the social life of the suffering person, including family relationships, at school and at play; ADHD inhibits respect for the rules and prevents social integration (Cooper and Bilton, 2002; Taylor, 2011).

Undoubtedly, ADHD is a complex condition (which affects four times as many men as women) (Berkley and Peters, 2012) and there is no simple explanation, despite a significant amount of research that try to isolate the causes of this disorder (Thapar, Cooper, Eyre and Langley, 2013).

We can conclude that all this information is a solid argument in favor of the hypothesis that attention deficit/hyperactivity disorder is an issue affecting the ability to adapt to school requirements, on a cognitive, social and school/social plan.

The child with ADHD has been included among those with special support needs and special educational needs in the USA since 1990, when the Individuals with Disabilities Education Act (IDEA) were adopted. This act ensures that all youngsters aged 3 to 21 years benefit from free and appropriate public education, regardless of their capacity. Having ADHD does not automatically qualify a child for special services according to IDEA. According to the guidelines, students must have a disability; need to have special education or related services due to disability. Although ADHD is not nominated as a disability, it is nominated as a condition in the category "Other Health Impairments" (Bailey, 2007). The child with ADHD is eligible for special educational services if he/she still has learning difficulties and is thus included in an Individualized Educational Program (PEI).

Therefore, reducing the symptom of the child with ADHD through intervention programs has been extensively studied over time.

First, many studies aimed to examine the efficacy of peer inclusion in interventions targeting the social functioning of children with ADHD. Cordier, Vilaysack, Doma, Wilkes-Gillan, and Speyer (2018) and Toplak, Connors, Shuster, Knezevic și Parks (2008) demonstrated that children with ADHD following this intervention have learned: contacts with adults at home and school, problem solving skills, relaxation and anger management techniques, typical social and language development, interaction strategies (instructing, helping, sharing, prompting,

praising, reaction to rejection, negotiation, being teased and socially criticized), absence of behavior difficulties, regular availability, alleviate pressures on teachers, health professionals, and parents, and an interest in interacting with the target child.

However, previous research suggests: usual course of medication for children should be used in combination with peer-inclusive treatments in order to obtain clear therapeutic gains (Cordier, Vilaysack, Doma, Wilkes-Gillan, and Speyer, 2018); children with the inattentive subtype of ADHD may imitate some of the negative behaviours displayed by other children without ADHD (Antshel and Remer, 2003); the child with ADHD following this intervention cannot generalize functional behavior in other contexts (Antshel and Barkley, 2008; Pelham and Fabiano,2008).

Second, the literature suggests the hypothesis according to which academic problems are typical among students with attention-deficit/hyperactivity disorder (ADHD) at the beginning of the elementary school (Schultz, Evans and Serpell, 2009). The extent of learning difficulties and their definition is still a controversial issue. Experts believe that this situation is partly due to the heterogeneous nature of these difficulties, and to the unique behavioral pattern that each student faces with such problems. Despite the fact that most definitions of learning difficulties refer to the causes of the phenomenon (neurological causes, brain dysfunctions, etc.) and most of the descriptions of learning difficulties use medical language e.g. dyslexia, dysgraphia, dyscalculia, etc.), these factors rarely play a diagnostic role. Moreover, in educational practice, there is no justification for the use of these labels, as well as the search for hypothetical causes that cannot be proven in the field of education. Given that today a class of students is no longer formed by the performance level principle, or by other criteria that ensure a relative homogeneity but represent a heterogeneous environment, we can say that pupils with learning difficulties are a category of under-performing (McClure and Hillwing Garcia, 2013).

The difficulty of reading in ADHD students with the predominantly inattentive subtype is not caused by the presence of ADHD, but its presence exacerbates, aggravates the symptoms of ADHD. There is no question that these children are lazy, but that reading does not reserve them much satisfaction. Even when the student can read, the effort is so great that the meaning of the read is lost. In all these cases, it is highly recommended to use the cards as much as possible to improve the child's ability to recognize the words as images (Green and Chee, 2001).

On the other hand, a child with ADHD may also have discalculia. In this case, the teacher has to be creative in specifying the problem requirements (Gold, Ewing-Cobbs, Cirino, Fuchs, Stuebing and Fletcher, 2013; Friedberg, McClure and Hillwing Garcia, 2013).

Dyslexia is commonly found in the child / pupil with ADHD. He is not careful about the structure of words, omitting, replacing or adding letters. It loses a lot of time, especially when it has long words to write and do many corrections (Green and Chee, 2001).

In addition, the letters are disproportionate. Writing is therefore illegible and ineffective. It is noted the child's inability to stay within the preset writing and copying limits in school (Schoemaker, 2005). Children with ADHD can acquire the basics of writing. However, in order to achieve better control over writing, children with ADHD increase the average pressure on the pen and the result is disproportionate, with no effect on the writing fluency (Adi-Japha et al., 2007).

Difficulties encountered by children with ADHD in planning and monitoring of work, acquisition of phonological and spelling capabilities, and in the acquisition of declarative knowledge are well documented in the literature. Research in the field, as Vrăsmaș (2012) argues, shows that the texts of children with ADHD are short and poor as a structure, vocabulary, grammar structure, although they can develop as many ideas as a typical child for the age in question. In the case of a competition of difficulty, specialized intervention is recommended. Intervention in the case of ADHD is mainly aimed at learning strategies to monitor attention, focus on school tasks, self-regulate behavior.

The solution to all the academic problems of the child with ADHD is found by Volpe, DuPaul, DiPerna, Jitendra, Lutz, Tresco and Vile-Junod (2006) and developed by Pfiffner, Villodas, Kaiser, Rooney, and McBurnett (2013). They evaluate educational outcomes of a collaborative school–home behavioral intervention for ADHD. This intervention is based on individual and group intervention for children with ADHD, the involvement of parents and teachers in behavior change of children with ADHD. The authors used the observation method and the interview method before the intervention. The observation method will be used to find the symptoms of the child with ADHD. They will be implemented by the class teacher, the support teacher and the psychotherapist. The interview method will be used by the specialist to find out information, such as those referring to the behavior of the child with ADHD when he does his homework. The results of the intervention showed that teachers and parents learned strategies to promote children's self-control, motivation, and engagement, and children learned organizational, daily living, and social skills, which are reinforced by teachers and parents (Pfiffner, Villodas, Kaiser, Rooney, & McBurnett, 2013). A limitation of intervention is that it has short-term results. The authors also did not take into account the medication, which could influence the results of the intervention.

Other solution to all the academic problems of the child with ADHD is found by Barkley (1997b). He describes the stages of an intervention program aimed at reducing the symptoms of ADHD students by involving the parents of these students. The stages of this program for the difficult child are: in the first stage, parents are presented with the causes of the child's difficult behavior; in the second phase of the Program, parents learn effective methods to pay attention to the child's behavior; in the third stage, each parent learns the right time to praise, appreciate and

reward a child's behavior; in the fourth stage, parents learn more methods of rewarding child behavior, methods applied to increase the child's compliance with commands, but also to motivate the child; in the fifth step, parents learn how to introduce penalties in the Program for inappropriate behaviors in different contexts; in the sixth stage, increases the number of contexts, in which the inappropriate behavior of the child is punished; in the seventh stage, parents learn how to manage the child's behavior in public places; in the eighth stage, the parent learns how to manage the child's behavior at school. This is done through a daily school performance monitoring sheet and a reward system; in the ninth stage, parents learn how to handle future problem behaviors using the methods already learned. In addition, they learn how to create and implement a Behavioral Change Program; in the tenth stage, parents are attending fixation and fallow-up meetings. Parents are invited after a month to meet in order to evaluate how they applied the learned methods or to remove the reward system, wherever they were supposed to, and to be supported, to help manage future behavioral problems. Parents are alerted about possible relapse - the reuse of inefficient methods used before learning the effective ones within this program. A fallow-up meeting is scheduled over three months during which progress is assessed (Barkley, 1997a).

Thirdly, it is well known that the environment can influence gene expression. Other intervention for children with ADHD is preventive intervention. This intervention aims at the control of genetic expression (prenatal and postnatal factors) through the influence of the environment. Early intervention may reduce the risk of worsening of ADHD symptoms in adolescence or young adulthood.

Specialists need to know that environmental factors associated with ADHD, epidemiological, include psychosocial adversity, maternal mental illness, domestic violence, stress, smoking and alcohol consumption in prenatal and childhood (Kahn, Khoury, Nichols and Lanphear, 2003; Becker, El-Faddagh, Schmidt, Esser and Laucht, 2008; Heath, Horst and Picciotto, 2010; Kim et al., 2013). In a longitudinal study conducted in Brazil by Pires and his colleagues tried to correlate family environment and pregnancy diagnosis of ADHD in children and symptoms described by various informants (mothers and teachers). These authors found that family dysfunction, lack of social support for mothers, traumatic life events and disagreements during pregnancy were associated with ADHD (Pires da Silva and de Assis, 2013).

In recent years, neuropsychological combined studies with imaging methods of the brain have suggested that dysfunction executive is the headline deficit in ADHD (Rubia, 2011; O'Brien, Dowell, Mostofsky, Denckla, & Mahone, 2010; Weyandt et al., 2013; Schuch et al., 2015). Executive functions are a set of cognitive skills associated with functions of the prefrontal cortex, which allow individuals to focus and to shape behavior to achieve the objectives set (Schuch et al., 2015).

Executive functions are essential for performing complex behaviors. They are involved in controlling attention, in motor and cognitive inhibition, and in planning adapted behaviors to contexts in which the person is.

Many researchers see executive functions as a macroconstruct that recognizes the inherent complexity of self-regulating processes involved in problem solving (Zelazo, Carter, Reznick, & Frye, 1997).

Currently these functions are divided into two categories. The first category is purely cognitive and used in tasks that require manipulation of abstract concepts such as attention, working memory, planning, cognitive flexibility, alternation and inhibition. This category of executives is mainly closely related functions dorsolateral prefrontal cortex. In turn, the second category of executives is used in tasks that require motivation and emotions, and is associated with orbitofrontal and ventromedial cortex. Although the neuro-psychological assessment makes a significant contribution to the understanding of ADHD, most tests are conducted in artificial environments, and the results do not reflect the deficits shown by children affected daily lives. Scale, such as the checklist of child behavior (CBCL), is currently used to detect deviant behavior of children in different life situations, like school. Besides providing quantitative measures, CBCL allow for certain features of the two categories of executive positions, including emotional self-regulation (O'Brien, Dowell, Mostofsky, Denckla, & Mahone, 2010).

The adult form of attention deficit/hyperactivity disorder has a prevalence of up to 5% (Bonvicini, Faraone and Scassellati, 2016). Family studies in clinical samples suggest an increased familial liability for adult form of attention deficit/hyperactivity disorder compared with childhood ADHD, whereas twin studies based on self-rated symptoms in adult population samples show that there is a moderate heritability (41%) (Schultz, Rabi, Faraone, Kremen and Lyons, 2006). However, using multiple sources of information, the heritability of clinically diagnosed adult form of attention deficit/hyperactivity disorder and childhood ADHD is very similar (Franke et al., 2012).

Results of candidate gene as well as genome-wide molecular genetic studies in adult form of attention deficit/hyperactivity disorder samples implicate some of the same genes involved in ADHD in children, although in some cases different alleles and different genes may be responsible for adult versus childhood ADHD. Linkage studies have been successful in identifying loci for adult form of attention deficit/hyperactivity disorder and led to the identification of LPHN3 and CDH13 as novel genes associated with ADHD across the lifespan.

LPHN3 was associated with ADHD in a large sample of children and adults, and subsequently replicated in an independent adult form of ADHD sample. The function of this gene, which encodes a G-protein-coupled receptor, is still not well understood (Martinez, Muenke, & Arcos-Burgos, 2011; Arcos-Burgos et al., 2010).

In addition, studies of rare genetic variants have identified probable causative mutations for adult form of attention deficit/hyperactivity disorder. Use of endophenotypes based on neuropsychology and neuroimaging, as well as next-generation genome analysis and improved statistical and bioinformatic analysis methods hold the promise of identifying additional genetic variants involved in disease etiology. Large, international collaborations have paved the way for well-powered studies. Progress in identifying adult form of attention deficit/hyperactivity disorder risk genes may provide us with tools for the prediction of disease progression in the clinic and better treatment, and ultimately may help to prevent persistence of ADHD into adulthood (Franke et al., 2012).

Bonvicini et al. (2016) confirmed significant role of BAIAP2 and DHA in the etiology of ADHD exclusively in adults. The DHA was associated with hyperactivity in adults with ADHD, and it seems to be essential for prenatal and postnatal brain development. One the other hand, BAIAP2 is expressed at higher levels in the left human cerebral cortex and participates in neuronal proliferation, survival and maturation. It encodes the insulin receptor tyrosine kinase substrate protein of 53 kDa (IRSp53), a member of a group of downstream signaling molecules that participate in the signal transduction pathways of insulin and insulin-like growth factor 1 (Ribasés et al., 2009). Moreover, BAIAP2 expression in rat cerebral cortices is enhanced by treatment with MPH. This association was found for ADHD in adults, but not in children, suggesting a distinct genetic load between persistent and remitting ADHD and a potential genetic marker for persistent ADHD (Ribasés et al., 2009).

Early intervention is recommended under these unfavorable biological conditions (Halperin, Bédard and Curchack-Lichtin, 2012).

In the case of children with ADHD, complications associated with academic failure, low self-esteem, poor social relationships, and negative parent and family attitudes can potentially be avoided if effective interventions can be established early. Early intervention is based on therapeutic activities into daily life or in the school environment (Tamm, Nakonezny and Hughes, 2014).

Therefore, the symptomatology of the child with ADHD is complex and in order to reduce it, a holistic approach is needed, which takes into account both the characteristics of the child and the learning environment.

The behavioral change of a student with effective ADHD is obtained by applying the cognitive-behavioral therapy techniques. One of them is self-training, which involves focusing on work-load and accurately doing school tasks. This technique should be applied with a reward system (Mennuti, Christner and Freemna, 2012).

Another technique used in the behavioral change of students with ADHD is self-regulation, which includes: self-monitoring, self-evaluation and self-compensation. Self-

monitoring requires the teacher to teach the student to be careful about their behavior in order to make the student aware of their behavior and ability to function independently (Wills and Mason, 2014). Self-compensation and self-evaluation imply that the student compares the self-observed behavior with a standard set and then gives a reward for the achieved goal. It is important to apply this technique together with parental behavioral training (Terenzi, Ervin and Hoff, 2010; Mirnasab and Bonab, 2011).

In conclusion, any intervention, regardless of type, begins with a very good evaluation. It is important, therefore, that specialists identify as early as possible the symptoms of ADHD in the childhood. The solution to all the academic problems of the child with ADHD is a collaborative school–home behavioral intervention and peer integration intervention. All interventions should be seen as starting points in practice. They are based on the resources and special educational needs of the child with ADHD. A child with ADHD has a real health problem, characterized by impulsive behavior, a lack of self-motivation, attention and working memory problems (Thomas, 2007). The presence of ADHD does not cause a child to be mischievous or to have an antisocial attitude. The difference between normal but difficult behavior and ADHD cannot be clearly defined in terms of white or black. Such a child is not deliberately difficult, but simply acts without analyzing it. For a child to be diagnosed with such a disorder, he must meet all the criteria contained in DSM 5 (Green and Chee, 2001).

ADHD is a real affection that causes many difficulties to children. With understanding, patience and help, we can improve their efficiency of the study, relationships with peers, education and self-esteem. Our role is to encourage intelligent, talented children to believe in their own capacities and to no longer feel incompetent, inferior and inappropriate.

II. MATERIAL AND METHODS

1. Objectives and assumptions

Starting from the premise that problem-solving ability influences the ability to find a motor behavior adapted to situations which involving emotional difficulties, the present study aims to explore the possible moderating effects of emotional regulation on the relationship between problem solving ability and visuomotor precision and the possible moderating effects of emotional regulation on the relationship between problem solving ability and visuomotor integration.

At the same time, we also propose identifying possible effects of a problem solving intervention program on the frequency of symptoms of hyperactivity and attention deficit, visuomotor precision, visuomotor integration (which includes visuospatial abilities, such as

estimating distances between objects, line orientation, angularity, and fine motor coordination) and emotional regulation of students with ADHD.

The assumptions of this study are:

H1. Emotional regulation has a moderating effect on the relationship between problem solving ability and visuomotor precision.

H2. Emotional regulation has a moderating effect on the relationship between problem solving ability and visuomotor integration.

H3. The problem-solving intervention program has effects on the frequency of symptoms of hyperactivity and attention deficit, visuomotor precision, visuomotor integration and emotional regulation.

2. Study design and sample size

The research design is non-experimental (one-group pretest-posttest design).

This study included 30 patients (22 boys and 8 girls) with their 10 teachers. Before the students were tested, parents, teachers and school leader have given their consent for research to be done. They signed the informed consent forms and return this document to school within 2 days. Also, parents and school leaders have been assured that all data collected is confidential.

Teachers completed a scale to illustrate their perceptions on the symptom of hyperactivity and attention deficit of students before and after the intervention program was applied. They were assured that there is no right or wrong answers and that their opinion is important.

Students were aged 6 and 10 (m=8.5 years, and a SD= 17.57, 0-4 grades), had an IQ between 75 and 100. The students were from urban areas, from Teleorman Country. 5 of the students had poor school results, 16 had average results and 9 good school results. The inclusion criteria for participants in the sample were:

- the child must be diagnosed by a psychiatrist specialized in pediatric psychiatry;
- QI $\geq$75;
- participants aged 6-12 years (0-4 grades).

3. Measuring tools

In this study, the Teacher Rating Scale/TRS-P from BASC-2 (Behavior Assessment System for Children-2) - Romanian version developed and standardized by Reynolds and Kamphaus (2011) for 6-11 years was used to measure the level of hyperactivity and attention.

The Neuropsychological Development Assessment (NEPSY, Korkman, Kirk, Kemp, 1998, 2007) was used to assess neuropsychological functioning in three domains: Attention/Executive functioning, Visuospatial and Sensorimotor. NEPSY is a tool that evaluates

key child functions for higher school and out-of-school performance and applies to all children aged 3 to 12 years. In this study, we used the following evaluation methods: Tower, which measure the problem solving ability, Design Copying, which measure the visuomotor integration, and Visuomotor Precision.

The IQ level of the child with ADHD will be calculated using the Raven Standard Progressive Matrices for the general population of 6-80 years.

An image system was developed for this study to identify difficulties of emotional regulation (difficulties in recognizing facial expressions, identifying emotions, identifying emotional responses) based on the Social Emotional Assessment (Wiig, 2008), which applies to children aged 6 to 12 years and 11 months.

3.1. Intervention program

After the informed consent was signed, the teachers completed the scales and the children were tested with NEPSY, the intervention program based on what was observed and measured until that moment was done and applied.

First, the teachers had a session where psycho-education was done by the researchers. Teachers were given all the information about the characteristics of this disorder and about how to work with students with ADHD by the researchers.

Among the work strategies learned by teachers, the following should be mentioned:

- The rules are clear for each student with/without ADHD (Piffner, Villodas, Kaiser, Rooney and McBurnett 2013);
- All classroom interventions on the student with ADHD should be invisible to the other students, because they might see him as a student who needs extra help (when the student with ADHD tends to interrupt a colleague, the teacher shows his ear lobe or touches his ear lobe and he knows that it is necessary to listen to what the interlocutor wants to say) (US Department of Education, 2006);
- The child with ADHD will take frequent breaks (Piffner, Villodas, Kaiser, Rooney and McBurnett 2013);
- The teacher makes diagrams with the essential information that the students with ADHD will have to learn (Thomas, Vaz-Ceniglia, Willems, 2011);
- The teacher uses an hourglass for each activity (US Department of Education, 2006);
- Problem solving is done in small groups of 2-4 students, where each child respects the same rules (Thomas, 2007).

We decided to apply a problem solving intervention program, because the problems of these students were: self-control, emotional regulation, visuomotor integration and visuomotor precision.

In conclusion, the objectives of this program were:

1. Reducing the symptoms of ADHD students from the clinical level to the normal level for their age and gender.

2. Improving the fine vizuomotor coordination and visuomotor integration.

3. Recognition, understanding and managing emotions in school tasks by the student with ADHD.

The group of students with ADHD participated in the 120-session program for 6 months, five times a week, 50 minutes per session.

At the beginning of each session, the students were running and jumping the rope, and then they were given a problem-solving strategy that they practiced. Strategies included:

1. Recognizing the problem;

2. Generating alternative solutions;

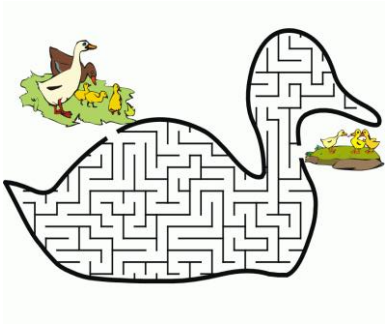
3. Generating as many consequences as possible for each identified solution;

4. Anticipating the obstacle;

5. Adopting behaviors in line with the purpose of solving the problem;

6. Evaluation of actions and consequences.

Example of the problem: Help the ducks to return on the shortest route to the farm. The line drawn must not touch the edges of the road. You have 60 seconds to solve this problem.



The used strategies are the following:

1) Identification of the farm and ducks locations;

2) Estimating the difficulty of the road;

3) Identifying, understanding and managing dysfunctional emotions at that time (e.g. anger caused by the inability of solving the problem very quickly);

4) Visualization and understanding of two-dimensional spatial relationships;

5) Motor planning;

6) Monitoring the execution of the movements;

7) Integrating fine motor coordination with visuospatial skills such as distance estimation and line drawing.

All students are grouped into 6 teams. The teacher draws any geometric figure on the board. The children in each team go to the board and complete the picture drawing various details. While a child is at the board, the other children from the other teams close their eyes and open them after the detail has been drawn. In turn, the students will guess what was drawn. Win the team with the most guessed details.

Another example of activity is the following: Some workers want to make a wall with many bricks. Help them build it knowing that any of the bricks that rest on two other bricks is their sum. Please write the corresponding number on each brick. You have 60 seconds to solve the problem.

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87	**97**						
56	**75**	**45**	**59**	**90**	**63**	**98**	**72**
31	**22**	**11**	**16**	**23**	**19**	**20**	**84**

After the students have learned the strategies for solving the problems of visuomotor precision and visuomotor integration, the remaining sessions have been used to practice cognitive-behavioral strategies applied in specific situations such as: management of anger and anxiety, managing a conflict with a colleague, self-control during classes.

Every week, students were allowed to translate by role play a learned strategy and receive feedback from group therapists and other students.

The meetings ended with homework, which facilitated the practice of solving the problem, but also the generalization of this behavior outside of the context in which it was learned.

It should be mentioned that the intervention program was applied in the classes in which students learned. In this way, the researchers wanted to integrate the student diagnosed with ADHD into the classroom. The intervention program in broad lines is described in the table below.

Table 1. *Intervention program based on problem solving*

Session objectives	*Session content*
Setting Group Rules	- Student expectations about what to learn.

	- Define the basic rules and set the rewards in the group.
Identify the problem	- Understanding the thoughts that indicate the existence of a problem. - Identifying automatic thoughts and emotions. - Assessing evidence in favor and against thoughts.
Generating alternative solutions	- All the solutions are evaluated at the group level. - Identify all alternative thoughts and emotions.
Identify the consequences of behaviors	- Learn alternative thinking and finding alternative strategies. - Discussing the emotional and behavioral implications of the actions. - It can be concluded that other people will choose other strategies and that they will be affected differently by these choices.
Anticipating obstacles encountered in solving problems	- Obstacles were found for each solution. - It can be concluded that an action plan sometimes does not apply as it has been established
Learning specific behaviors	- A backup plan is being developed.
Evaluating the activities and the consequences of their own behaviors	- They self-assess their behavior and consequences. - Applies to the backup plan if it is necessary.
Identifying interpersonal conflicts	- The problem-solving process applies in specific situations.
Learning anger and anxiety management strategies	- The problem-solving process applies in specific situations.
Getting self-control in class	- The problem-solving process applies in specific situations.

3.2. Statistical analysis

The data obtained were put into excel documents, and then transferred to the IBM SPSS 22 statistical analysis program and to Jamovi version 0.9.1.1.2. To ensure confidentiality, personal data, such as: name of the child/parent, parent's phone number, child address or his/her personal identification code, were not collected.

IV. RESULTS

Prior to testing the three assumptions, the normal distribution of the research variables was checked. The results of the normality test can be seen in Table 2.

This test showed that all variables have normal distribution (p>0, 05 for all variables in pretest) (Table 1). In this situation, we can apply parametric tests.

Table 2. *One-Sample Kolmogorov-Smirnov Test*

		H2	PSA1	VP1	VI1	ER1	AD1	H1	PSA2	VP2	VI2	ER2	AD2
N		30	30	30	30	30	30	30	30	30	30	30	30
Normal	M	12,00	6,63	16,00	41,77	16,73	17,50	23,73	8,77	20,83	48,80	28,63	9,30
Parameters[a,b]	SD	2,519	1,991	4,857	7,925	13,587	3,511	5,132	2,431	4,411	5,248	9,463	3,019
Test Statistic		,186	,194	,162	,192	,217	,210	,199	,161	,163	,162	,169	,177
Asymp. Sig. (2-tailed)		,100[c.d.]	,175[c.d.]	,184[c.d.]	,226[c.d.]	,121[c.d.]	,200[c.d.]	,200[c.d.]	,146[c.d.]	,180[c.d.]	,192[c.d.]	,100[c.d.]	,117[c.d.]

a. Test distribution is Normal.
b. Calculated from data.
c. Lilliefors Significance Correction.
d. This is a lower bound of the true significance.
Note.PSA1=Problem solvin ability in pretest, PSA2=problem solving ability in posttest, VP1= visuomotor precision in pretest, VP2=visuomotor precision in posttest, VI1= Visuomotor integration in pretest, VI2= Visuomotor integration in posttest, H1=hyperactivity in pretest, H2=hyperactivity in posttest, AD= Attention defficit in pretest, AD2=Attention deficit in posttest.

To test the first assumption according to which emotional regulation has a moderating effect on the relationship between problem solving ability and visuomotor precision, we have applied the moderation procedure in Jamovi.

In Table 3, it can be observed that the assumption mentioned above is supported by statistical data (Z=-2.37, p<0.05, P=0.018) and in Table 4, it is illustrated that regardless of the level of the moderator, the effect of this variable is statistically significant ($Z_{Acerage}$= 11.01, p<0.001, Z_{Low}=9.43, p<0.001, $Z_{Highcer}$= 6.65, p<0.001).

Table 3. *Moderation Estimates*

			95% Confidence Interval			
	Estimate	SE	Lower	Upper	Z	p
Problem solvin ability.1	2.0393	0.1709	1.70427	2.37426	11.93	< .001
Emotional.regulation.1	0.0537	0.0250	0.00467	0.10276	2.15	0.032
Problem solving ability.1 ✻ Emotional.regulation.1	-0.0292	0.0123	-0.05339	-0.00505	-2.37	0.018

Table 4. *Simple Slope Estimates*

			95% Confidence Interval			
	Estimate	SE	Lower	Upper	Z	p
Average	2.04	0.185	1.68	2.40	11.01	< .001
Low (-1SD)	2.43	0.258	1.92	2.93	9.43	< .001
High (+1SD)	1.65	0.248	1.16	2.14	6.65	< .001

Note. shows the effect of the predictor (Problem solving ability.1) on the dependent variable (Visuomotor.precision.1) at different levels of the moderator (Emotional.regulation.1)

To test the second assumption according to which emotional regulation has a moderating effect on the relationship between problem solving ability and visuomotor integration, we have applied the moderation procedure in Jamovi.

In Table 5, it can be observed that emotional regulation has a moderating effect on the relationship between visomotor precision and problem solving ability (Z=-3.97, P<0.001) and in

Table 6, it is illustrated that regardless of the level of the moderator, the effect of this variable is statistically significant ($Z_{Acerage}$= 7.35, p<0.001, Z_{Low}=7.75, p<0.001 , $Z_{Highcer}$=3.23, p<0.001).

Table 5. *Moderation Estimates*

			95% Confidence Interval			
	Estimate	**SE**	**Lower**	**Upper**	**Z**	**p**
Problem.solving.ability.1	2.6733	0.2967	2.092	3.2548	9.01	< .001
Emotional.regulation.1	0.2117	0.0434	0.127	0.2968	4.87	< .001
Problem.solving.ability.1 ✻ Emotional.regulation.1	-0.0849	0.0214	-0.127	-0.0429	-3.97	< .001

Table 6. *Simple Slope Estimates*

			95% Confidence Interval			
	Estimate	**SE**	**Lower**	**Upper**	**Z**	**p**
Average	2.67	0.362	1.964	3.38	7.39	< .001
Low (-1SD)	3.81	0.491	2.844	4.77	7.75	< .001
High (+1SD)	1.54	0.476	0.606	2.47	3.23	0.001

Note. shows the effect of the predictor (Problem.solving.ability.1) on the dependent variable (Visuomotor.integration.1) at different levels of the moderator (Emotional.regulation.1)

H3. The problem-solving intervention program has effects on the frequency of symptoms of hyperactivity and attention deficit, visuomotor precision, visuomotor integration and emotional regulation is supported by statistical data (Table 7 and 8).

There was a significant difference in the scores for problem solving ability in pretest (M=6.63, SD=1.99) and problem solving ability in posttest (M=8.77, SD=2.43) conditions; t(29)=-11.59, p<0.001. The effect size expressed by Cohn's d parameter is -2.12.

A significant difference was also found in the scores for visuomotor precision in pretest (M=16, SD=4.86) and visuomotor precision in posttest (M=20.83, SD=4.41) conditions; t(29)=-20.54, p<0.001. The effect size expressed by Cohn's d parameter is -3.75.

The students obtained statistically significant differences between the scores for visuomotor integration in pretest (M=41.76, SD=7.93) and the scores for visuomotor integration (M=48.80, SD=5.25) in posttest conditions; t(29)=-6.74, p<0.001. The effect size expressed by Cohn's d parameter is -1.23.

Symptoms of hyperactivity and attention deficit decreased after the program was applied. There was a significant difference in the scores for attention deficit in pretest (M=17.27, SD=3.52) and attention deficit in posttest (M=9.30, SD=3.02) conditions; t(29)= 23.86, p<0.001. The effect size expressed by Cohn's d parameter is 4.36. Also, there was a significant difference in the scores for hyperactivity in pretest (M=23.73, SD=5.13) and hyperactivity in posttest

(M=12, SD=2.52) conditions; t(29)=19.66, p<0.001. The effect size expressed by Cohn's d parameter is 3.59.

Table7. Descriptives

	N	Mean	Median	SD	SE
Problem.solving.ability.1	30	6.63	6.00	1.99	0.364
Problem.solving.ability.2	30	8.77	9.00	2.43	0.444
Visuomotor.precision.1	30	16.00	16.00	4.86	0.887
Visuomotor.precision.2	30	20.83	20.50	4.41	0.805
Visuomotor.integration.1	30	41.77	45.00	7.93	1.447
Visuomotor.integration.2	30	48.80	50.00	5.25	0.958
Attention.deficit.1	30	17.27	18.00	3.52	0.643
Attention.defficit.2	30	9.30	9.00	3.02	0.551
Hyperactivity.1	30	23.73	22.00	5.13	0.937
Hyperactivity.2	30	12.00	12.00	2.52	0.460

Table8. Paired Samples T-Test

			statistic	df	p	Mean difference	SE difference	Cohen's d
Problem.solving.ability.1	Problem.solving.ability.2	Student's t	-11.59	29.0	< .001	-2.13	0.184	-2.12
Visuomotor.precision.1	Visuomotor.precision.2	Student's t	-20.54	29.0	< .001	-4.83	0.235	-3.75
Visuomotor.integration.1	Visuomotor.integration.2	Student's t	-6.74	29.0	< .001	-7.03	1.043	-1.23
Attention.deficit.1	Attention.defficit.2	Student's t	23.86	29.0	< .001	7.97	0.334	4.36
Hyperactivity.1	Hyperactivity.2	Student's t	19.66	29.0	< .001	11.73	0.597	3.59

V. DISCUSSIONS AND CONCLUSIONS

This study aims to check the effectiveness of a problem solving intervention program on the frequency of symptoms of hyperactivity and attention deficit, visuomotor precision, visuomotor integration (which includes visuospatial abilities, such as estimating distances between objects, line orientation, angularity, and fine motor coordination) and emotional regulation of students with ADHD.

On the other hand, in this study it was checked whether emotional regulation had an effect on two relationships between: problem solving ability and visuomotor integration of students with ADHD, problem solving ability and visuomotor precision of students with ADHD. A problem solving intervention program consisting of 120 activities was carried out for 6 months with 30 elementary school students (grades 0-4) diagnosed with ADHD and integrated in normal school. The results on this research can be discussed as follows.

First, in this study it was demonstrated that emotional regulation has a moderating effect on the relationship between problem-solving ability and visomotor integration and visomotoric precision, the last two variables being dependent variables. These results are consistent with the results of previous studies. Banaschewski et al. (2012) in a study conducted on 366 students with ADHD combined subtype demonstrated that emotional regulation is predicted by cognitive/motivational dysfunctions, and this relationship is mediated by the presence of ADHD symptomatology.

Moreover, Wauters-Krings (2012) argues that emotions influence the ability to pay attention to detail, which in turn influences the quality of motor expressiveness.

Second, a problem solving intervention program is found to have a positive effect on visuomotor precision, visuomotor integration and emotional regulation of students with ADHD. This result is supported by other research in the literature. For example, Song (2012) in his study on mediation of children diagnosed with ADHD through psychomotricity reported that it improved the children's ability to read other people's feelings. In addition, Kim and Suh (2016) have demonstrated that the application of an intervention program based on psychomotoricity has had effects on ego-resilience of students diagnosed with ADHD.

Thirdly, a problem solving intervention program is found to have a positive effect on frequency of ADHD symptoms. It is well known that the symptomatology of the child with ADHD is complex and in order to reduce it, a holistic approach is needed, which takes into account both the characteristics of the child and the learning environment.

The behavioral change of a student with effective ADHD is the cognitive-behavioral therapy techniques. One of them is self-training, which involves focusing on work-load and accurately doing school tasks. This technique should be applied with a reward system (Mennuti, Christner and Freemna, 2012).

Another technique used in the behavioral change of students with ADHD is self-regulation, which includes: self-monitoring, self-evaluation and self-compensation. Self-monitoring requires the teacher to teach the student to be careful about their behavior in order to make the student aware of their behavior and ability to function independently (Wills and Mason, 2014). Self-compensation and self-evaluation imply that the student compares the self-observed behavior with a standard set and then gives a reward for the goal achieved. It is important to apply this technique together with parental behavioral training (Terenzi, Ervin and Hoff, 2010; Mirnasab and Bonab, 2011).

One limit of this study is the participants were not randomly selected, and their number is small. For this reason, we cannot generalize the obtained results.

Finally, research in which the effectiveness of a problem solving intervention program on the frequency of symptoms of hyperactivity and attention deficit, visuomotor precision,

visuomotor integration (which includes visuospatial abilities, such as estimating distances between objects, line orientation, angularity, and fine motor coordination) and emotional regulation for children with ADHD are described is greatly lacking. Many research studies take into account only a problematic aspect of the child's ADHD behavior, which makes the results of this study meaningful baseline data. Moreover, the problem solving intervention program designed in this study can be utilized in the classroom.

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