

## SOME EFFECTS OF HEG NEUROFEEDBACK IN CHILDREN WITH ASD – A BRIEF REPORT

**Abstract:** The article presents the results of a study carried out for the first time on the territory of Bulgaria and related to the application of HEG neurofeedback training in children with autism spectrum disorders (ASD). Particular attention is given to the possibilities of the HEG neurofeedback training over different development stages in the children with ASD and in different groups of children with such a pathological condition, as well as to the duration of the neurofeedback training sessions. Used is one of the newest children with ASD group classification.

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### Author information:

**Mitko Shoshev**

MD, PhD, Neurologist,  
Clinical psychologist

Medico-pedagogical consultative correctional center

Stara Zagora

✉ [mitko.shoshev@gmail.com](mailto:mitko.shoshev@gmail.com)

🌐 Bulgaria

### Keywords:

Autism, hemoencephalography, HEG biofeedback,  
ATEC scale, sociability, Sensitivity awareness, autism  
classification.

### 1. Introduction

The infantile autism syndrome was described for the first time in 1943 by the Austrian Psychiatrist Leo Kanner. In 1943 the Austrian Pediatrician and Psychiatrist Hans Asperger in his work „Autistischen Psihopathen im Kindesalter“ for the first time published the description of a new pattern of behavior in children which he called “autistic psychopathy”.

In 1981 the English medical doctor/Psychiatrist Lorna Wing introduced and popularized the term “Asperger Syndrome” after studying and publishing the description of a series of disorders with similar clinical signs and symptoms. Significant is her contribution also for the contemporary understanding of epidemiology, clinical forms and other topical issues related to autism. In 1972, analyzing patients data from the Psychiatry Departments and summarizing the experience of other researchers, Lorna Wing formulated her “Autism Triad of Impairments” later named after her “Wing’s Triad”. The triad includes the following characterological features:

1. Qualitative impairment in social interaction;
2. Qualitative impairment in verbal and non-verbal communication and imaginative activity;
3. Significant restriction of the activities and interests.

Autism is a complex set of behavioral and emotional characteristics occurring before the child reaches the age of 3. People with autism have abnormal functioning in three areas: social interaction, social communication and behavior. The most important signs of autism are: lack of contact or avoiding contact with the others, withdrawal, indifference to the surrounding world, emotional inertia or coldness, repetitive and stereotyped movements, etc. At the same time, observed are deviations in the child’s speech development, intelligence and socialization, **strictly individual and different for each child.**

The etiologic factors causing the autistic disorder are extremely diverse, some of them are identical to the factors causing the occurrence of mental retardation, some of these are probably still unknown to us, other are disputable.

Undeniable, however, is the influence of the social factors responsible for the occurrence and persistence of pathological tendencies in the behavior of children with autistic spectrum disorders and the child's personality development. The American Psychologist Bruno Bettelheim has a serious contribution to the child's psychology and the study of autism since he was the one to launch the idea for the importance of social factors.

From a medical point of view, the neurological research shows that in autism there is a brain dysfunction. Discussed is also the importance of the genetic factors for the development of autism in children and it is admitted that the occurrence of a number of genes leads to the occurrence of particular symptoms in its development. Reported is a higher risk for the children born in families in which there is already another child diagnosed with autism or autism spectrum disorder. Discussed is also the occurrence of gene mutations caused by various factors, those mutations leading to a change in the child's genome, change in the synthesis of particular proteins and hence the occurrence of autism.

All of the above reveals the complexity of autism as a condition, the difficulties related to identifying its etiology and pathogenesis and respectively the difficulties related to finding a proper treatment approach and possibilities for suitable education and socialization.

According to information of the WHO, autism occurs in 1 to 6 individuals out of 1000. In 2010, 1 in 110 children were diagnosed with autism and this number is constantly growing. The Centers for Disease Control and Prevention, USA, indicates autism prevalence average of 1 in 88 children according to a study conducted in 2008. Comparison of the autism prevalence data for 2002, 2006 and 2008 shows that there is an increase of 23% up to 78% in some states. In 2014 according to the published Annual Report of the National Autism Association, USA, about 1% of the children have an autism spectrum disorder. In other words, these are 3,5 million Americans ([www.cdc.gov/mmwr](http://www.cdc.gov/mmwr)). In Russia, according to information of N. V. Filipova and Y.B. Barilnik, the autism spectrum disorders occur in 1% of the population.

It is estimated that the annual cost of treatment and support for U.S. individuals with autism spectrum disorders are between \$236 billion and \$262 billion.

In Bulgaria, however, unknown is the exact number of children with autistic spectrum disorders. Moreover, with the increasing opportunities to diagnose, this frequency also is showing an increasing tendency. Apart from that, there is no established clear policy for collaboration between specialists from different fields of psychology, medicine and education for the successful treatment of the ASD symptoms. These figures reveal the seriousness of the problem and the urgent need of finding new methods for its overcoming.

Recent trends in the treatment of children with autistic spectrum disorders include simultaneous treatment in several directions, i.e:

- interventions to influence behavior;
- training activities;
- medication treatment;
- physiotherapy;
- application of alternative medical methods;
- psychotherapy sessions;
- contemporary methods in the field of clinical and specialty area psychology in support of the above-listed methods.

Only lately, biofeedback training has become known to us as a modern method of therapeutic intervention. The application of different, appropriately selected according to the type of disorder, forms of biofeedback, including neurofeedback, in combinations with the other methods enlisted,

could possibly help for a positive effect on the symptoms of the autistic spectrum disorders and an improvement in the child's overall condition.

## **2. Classification used in the study**

Of particular interest for the classification of autism is the classification proposed by O. S. Nikolyskaya, E. R. Baenskaya and M.M. Liebling built on the ASD symptom severity. They divide the children with ASD into 4 groups. This classification is used also for the formation of groups for the purposes of this study.

### **First Group**

The children included in this group do not develop active selectiveness in their contacts with the surrounding world and in practice they do not respond to contacts with other people and do not use speech or non-verbal means of communication.

### **Second Group**

In the second group we can include children with ASD whose dysontogenesis symptoms are not that clearly pronounced. In these children seen are only the simplest forms of active contact with other people, used is stereotypic behaviour and speech, they strive for maintaining the "order" created by themselves.

### **Third Group**

Children with autism included in the third group experience difficulties establishing relationships with other people, demonstrating incapability of making a dialogue. They create the impression of children who are "absorbed" by their stereotypic interests.

### **Fourth Group**

This is the group of children with autistic spectrum disorders who feature a general disability in the psychological and social development.

**The presented groups of children with autism spectrum disorders are a basis for orientation firstly in the psychological diagnosis of each child from the selected target group, determining in depth the qualitative impairment in the child's contacts with the surrounding world, assessment of the disorder condition severity level and defining a prognosis for the child's development. It is necessary to emphasize that the formation of these groups should not be seen as different forms of child autism, but rather as an approach for a more precise orientation in the continuum of markedness of the disorders in each one of the children with autism.**

## **3. Neuropsychological Hypotheses of Autism.**

Robert M. Joseph summarizes three neuropsychological theories of autism: the executive dysfunction hypothesis, the weak central coherence hypothesis and the limbic system hypothesis. (R. M. Joseph, 1999, 309 – 324).

**The first** of these hypotheses, i.e the executive dysfunction hypothesis sees autism as a primary deficit of the executive control over behavior.

**The second** hypothesis, the weak central coherence hypothesis postulates that the partial perceptual and cognitive processes dominate over the entire processing of information and lead to abnormal behavior as well as to unusual patterns of the cognitive process that characterize autism.

**The third** hypothesis referring to the participation of the limbic system suggests that the psychological dysfunctions are traditionally associated with the structures and more precisely with dysfunction of the limbic brain structures which anatomically speaking are situated in the orbitofrontal cortex, the medial temporal lobe (hipotalamus) and amygdala. This theory is dominant. The theories presented above to some extent are "ancestors" of the changes in the grey matter in these lobes of the cortex confirmed later by MRI.

Above theories give us ground to draw our attention and look for changes in the cerebral cortex in its pre-frontal lobes and its leading part in the control and management of the cognitive processes in

children with autism spectrum disorders, and further, searching for methods and means to influence it and improve its functions, respectively improve the condition of children with such disorders.

#### **4. HEG Neurofeedback and its Application in Children with ASD**

The modern technique for monitoring the brain activity is called “Hemoencephalography” (HEG). It shows us the qualitative changes in the brain activity in a slightly different way.

**How does the hemoencephalography work?** Just like the functional MRI, HEG registers the changes in the brain activity by the changes in the oxygenation level.

Hemoencephalography (HEG) is a new field of research which studies the cortical hemodynamics: vascularisation, blood volume, oxygenation, metabolism and temperature in real time

The elegance and advantages of using HEG compared to EEG is the easy and comfortable learning control. The outstanding clarity of the HEG biofeedback signal simplifies learning and is a simple criterion for a successful session. An increase of 10% in the average HEG readings in a 10 - minute trial *is a proven factor for a good, easily measured therapeutic effectiveness of the method.* Respectively, the goal achieved leads to more effective efforts on side of the trainee.

#### **5. Participants in the Study**

Six children in the age range of 3 and 15 who have been diagnosed with autism spectrum disorders are included in the study, as seen from the Table. The diagnoses of all children have been set in the Children's Psychiatry Clinic with the University Multi-Profile Hospital for Active Treatment “Aleksandrovska”, Sofia.

Accompanying diseases have not been reported for any of the children included in the study.

According to the initial (baseline) total score of the ATEC evaluation checklist provided by Autism Research Institute (ARI), the children who take part in the study, are divided according to their percentile severity as it follows:

- Child 1 (total score 54), percentile severity of the ASD condition 30 – 39%;
- Child 2 (total score 70), percentile severity of the ASD condition 50 – 59%;
- Child 3 (total score 64), percentile severity of the ASD condition 40 – 49%;
- Child 4 (total score 95), percentile severity of the ASD condition 80 – 89%;
- Child 5 (total score 60), percentile severity of the ASD condition 40 – 49%;
- Child 6 (total score 34), percentile severity of the ASD condition 10 – 19%.

ARI does not provide an accurate distribution of the severity level in accordance with the total score and the percentile severity of the ASD condition. The only guideline for elaborating the final evaluation is that the severity level of the condition of a child with ASD is inversely proportional to the ATEC checklist total score, i.e. the lower the score, the better the child is doing and the disorder has become less severe. This is how every researcher has the freedom to determine in a critical manner the severity of the condition of each child studied and according to the researcher’s individual assessment. Of course, it is important to underline that the ASD condition severity, evaluated according to the ATEC evaluation checklist, cannot be linked with the form of the disorder, the DSM-V classification system or the classification proposed by O.S. Nikolskaya. For example, the condition of child No. 2 is evaluated as moderate according to this system of distribution but according to the classification of Nikolskaya, it belongs to group 2. The condition of child No. 1 is evaluated according to this system of distribution as moderate, but according to the classification of Nikolskaya, it belongs to group 4. The children who took part in the study can provisionally be rated according to the ATEC rating scale and grounds for this is provided by the above analysis. This distribution is as follows:

- Mild - percentage distribution 0-29%
- Moderate- percentage distribution 30-69%
- Severe- percentage distribution 70-99%

In the group of children with a mild degree of the condition according to the ATEC rating scale included is Child No. 6 with a total score of 34 or percentile severity of the ASD condition 10-19%.

In the group of children with a moderate degree of the condition according to the ATEC rating scale included is Child No. 1 with a total score of 54 and percentile severity of the ASD condition 30-39%; Child No. 2 with a total score of 70 and percentile severity of the ASD condition 50-59%; Child No. 3 with a total score of 64 and percentile severity of the ASD condition 40-49%; Child No. 5 with a total score of 60 and percentile severity of the ASD condition 40-49%.

In the group of children with severe degree of the condition according to the ATEC rating scale included is Child No. 4 where the ATEC baseline score is 95 and the percentile severity of the ASD condition is 80-89%.

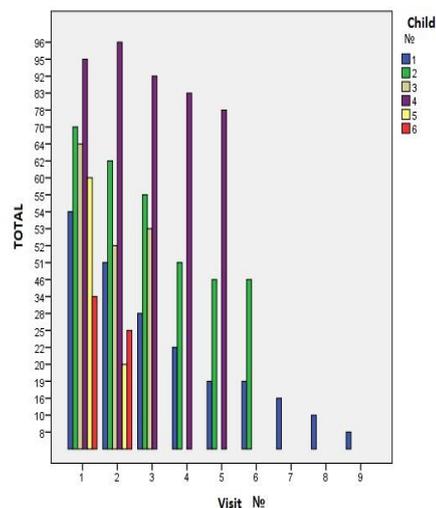
According to the design, accepted in the study, for each child a HEG neurofeedback training session at least twice a week is ensured. The training sessions last 30 min or until the tolerance has been reached. This means that at least 8 sessions are held for each child monthly.

### 6. Results from the Study

All of the children have attended a total of **174 HEG neurofeedback training sessions**, each of them lasting 30 min. As it was already mentioned, each child participates in the study for a different period of time which is between 2 and 15 months. This allows us to register the duration of the sessions and their effect onto each child. The differences displayed on the diagrams give us a chance to make important conclusions with regard to how the child is affected considering the varying duration, frequency of visits and type of disorder.

#### *Diagram 1*

*Dynamics of the total score according to the ATEC rating scale for the children included in the study*



The color legend in the right shows the number of each child in the relevant color. Clearly seen is a decreasing tendency of the total score according to the ATEC rating scale and moreover, this decrease is progressive regardless of the disorder severity level. In accordance with Hypothesis 1, accepted at the start of the study, the HEG neurofeedback training improves the overall condition of the children with autism spectrum disorders. **These data have confirmed Hypothesis 1.**

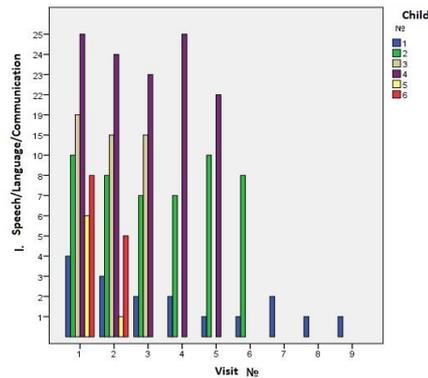
Since the duration of the HEG neurofeedback training sessions is relatively constant in time, of significance are the number and the frequency of the applied HEG neurofeedback training sessions. **This allows confirmation of Hypothesis 2 according to which the condition of the children with autism spectrum disorders improves and is directly dependent on the duration of the training in time, as well as the frequency of the HEG neurofeedback training application.**

The following diagrams present the changes based on the following criteria: “Articulation, Speech, Communication”; “Sociability”; “Sensory Sensitivity/Senses” and “Health Condition/Behaviour”

The analysis of the effects based on the “Speech, Language, Communication” criterion can be made after a detailed review of Diagram 2.

**Diagram 2:**

***Dynamics of the values based on “Speech, Language, Communication” criterion for the children included in the study***

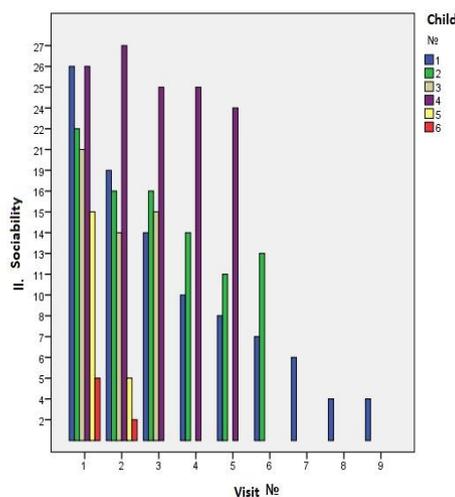


The analysis reveals a clear tendency for decreasing of the values based on this criterion which according to the guidelines provided by the ARI means improvement of the criterion characteristics. However, noticed is a non-uniformity in the rate and extent of decrease in the criterion values for each child. This, in our opinion, depends on the type of ASD as well as the group to which the child belongs according to the classification proposed by O.S. Nikolskaya.

The following diagram presents the changes based on the “Sociability” criterion:

**Diagram 3**

***Dynamics of the values based on the “Sociability” criterion for the children included in the study***



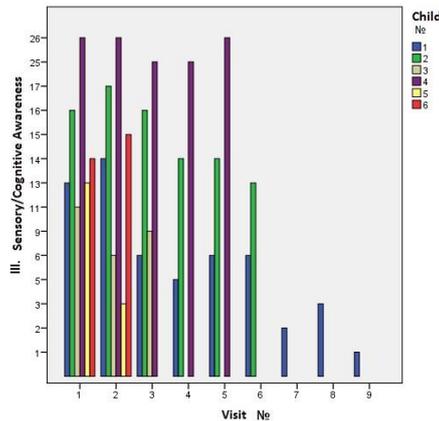
The analysis of the diagram presented again shows a decrease of the score based on this criterion and this decrease happens at a relatively equal rate for all the children included in the study regardless of its baseline values, type of disorder and the group according to the classification of Nikolskaya to

which each child belongs. At the same time, however, it is seen that the decrease of the score is dependent on the number of the HEG neurofeedback training sessions and the exponent of the decrease is linked to the type of disorder.

The “Sensory/ Sensitivity awareness” criterion is presented in Diagram 4.

**Diagram 4**

*Dynamics of the values based on the “Sensory/Sensitivity awareness” criterion for the children included in the study*

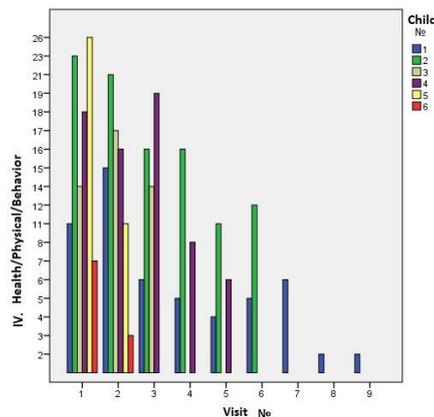


The analysis of the data based on this criterion, however, shows inequality in the tendency for a decrease in the sub-score as well as a fluctuation in their total score. This in our opinion shows insufficiency of the duration of HEG neurofeedback training or a necessity of including supplementary techniques for stimulation of the sensory sensitivity in the children with autism spectrum disorders. The researcher is planning to include such a sensory sensitivity stimulation technique provided that work is continued in future.

The last criterion assessed according to the ATEC rating scale is “Health Condition/Behavior”. On the diagram presented, the dynamics of the values based on this criterion can be seen

**Diagram 5**

*Dynamics of the values based on the “Health/Physical Behavior” criterion the children included in the study*



The analysis of this diagram shows the same tendency for a decrease in the values based on this criterion as well as the ones which are based on the “Overall Condition” and “Sociability” criteria. It can be seen, however, that there are fluctuations, just like in the values based on the “Sensory Sensitivity/Senses” criterion but these fluctuations are less pronounced. This reveals the link between

the sensory sensitivity, health condition and behaviour in the children with autism spectrum disorders. This connection is seen in varying degrees and proportions in each child, and is again dependent on the severity level and the group belongingness according to the classification of O.S. Nikolskaya, as referred by us.

## **7. OVERALL CONCLUSIONS**

The results from the study carried out and related with the possibilities of the HEG neurofeedback training in the work with children with ASD in an attempt to improve their condition, allowed us to confirm two of the formulated hypotheses.

**Hypothesis 1:** The condition of the children with ASD has improved after application of HEG neurofeedback training.

**Hypothesis 2:** The improvement in the overall condition of the children with ASD is directly linked to the HEG neurofeedback training duration in time and its application frequency.

**Hypothesis 3** has not been confirmed, i.e. when using the HEG neurofeedback training the groups of qualitative characteristics included in the ATEC rating scale are affected in an equal degree.

Instead, **Alternative Hypothesis 3** has been confirmed, i.e. when using HEG neurofeedback training, the groups of qualitative characteristics included in the ATEC rating scale are affected in an unequal degree.

## **Conclusions**

1. HEG neurofeedback training can be applied to children with ASD of various severity levels.
2. The HEG neurofeedback training has a positive effect onto the overall condition of the child with ASD.
3. The application of HEG neurofeedback training improves the communicative skills of the children with ASD.
4. The children with ASD show a positive change with regard to their social skills.
5. Depending on the impairment level, registered is certain improvement in the sensory sensitivity of the children with ASD.
6. The use of the HEG neurofeedback training technique confirms a tendency for a positive change in of the behavior of children with ASD.
7. It is appropriate that the HEG neurofeedback training is used together with another technique for stimulating the sensory sensitivity in children with ASD.

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