PREDICTORS OF VISUAL-MOTOR INTEGRATION IN CHILDREN WITH 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 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. The objective of this study is to find the possible predictive role of emotional regulation, attention defficit and problem-solving ability on visuomotor integration (which includes visuospatial abilities, such as estimating distances between objects, line orientation, angularity, and fine motor coordination).This study included 30 elementary school students (grades 0-4) diagnosed with ADHD (predominantly inattentive subtype) and integrated in normal school. TRS-P was used to evaluate changes in the frequency of symptoms of attention defficit 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 two domains: Attention / Executive functioning, Visuospatial Integration.

In this study it was demonstrated that emotional regulation, attention defficit and problem solving ability are significant predictors for visuomotor integration. These results can be used in the development of intervention programs based on cognitive behavioral therapy techniques.

Keywords: ADHD; emotional regulation; problem solving ability; visual-motor integration.

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) [1, 2, 3, 4, 5].

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 [6, 7, 8,]. 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 [9].

This disorder is a neuro-behavioral development characterized by an early onset (usually in the first five years of life) [9, 10]. 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 disocial behavior and low self-esteem [11].

ADHD is characterized by attention deficit and/or hyperactivity disorder. There are three categories of ADHD: predominantly inattentive, predominantly hyperactive / impulsive and mixed [12]. 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 [13]. 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 [14].

Undoubtedly, ADHD is a complex condition (which affects four times as many men as women) [3] and there is no simple explanation, despite a significant amount of research that try to isolate the causes of this disorder [15].

Moreover, poor motor coordination or motor performance is common coexisting difficulty in children with ADHD, though it has received less attention in research.

Motor skills are actions carried out when the brain, nervous system and muscles work together. It is a function that involves the precise movement of muscles with the intent to perform a specific act. They are categorised into two groups: gross motor skills and fine motor skills. Gross motor skills are involved in movement and coordination of the arms and legs and actions such as running, crawling and swimming. Fine motor skills are required in smaller movements that occur in the wrists, hands, fingers, feet and toes and include more precise actions such as picking up objects between the thumb and finger and writing carefully. Poor fine motor skills can make cognitive learning and performance more difficult because of the involvement of fine motor skills in cognitive activities [16, 17].

Most studies show a strong association between ADHD and fine motor problems. Kadesjö and Gillberg (2001) and Cummings et al. (2005) affirm that inattentive symptoms relate mostly to motor coordination problems, though a relationship between hyperactive and impulsive symptoms and motor coordination problems has also been reported [18, 19]. Motor problems lead to difficulties in everyday living, including academic performance, sport, play and self-esteem [18, 20]. Motor problems severely affect children's daily lives and are an active predictor of a child's popularity and self-esteem [21]. These deficits may have an intense effect on children's development, leading to difficulty with written communication, inhibited social

interaction and poor performance in sports activities [22].

Several studies have identified dopamine as the key neurotransmitter in the brain in ADHD. Three pathways, namely the mesocortical, mesolimbic and nigrostriatal, have been shown to be dysfunctional and consequently cause deficiencies in the cortical areas, resulting in symptoms typical to ADHD: inattention, hyperactivity and impulsiveness [23]. The nigrostriatal dopaminergic pathway is involved in the coordination of movement. Sagvolden et al. (2006) assert that a hypofunctioning nigrostriatal dopamine branch causes impaired modulation of motor functions and deficient non-declarative habit learning and memory [24]. The altered dopaminergic function and hypofunctioning nigrostriatal dopamine will give rise to clumsiness and problems with gait, balance and laterality, as well as gross and fine motor control [22]. Difficulties with motor inhibition may be associated with disturbances in the orbital prefrontal circuit system, which also plays a central role in executive functions. This view is further supported by Berquin et al., 1998, who suggest that cerebellar-prefrontal circuit dysfunction may underlie the motor control, inhibition and executive function deficits encountered in ADHD [25].

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.

As we said in other articles, ADHD is a real affection that causes many difficulties to children. With understanding, patience and help, we can improve them 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.

MATERIALS AND METHODS

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 predictive role of emotional regulation, attention defficit and problem-solving ability on visuomotor integration (which includes visuospatial abilities, such as estimating distances between objects, line orientation, angularity, and fine motor coordination).

The hypothesis of this study is:

H1. Problem-solving ability, emotional regulation and attention defficit influence visuomotor integration in children diagnosed with ADHD.

Study design and sample size

The research design is non-experimental.

This study included 30 patients (25 boys and 5 girls). 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. 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 ≥75;
- participants ages 6-12 years (0-4 grades).

Table no 1. Correlation Matrix

		Problem.solving.ability	Emotional.regulation	Attention.defficit	Visuomotor.integration
Problem.solving.ability	Pearson's r	—	0.238	-0.130	0.853
	p-value	—	0.206	0.493	< .001
Emotional.regulation	Pearson's r		—	0.111	0.674
	p-value		—	0.558	< .001
Attention.defficit	Pearson's r			—	0.598
	p-value			—	< .001
Visuomotor.integration	Pearson's r				—
	p-value				—

Measuring tools

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

The Neuropsychological Development Assessment (NEPSY, Korkman, Kirk, Kemp, 1998, 2007) was used to assess neuropsychological functioning in two domains: Attention/Executive functioning and Visuospatial. 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 and Design Copying, which measure the visuomotor integration.

The IQ level of the child with ADHD (predominantly inattentive subtype) 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, which applies to children aged at 6 to 12 years and 11 months.

STATISTICAL ANALYSIS

The data obtained were put into excel documents, then transferred 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.

RESULTS

To test the hypothesis according to which problem-solving ability, emotional regulation and attention deficit influence visuomotor integration in children diagnosed with ADHD (predominantly inattentive subtype), we have applied the regresion procedure in JAMOVI.

Table 1 shows that there are a statistically significant positive relationship between Visuomotor.integration and Problem.solving.ability ($r = 0.853$, $p < 0.01$) with an effect size $r^2 = 0.72$ (a strong association between these variables), a statistically significant positive relationship between Visuomotor. integration and Emotional.regulation ($r = 0.674$, $p < 0.01$) with an effect size $r^2 = 0.45$ (a moderate association between these variables) and a statistically significant positive relationship between Visuomotor.integration and Attention.defficit ($r = 0.598$, $p < 0.01$) with an effect size $r^2 = 0.35$ (a small association between these variables).

The table below shows that the regression model chosen fits our data (R>0,80).

Table no 2. Model Fit Measures

Model	R	R^2
1	0.853	0.728
2	0.877	0.770
3	0.896	0.803

Table no 3. Omnibus ANOVA Test

	Sum of Squares	df	Mean Square	F	p
Problem.solving.ability	453.5	1	453.5	32.82	< .001
Emotional.regulation	106.4	1	106.4	7.70	0.010
Attention.defficit	60.1	1	60.1	4.34	0.047
Residuals	359.3	26	13.8		
Note. Type 3 sum of squares					

Table no 4. Model Coefficients

			95% Confidence Interval					95% Confidence Interval	
Predictor	ß	SE	Lower	Upper	t	p	Stand. Estimate	Lower	Upper
Intercept	21.950	3.4406	14.8782	29.02266	6.38	< .001			
Problem.solving.ability	2.558	0.4466	1.6404	3.47649	5.73	< .001	0.643	0.4121	0.87343
Emotional.regulation	0.260	0.0938	0.0674	0.45286	2.77	0.010	0.311	0.0805	0.54076
Attention.defficit	-0.495	0.2375	-0.9832	-0.00687	-2.08	0.047	-0.189	-0.3745	-0.00262

ANOVA illustrates that the prediction based on the calculated model is better than the random prediction ($p < 0.05$ for all predictors) (Table 3).

The table below shows that problem solving ability is a significant predictor for visuomotor integration, **ß**=2.55, $p < 0.05$, and the regression equation is: 2.55 + 21.95 * problem solving ability.

Also emotional regulation is a significant predictor for visuomotor integration, **ß**=0.26, $p < 0.05$, and the regression equation is: 0.26 + 21.95 * emotional regulation and attention defficit is a significant predictor for visuomotor integration, **ß= -**0.49, $p < 0.05$, and the regression equation is: 21.95 - 0.49 * attention defficit.

The condition of collinearity is respected considering the values of VIF and Tolerance (Table 5).

Table no 5. Collinearity Statistics

	VIF	Tolerance
Problem.solving.ability	1.66	0.603
Emotional.regulation	1.65	0.605
Attention.defficit	1.08	0.927

DISCUSSION

In this study it was checked whether problem-solving ability, emotional regulation and attention deficit influence visuomotor integration in children diagnosed with ADHD (predominantly inattentive subtype). This assumption was supported by statistical data. It was demostrated that problem solving ability is a significant predictor for visuomotor integration, **ß**=2.55, $p < 0.05$, and the regression equation is: 2.55 + 21.95 * problem solving ability. Also emotional regulation is a significant predictor for visuomotor integration, **ß**=0.26, $p < 0.05$, and the regression equation is: 0.26 + 21.95 * emotional regulation and attention defficit is a significant predictor for visuomotor integration, **ß=** 0.49**-**, $p < 0.05$, and the regression equation is: 0.49 - 21.95 * attention defficit.

These results are consistent with the results of previous studies. Wauters-Krings (2012) argues that emotions influence the ability to pay attention to detail, which in turn influences the quality of motor expressiveness [26].

The studies conducted by Mous S. in 2017 and Dahan A. in 2018, implied that fine motor skills of writing were predicted by the severity of symptoms of inattention [27, 28]. Motor responses require attention to a target and attention during the response. If the target is not properly attended to, it will affect the subsequent motor planning and consequent performance. Additionally, when the target is not noticed in time, it can reduce the time remaining for motor preparation and accordingly affect the performance [29].

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.

These results can be used in the development of intervention programs based on cognitive behavioral therapy techniques. One of them is self-training, which involves focusing on pregnancy and accurately doing school tasks. This technique should be applied with a reward system [30].

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