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DİQQƏT ƏSKİKLİYİ VƏ HİPERAKTİVLİK POZUNTUSU OLAN UŞAQLARDA TORMOZLANMAYA NƏZARƏT

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КОНТРОЛЬ ТОРМОЖЕНИЯ У ДЕТЕЙ С СИНДРОМОМ ДЕФИЦИТА ВНИМАНИЯ И ГИПЕРАКТИВНОСТИ

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INHIBITORY CONTROL IN CHILDREN WITH ATTENTİON DEFİCİT AND HYPERACTİVİTY DİSORDER

Xülasə. Məqalədə DƏHP zamanı uşaqlarda icraedici funksiyalardan biri olan tormozlanmaya nəzarət haqqında danışılır. Bu uşaqlarda icraedici funksiyalar həmişə pozulmuş olur. Lakin icraedici funksiyaların pozulması hər zaman DƏHP demək deyil. İcraedici funksiyaların qiymətləndirilməsi bu neyroinkişaf pozğunluğunun diaqnozuna kömək edə bilər. DƏHP ilə əlaqədar olan ən əsas icraedici funksiya pozuntularından biri tormozlanmaya nəzarətdə olan problemdir. Onlar qeyri-adekvat reaksiya və ya impulsiv davranışları, kənar müdaxilələri tormozlamaqda çətinlik çəkirlər və bu səbəbdən diqqəti cəmləməklə bağlı problem yaşayırlar. Diqqəti cəmləmək üçün kənar müdaxilənin sıxışdırılmasını, yadda saxlanılan məlumatın geri çağırılması üçün lazım olmayan işarələri nəzərə almamağı və adaptiv qərar qəbul etmək üçün vərdişlə verilən reaksiyaların qarşısını almağı tələb edən uğurlu davranışda tormozlanma mühüm rol oynayır. Pozulmuş tormozlanma reaksiyası birbaşa dörd icraedici funksiyaya təsir edir: operativ yaddaş, özünü tənzimləmə, nitqin internallaşması və yenidən qurulması. Bu da, öz növbəsində, xüsusən də motor nəzarəti, səlislik və sintaksis ilə bağlı olan mürəkkəb hərəkətləri və məqsədyönlü davranışları yerinə yetirməkdə çətinliklərə səbəb olur. Müəllif tormozlanmaya nəzarətin DƏHP-ə təsirini nəzərə alaraq, tormozlanmanı gücləndirməyə yönəlmiş təlimlərin DƏHP simptomlarını yaxşılaşdırmaq potensialına malik olduğu haqda danışır. Bu sahədə bir sıra tədqiqatlar tormozlanmaya nəzarəti gücləndirmək üçün nəzərdə tutulmuş məşqlərin effektivliyini nümayiş etdirmişdir.
Açar sözlər: *DƏHP, diqqət çatışmazlığı, impulsivlik, hiperaktivlik, tormozlanma*

Резюме. В статье говорится о контроле торможения у детей с СДВГ, который является одной из управляющих функций. У этих детей всегда нарушены исполнительные функции. Однако нарушение исполнительных функций не всегда означает СДВГ. Оценка исполнительных функций может помочь диагностировать это нарушение нервного развития. Одним из наиболее распространенных нарушений исполнительных функций, связанных с СДВГ, является проблема с контролем торможения. Им трудно сдерживать неуместное или импульсивное поведение, внешнее вмешательство и, следовательно, возникают проблемы с концентрацией внимания. Торможение играет важную роль в успешном поведении, требуя подавления постороннего вмешательства для фокусировки внимания, игнорирования ненужных сигналов для вызова сохраненной информации и подавления привычных реакций на адаптивное принятие решений. Нарушение тормозной реакции напрямую влияет на четыре исполнительные функции: рабочую память, саморегуляцию, интернализацию речи и реструктуризацию. Это, в свою очередь, приводит к трудностям при выполнении сложных движений и при целенаправленном поведении, особенно тех, которые связаны с моторным контролем, беглостью речи и

синтаксисом. Учитывая влияние тормозного контроля на СДВГ, автор утверждает, что тренировки, усиливающие торможение, могут улучшить симптомы СДВГ. Ряд исследований в этой области продемонстрировали эффективность упражнений, направленных на усиление контроля над торможением.

Ключевые слова: *СДВГ, дефицит внимания, импульсивность, гиперактивность, торможение*

Summary. The article talks about inhibitory control, which is one of the executive functions in children with ADHD. These children always have impaired executive functions. However, executive dysfunction does not always mean ADHD. Evaluation of executive functions can help diagnose this neurodevelopmental disorder. One of the most common executive function deficits associated with ADHD is problems with inhibitory control. They find it difficult to control inappropriate or impulsive behavior, external interference, and therefore have trouble concentrating. Inhibition plays an important role in successful behavior, requiring the suppression of extraneous interference to focus attention, the ignoring of irrelevant cues to recall stored information, and the suppression of habitual responses to adaptive decision making. Impaired response inhibition directly affects four executive functions: working memory, self-regulation, language internalization, and restructuring. This, in turn, leads to difficulties with complex movements and goal-directed behavior, especially those related to motor control, verbal fluency, and syntax. Given the influence of inhibitory control on ADHD, the author argues that training that enhances inhibition may improve ADHD symptoms. A number of studies in this area have demonstrated the effectiveness of trainings designed to enhance inhibitory control.

Key words: *ADHD, attention deficit, impulsiveness, hyperactivity, inhibition*

Attention deficit hyperactivity disorder (ADHD) is a neurodevelopmental disorder of childhood characterized by age-inappropriate levels of inattention, hyperactivity, and impulsivity [1]. There are three main types of ADHD according to DSM-5: predominantly inattentive type, predominantly hyperactive/ impulsive type and a combined form of ADHD [2]. The prevalence of this disorder among children is about 5-10 percent, and between 3-5 percent among adults [3]. More boys are diagnosed with ADHD than girls. But according to some researchers ADHD is underdiagnosed in girls. Because girls mostly have predominantly inattentive type of ADHD and this type is usually more difficult to diagnose.

Etiology of ADHD is not understood completely. It is complex and different factors play a role in the development of ADHD. There is no single cause that has been identified as a main contributor to the development of this neurodevelopmental disorder. Genetic factors play an important role. There is a strong evidence supporting the impact of genetic factors. According to different studies with twin families the heritability estimate is around 70-80% [4]. If a close family member or sibling has ADHD, there is a high probability that the other child will manifest ADHD as well. Research using neuroimaging techniques has showed that the structure of certain brain regions and their function is different in individuals with ADHD. This includes prefrontal cortex and basal ganglia. ADHD is linked with low levels of neurotransmitters such as dopamine and noradrenalin [5]. Environmental factors such as exposure to alcohol, smoking, some toxins during pregnancy, also low birth weight, premature birth also have been identified as risk factors. Although psychosocial factors such as childhood trauma, neglect, significant stressors, or poor parenting does not cause ADHD directly, it may make symptoms worse. ADHD is a heterogeneous disorder. It means that individuals with ADHD may have different symptom profiles. Also there are various underlying factors that could cause ADHD. The interplay of genetic and environmental factors may may contribute to the development of ADHD.

Impairment of different genes make the child more vulnarable to the effect of environmental factors and genetic and environmental factors together cause ADHD. Executive functions are also affected in ADHD. It is not clear if impairment of executive functions cause ADHD or whether it is the other way around. But one thing is clear that executive functions are always affected in ADHD, although not all executive dysfunctions mean a person has ADHD. Assessment of executive functions could help with diagnosis of ADHD [6].

Executive functions are top-down mental processes that are responsible for cognitive

control and managing various aspects of goal-directed behavior. They are essential for psychological, as well as cognitive and social development.

These functions include skills such as attentional control, inhibitory control, working memory, cognitive flexibility, reasoning, problem-solving, time management, and planning. They play a crucial role in focusing and maintaining attention, in regulating and coordinating complex cognitive processes to achieve goals [7]. Executive functions start developing during the infancy stage and continue developing untill the late twenties. Between the age of 3 and 5 there is a significant advancement in the development of executive functions.The development of executive functions depend on the maturation of the frontal lobe, particularly prefrontal cortex. In individuals with ADHD the development of executive functions are delayed by a few years. And when we talk about the symptoms of ADHD we mention age inappropriate level of inattention, hyperactivity and impulsiveness. As children grow they learn to manage hyperactivity and impulsiveness. But it is hard to control attention problems.

People with executive function problems experience difficulties in planning and organizing tasks, completing projects in time, time management, attention, etc [6]. The specific difficulties can vary among individuals with ADHD. One of the most common executive function challenges associated with ADHD is problem with inhibitory control. They have difficulty inhibiting inappropriate responses or impulsive behaviors, or inhibiting distractions and because of that experience problem with focusing attention.

In psychology, inhibition plays a crucial role in successful behavior, requiring the suppression of distracting information to focus attention, disregarding irrelevant cues for memory retrieval, and restraining habitual responses for adaptive decision-making [8,9]. The capacity for inhibitory control operates on both conscious and unconscious levels. Inhibition is an essential cognitive function.

It enables individuals to manage their attention, behavior, thoughts, and emotions. It does not mean that one absteins from a desired action, rather it entails a toning down of behavioral responses to a stimulus, thus providing an opportunity for thoughtful deliberation. Inhibitory control begins to develope at an early age. As infants learn basic inhibitory control they delay response to stimuli. It becomes more evident during early childhood and there is a notable development between the ages of 3 and 6 [10].

Children at this stage learn to wait for their turns, follow simple rules. Development of inhibitory control continues during the middle childhood and adloescence. They become better at planning, organizing, decision-making, goal-directed behaviors. With the challenges adolescents face such as peer pressure, emotional regulation, etc they need better inhibitory control. As prefrontal cortex continues to mature and neural connectivity improves, adolescents become better at inhibitory control. The full development of inhibitory control occurs by the late twenties, but the rate of development slows compared to earlier stages. Inhibitory control undergoes a gradual decline with normal aging [7].

Individual differences exist in the development of inhibitory control. Other factors, such as environmental factors, genetics can influence the development of it. Inhibitory control works closely with working memory, another executive function.

They support each other. One needs working memory to know what is relevant, what is not. Remembering better with the help of visual clues can help with inhibitory control too. On the other hand inhibitory control keeps the mind focused and prevents distractions, thus supporting working memory [7,11]. Several researchers have described two types of inhibitory control: response inhibition (or behavioral inhibition) and attention inhibition [7,12].

Response inhibition, a main characteristic of adaptive human behaviour, involves a range of processes aimed at regulating motor behavior, specifically the suppression of undesirable, automatic, or reflexive actions. It is the ability to stop or delay an ongoing action or also to resist the temptation. In his theoretical model of the etiology of ADHD Barkley suggests that response inhibition is made up of three interrelated processes: the ability to stop

an automatic response or one that is likely to result in immediate reinforcement, the ability to delay or pause a response that has already been initiated, and the ability to stay focused on the response and not be distracted by other stimuli [13,14]. Attentional inhibition is the ability to filter out distractions, ignore irrelevant stimuli and be able to focus on relevant information [15]. Early inhibitory control could be a strong predictor of lifelong outcomes.

Moffitt et al. tracked the development of 1,000 children born in the same city in the same year for 32 years. Children with better inhibitory control before the age of 10 were more likely to remain in school during their teenage years and less prone to engaging in risky behaviors, or substance abuse. And as adults these individuals demonstrated better physical and mental health, they experienced greater happiness [7,16]. Better inhibitory control leads to better school readiness and can predict better grades for mathematics and reading at school [10]. Go/No-go and StopSignal tasks are main paradigms employed for studying response inhibition [17].

In the Go/No-go task, which was developed by Donders in the nineteens century, participants are instructed to press a button upon encountering a "go" signal and not respond when presented with a "no-go" signal. Here deficient inhibitory control is evident through a high rate of commission errors. In the stop-signal paradigm, wich was developed by Logan in the 1980s, participants must respond to the stimulus when they are in a go task. Periodically, when there is a stop signal they must refrain from responding. In this paradigm impaired inhibitory control is reflected in a prolonged stop-signal reaction time (SSRT).

Inhibitory control is managed by prefrontal cortex [18]. The specific region within the prefrontal cortex responsible for inhibitory control and the precise mechanism of this process remain a subject of ongoing scientific debate and lacks clarity.

There are varying opinions. Hardung at al, based on their reserarch on rodents, came to the conclusion that the interplay between medial cortex and ventral orbitofrontal cortex systems helps inhibition. In other words medial cortex system is implicated in proactive control over actions. The second system, located in the ventral orbitofrontal cortex, is associated with reactive control [19]. According to the review articles by Dillon and Pizzagalli (2007) and Hung at al (2018), inhibition is heterogeneous when it comes to which part of the brain controls various dimensions if inhibition. Left anterior insula takes part in all inhibitory actions.

Response inhibition is controlled by prefrontal cortex-basal ganglia networks [8, 20]. The cortico-striatal pathways are the main pathways that connect the cortex and the striatum (part of basal ganglia) and are crucial for motor and cognitive control [21]. Cognitive inhibition is controlled by orbitofrontal cortex [8, 20].

Impaired response inhibition directly disrupts four executive functions: working memory, self-regulation, internalization of speech, and reconstitution. And this in turn, leads to difficulties carrying out complex actions and goal-directed behaviors, particularly those related to motor control, fluency, and syntax [13, 14, 22]. Deficiency in response inhibition is a regularly observed characteristic in individuals with attention deficit hyperactivity disorder [17]. Smullen et al. studied the role of the inferior frontal gyrus (IFG) and the intraparietal sulcus (IPS) in response inhibition in individuals with ADHD. To better understand this circuit's function, researchers examined the white matter connections between the IFG and IPS in individuals with ADHD and healthy individuals. Findings indicate that structural changes in the IFG-IPS circuit may underlie the impaired response inhibition seen in ADHD.

Furthermore, the results support the idea that ADHD is like a continuum and that differences in the connections between brain regions could serve as neuromarkers for the disorder. Kolodny et al. mentioned in their study results that individual differences in ADHD symptom severity played a significant role in the engagement of the IPS and functional connectivity between the IPS and right inferior frontal gyrus (rIFG) related to increased demand for inhibition. In milder cases the IPS and IFG was not affected and was involved in inhibitory control. But in more severe cases the engagement IPS and rIFG in inhibitory control was weakened [17, 22].

Several other research showed that people with ADHD has reduced grey matter volume (GMV) in orbitofrontal and anterior cingulate cortex [23, 24, 25]. In general several attempts to understand the main brain mechanism that causes response inhibition impairments in individuals with ADHD gave mixed results. Because ADHD is heterogenous disorder, using average statistics does not give the full picture. When each case is analysed based on the severity of the symptoms the results are different and the role of brain regions participating in inhibitory control is more evident in more severe cases.

Several studies in this field have demonstrated the effectiveness of exercises designed to enhance inhibitory control. Engaging children and adolescents with ADHD in activities that focus on improving the inhibitory control helps to improve core ADHD symptoms such as inattention, hyperactivity and impulsivity. Cognitive training that addresses both working memory and inhibitory control can improve ADHD symptoms. Activities aimed at improving the inhibitory control should be age appropriate. If tasks are too easy, or too difficult, it does not have the same effect [10, 26]. Considering the impact of inhibitory control on ADHD, it can be assumed that engaging in training to enhance inhibition has the potential to improve ADHD symptoms.

Significance of the issue: ADHD is a common neurodevelopmental disorder of childhood. Studying children with this disorder in Azerbaijan and trying to find therapy methods to help children and adolescents with ADHD to overcome difficulties they face in their daily lives and academic performance that is suitable for our country is needed.

Scientific novelty of the topic: Including activities and games that would help to develop inhibitory control could allow schools and families to assist children and adolescents with ADHD in managing their symptoms better, thus improving their academic performance and daily functioning.

Importance of its application: This article could be useful for teachers and psychologists who work with children and adolescents with ADHD.

Reference:

1. Zysset, A. Diagnosis and management of ADHD: a pediatric perspective on practice and challenges in Switzerland / A. Zysset, D. Robin, K. Albermann, [et al.] // BMC Pediatrics – 2023. 23, 103
2. American Psychiatric Association: Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition / Arlington, VA, American Psychiatric Association - 2013.
3. Polanczyk, G. The worldwide prevalence of ADHD: a systematic review and metaregression analysis / G. Polanszyk, MS de Lima, BL Horta [et al.] // American Journal of Psychiatry – 2007. 164(6), – pages 942-948
4. Brikell, I. Heritability of attention-deficit hyperactivity disorder in adults / I. Brikell, R. Kuja-Halkola, H. Larsson // American Journal of Medical Genetics Part B: Neuropsychiatric Genetics, – 2015. 168. 6, pages 406-413.
5. https://www.news-medical.net/health/How-does-ADHD-Affect-the-Brain.aspx
6. https://www.additudemag.com/7-executive-function-deficits-linked-to-adhd/
7. Diamond, A. Executive functions // Annual Review Psychology, – 2013. 64, – pages 135-168.
8. Dillon, D. G., Pizzagalli, D. A. Inhibition of action, thought, and emotion: A selective neurobiological review // Applied & Preventive Psychology; Elsevier BV, – 2007. 12(3). – pages 99-114.
9. Verbruggen, F., Logan, G. D. Automatic and controlled response inhibition: Associative learning in the go/no-go and stop-signal paradigms // Journal of Experimental Psychology: General, – 2008. 137(4) – pages 649-672.
10. Liu, Q. The effects of inhibitory control training for preschoolers on reasoning ability and neural activity / Q. Liu, X. Zhu, A. Ziegler, [et al.] // Scientific Reports, – 2015. 5, 14200.
11. Bodrova E., Leong D.J. Tools of the Mind: The Vygotskian Approach to Early Childhood education // – New York: Merrill Prentice Hall, – 2007.
12. Tiego, J. A Hierarchical Model of Inhibitory Control / J. Tiego, R. Testa, M.A. Bellgrove [et al.] // Frontiers in Psychology; Frontiers Media, – 2018
13. Barkley R.A. Behavioral inhibition, sustained attention, and executive functions: Constructing a unifying theory of ADHD // Psychological Bulletin, – 1997. 121, 65-94.

14. Pievsky M.A., McGrath R.E. The Neurocognitive Profile of Attention-Deficit/Hyperactivity Disorder: A Review of Meta-Analyses // Archives of Clinical Neuropsychology, – 2018. Volume 33, Issue 2. – pages 143-157.
15. Howard S.J, Johnson J., Pascual-Leone J. Clarifying inhibitory control: Diversity and development of attentional inhibition // Cognitive Development, – 2014. 31 (1). – pages 1-21.
16. Moffitt T.E. Childhood self-control predicts adult health, wealth, and crime // Multi-Disciplinary Symposium Improving the Well-Being of Children and Youth, – 2012.
17. Kolodny, T. Fronto-parietal engagement in response inhibition is inversely scaled with attention-deficit/hyperactivity disorder symptom severity / T. Kolodny, C. Mevorach, P. Stern [et al.] // Neuroimage Clinical, – 2020. 25,102119.
18. Narayanan N.S., Laubach M. Inhibitory control: mapping medial frontal cortex // Current Biology, 2017. 27 (4), -pages 148-150.
19. Hardung S. Diester A functional gradient in the rodent prefrontal cortex supports behavioral inhibition / S. Hardung, R. Epple, D. Eriksson [et al.] // Current Biology, 2017. 27, – pages 549-555.
20. Hung Y., Dissociations of cognitive inhibition, response inhibition, and emotional interference: Voxelwise ALE meta-analyses of fMRI studies / Y. Hung, S.L. Gaillard, P. Yarmak [et al.] // Human Brain Mapping, – 2018. 39(10), pages 4065-4082.
21. Gómez-Ocádiz R., Silberberg G. Corticostriatal pathways for bilateral sensorimotor functions // Current Opinion in Neurobiology, – 2023. 83.
22. Smullen, D. White matter properties in fronto-parietal tracts predict maladaptive functional activation and deficient response inhibition in ADHD / D. Smullen, A.P. Bagshaw, L. Shalev [et al] //Cold Spring Harbor Laboratory Press, – 2023
23. Lukito, S. Reduced inferior fronto-insular-thalamic activation during failed inhibition in young adults with combined ASD and ADHD compared to typically developing and pure disorder groups / S.Lukito, O.G. O'Daly, D.J. Lythgoe [et al.] // Translational Psychiatry, – 2023. 13(1), 133.
24. Lukito S, Comparative metaanalyses of brain structural and functional abnormalities during cognitive control in attention-deficit/hyperactivity disorder and autism spectrum disorder / S.Lukito, L.Norman, C. Carlisi [et al.] Psychological Medicine, – 2020. 50, – pages 894-919.
25. Francx W. Integrated analysis of gray and white matter alterations in attention-deficit/hyperactivity disorder / W.Francx, A.Llera, M.Mennes [et al.] // Neuroimage Clinical, – 2016. 11, – pages 357-367.
26. Johnstone, S.J. A Pilot Study of Combined Working Memory and Inhibition Training for Children With ADHD / S.J. Johnstone, S. Roodenrys, B. Russel [et al.] // ADHD Attention Deficit and Hyperactivity Disorders, – 2010. vol. 31-42, no. 1.

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