

Hemoencephalography (HEG) :

An additional treatment for autism*

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Background : The National Library of Medicine search turned up many imaging studies of Autism, Schizophrenia and Attention Deficit Hyperactive Disorders. It is clear that hypoperfused frontal cortex dominated the field. The dominance and importance of frontal hypoperfusion fits our experience in dealing with Autism

Objective : To study the Performance of autism before and after hemoencephalography (HEG) treatment.

Material : Instrumentation, HEG consists of a computer display that receives reflected light and a spectrophotometric measurement of blood oxygenation via a headband attach at the forehead of the subject and show feedback in graphical and audible form to a subject for voluntary control.

Method : Intensive use of the prefrontal lobe, facilitated by 40 sessions of HEG for 180 autisms, age between 3 to 18 years is reported.

Results : The study shows a direct relationship between an improvement of frontal lobe brain function and trained increases in available of blood supply. 86% of the subjects show improvement of cognitive function.

Conclusion : HEG can be used as simple non-invasive additional treatment for autism.

Key words : Hemoencephalography, Infrared, Brain blood flow, Spectrophotometry

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Autism was initially described by Leo Kanner (1943) with three major features were noted : The first was children's inability to relate themselves in ordinary ways to people and situations from the beginning of their life.

The second distinctive feature was the failure to use language for the purpose of their communication with other people.

The third characteristic was described as an anxiously obsessive desire for the maintenance of sameness, resulting in a marked limitation in the variety of spontaneous activity. Furthermore their playing habit was characterized with stereotyped, repetitive activities and lacking any creative or social function.

It is now also apparent that autistic children show a wide range of non-specific problems; such as temper tantrums, fears, phobias, sleeping and behavioral disturbances, in addition to their more specific difficulties. It is also clear that they are far from having normal cognitive skills. There are distinct and deviant cognitive patterns associated with the condition, as well as a tendency to overall mental retardation.

FUTURE PROGRESS IN TREATMENT

Although there has been great progress in the development of effective methods for treating the behavioral problems process by autistic children, it is also apparent that some autistic individuals remain handicapped throughout their lives. Treatment does not result in a 'cure' or anything closed to it. Is it likely that more can be accomplished in the future?

It is clear that autism has some kind of organic basis, although it remains uncertain just what that basis is. Until recently, the tools to investigate brain functioning were exceedingly limited, but advances in brain imaging techniques have opened up new horizons.

New studies using a variety of different technologies show interesting differences in the brains of people with autism and attention deficit disorders. Electroencephalographic (EEG) studies taking readings from the surface of the scalp reveal slower overall electrical activity. Other studies using SPECT (Single Photon Emission Computed Tomography) which can look at deeper structures, have found reduced blood flow in the brain's frontal area and limbic system, areas that are important for impulse inhibition, when the person with autism and ADD. is under stress. This may explain the impulsiveness

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of them. Blood flow was also decreases in the area of the striatum, the part of the brain that processes motor inhibition. This may contribute to hyperactivity. Researchers have also used PET (Positron Emission Tomography) scans to measure the rate of glucose metabolism in the brain, an indirect measurement of brain activity. PET scanning showed decreased glucose metabolism in the frontal region of the brains in both groups. The frontal area of the brain, called executive area, processes incoming information and selects out which information is relevant to the person, what needs to be acted on, and what should be ignores.

The National Library of Medicine search turned up many brain imaging studies of autism, attention deficit disorders and schizophrenia. The literature citation frequency for hypoperfused brain modules is illustrated. (Figure 1) Knowledge of the distribution of hypoperfused areas is useful in determining brain areas to be treated. It is cleared that the hypoperfused frontal cortex dominates the field and fits our experience in dealing with autism.

Objective

Our objective is a prospective clinical study of the performance of autistic children before and after using hemoencephalography (new technique neurofeedback) for additional treatment at the frontal areas.

Material

Instrumentation: Hemoencephalogram (HEG) which consists of a bio-computer display that receives reflected light and spectrophotometric measurement

of blood oxygenation via a headband attach at the forehead of the subject and show feedback in graphical and audible form to a subject for voluntary control. (Figure 2)

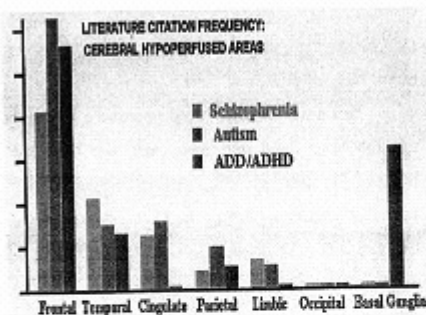


Figure 1*: Brain Imaging studies show frequency versus location of hypoperfusion of Schizophrenia, Autism and Attention Deficit Disorder

*Reference : The National Library of Medicine. Explore! 2(1); 2002, page 20



Figure 2

Hemoencephalogram is a new technique of neurofeedback. It is the study of regional Cerebral Blood flow (rCBF) and regional Cerebral Blood Oxygenation. Neurofeedback using HEG trains the subject to increase blood flow to a targeted area of the brain on demand. Neurofeedback as we have known it so far, measures the electrical activity of the brain, EEG, as a feedback signal to be controlled by the patient. Here we have substituted blood oxygenation data for the same purpose.

You have probably tried to shine a flashlight through your hand and have seen the dark side light up. Our tissues, Flesh, and bone are translucent. In HEG a light is shone into your brain through the translucent scalp and skull for the purpose of determining local blood oxygen levels. (Spectrophotometry)

The frontal lobes are particularly easy to reach from the forehead with a spectrophotometer headband. (Figure 3)

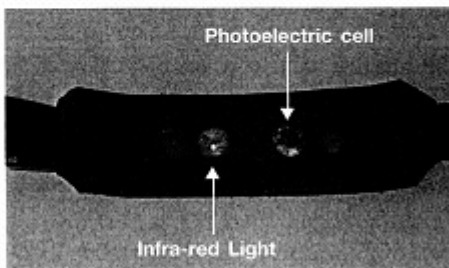


Figure 3

The headband (Spectrophotometer) is worn around the subject's forehead. Flashing red and infrared lights are alternately as an optode. The light collecting amplifier is another type of optode. It responds to the returned light that is reflected and refracted by the encountered tissue. These optodes are spaced 3 centimeters apart so as to conduct

most of the available light through cortical tissue. (Figure 4)

A computer program, receiving a measure of each light color, in turn, calculates their ratio and graphing the value for the patient to see, hear and alter from time to time during the treatment session.

The patient will see a moving bar graph on the left hand side of the screen which constitutes an effective display. The bar last for a selected few seconds and is replaced by a bar showing the average position. In this manner a histogram is generated which continuously compares the currently varying light ratio with the just completed average value. Each vertical increment is accompanied by variably pitched musical tone keyed to the current bar height. (Figure 5)

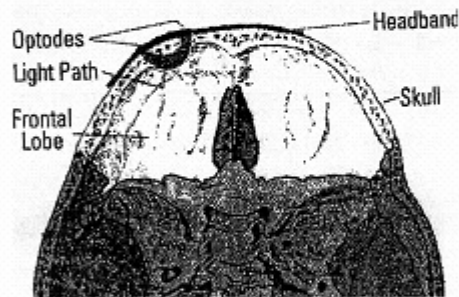


Figure 4

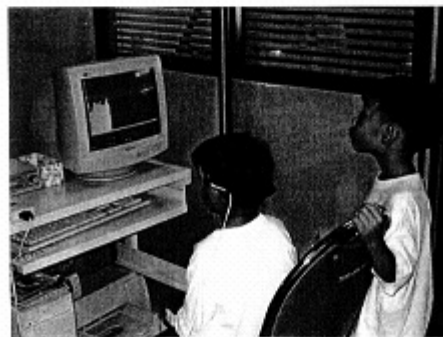


Figure 5

This new technique of neurofeedback provides a means to exercise selected brain areas. The exercise increases blood flow to the chosen brain module. Capillaries and dendrites grow with this brain exercise.

An audible tone has been devised to increase in pitch and signify increased blood oxygenation. To increase oxygenation on demand, one merely try to attend the highest note in each trill and wills the next higher note to sound.

Method

Autistic children should be prepared before they begin any HEG treatment. Because it's hard to get them to co-operate during the treatment, due to their social and communication problems which makes it hard for them to adapt themselves. They just don't want anyone to disturb them. If they are faced with a new situation or environment, they become worried with excessive anxiety or even panic. So it is necessary to keep them clam and relax during their treatment.

How to prepare the child?



Figure 6



Figure 7

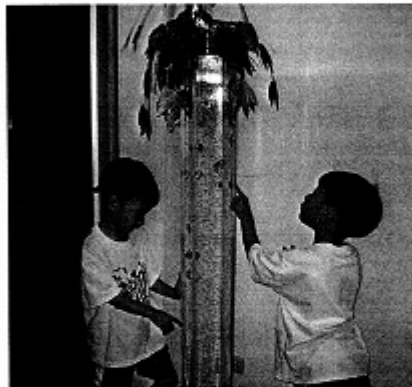


Figure 8

First of all we ask that parents have their child practice wearing an elastic headband similar to the headband worn during treatment until they get used to it.

Then bring their children to visit the HEG treatment room so that they can become acquainted with the place. The therapists should try to build up a relationship with the child, by showing them our artificial fish aquarium, some interesting pictures and books. (Figure 6, 7, 8)

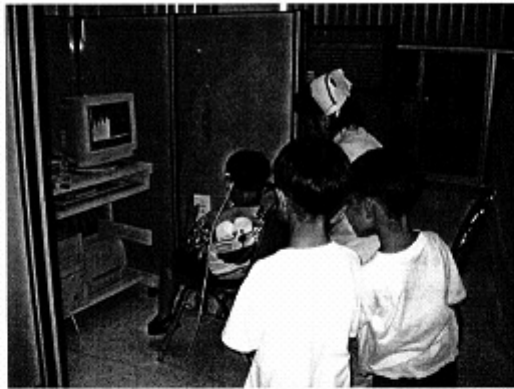


Figure 9



Figure 10



Figure 11

When they are comfortable with the surrounding in the HEG room, they will express an interest with other children who are having HEG treatment and want to do the same things that they are doing. At that time they will begin their own treatment. (Figure 9, 10, 11)

The treatment process is divided into ten minute segment. Usually 2 segments (FP1, FP2) constitute a subject's treatment session.

At the beginning, the treatment session should be for only 5 minutes and gradually increase to 20 minutes per session. During the HEG session, we

try to get the child to look at some pictures or books that they like, then help them to focus on the bar graph which moves upward on the computer screen and listen to the musical tones which change along with the bar graph.

It is noticeable that children after receiving one or two HEG treatment sessions, usually become very co-operative with the treatment.

Subject

The subject group is comprised of 180 children with autism.

Diagnosis was based on parent interviews regarding the child's social, communication, emotion, and behavioral functioning, autistic symptoms and developmental history, review of prior evaluations and early intervention, school records, clinical observation of the child and the diagnosis of autism was based on DSM-IV criteria.

Table 1 Number of children by age group , sex and education
(N=180; Male=153, Female =27)

Age group (yr.)	3-6		6-12		-18		Mean = 7.2	
	M	F	M	F	M	F	TOTAL	%
Therapeutic class	30	4	12	3	9	1	59	32.8
Kindergarten	27	4	6	3	-	-	40	22.0
Grade 1-6	-	-	43	8	8	2	61	33.9
Grade 7-9	-	-	1	-	17	2	20	11.1
TOTAL	57	8	62	14	34	5	180	100.0

Table 1 shows number of children by age group, sex and education.

The total number is 180 children of autism, 3 to 18 years of age (mean = 7.2)

Male = 153 Female = 27 M : F = 5.6 :1

For education, there are

32.8% in therapeutic classes of the hospital 22.0% in kindergarten

33.9% in grade 1-6 of public school 11.1% in grade 7-9 of public school

Table 2 Parent by education

Education	Father	Mother	TOTAL	%
Doctorate degree	7	2	9	2.5
Master degree	41	27	68	18.8
Bachelor degree	88	81	169	46.9
Certificate	11	18	29	8.1
High school	30	37	67	18.7
Grade 6-9	3	15	18	5.0
TOTAL	180	180	360	100.0

Table 2 shows the education of the subject's parents, there are 68.2% of high educational parents (doctorate, master and bachelor degree), 8.1% were graduated from vocational school, 18.7% finished from high school and 5% between grade 6-9.

Result

For the evaluation of HEG treatment, we analysed from :-

I. The average value of oxygenation before and after HEG treatment. (Figure 12)

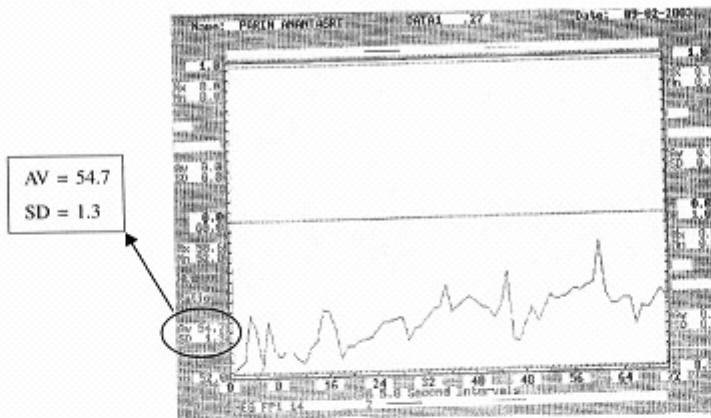


Figure 12

Table 3 Frontal cortex area by average value of oxygenation before and after HEG treatment (N = 180)

Frontal cortex Area	Average value of oxygenation					
	Control		After 40 sessions		increased	
	min-max	mean	min-max	mean	min-max	mean
FP1	38.7-87.90	53.56	50.30-117.80	81.83	1.30-64.45	28.26
FP2	37.4-75.52	54.48	57.70-120.00	83.85	3.60-67.93	29.37

The normal average value of oxygenation should not be lower than 60.

Table 3 shows the average value of oxygenation before (control) and after 40 sessions HEG treatment at the frontal cortex area (FP1, FP2).

FP1 (left prefrontal area) the average value of oxygenation of the 1st session (control) is between 38.7 and 87.90 (mean = 53.56) and after 40 sessions it is between 50.30 to 117.80 (mean = 81.83), so it increases between 1.30 and 64.45 (mean = 28.26)

FP2 (right prefrontal area) the average value of oxygenation of the 1st session (control) is between 37.4 and 75.52 (mean = 54.48) and after 40 sessions it is between 57.70 to 120.00 (mean = 83.85), so it increases between 3.60 and 67.93 (mean = 29.37). The normal average value of oxygenation is not lower than 60.

II. The Characteristic of the line graph which shows the total average value of oxygenation in each session. (Figure 13, 12)

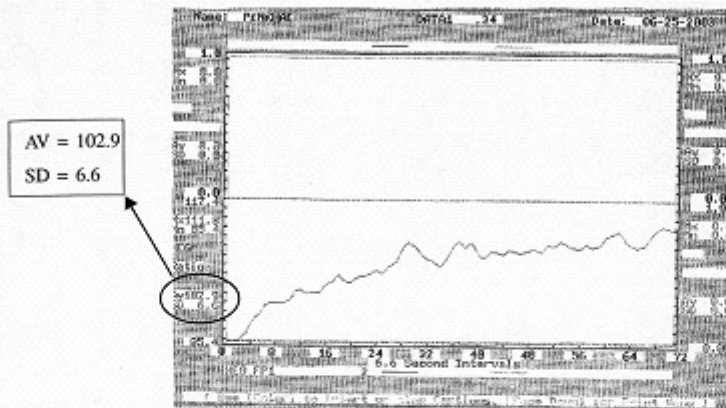


Figure 13

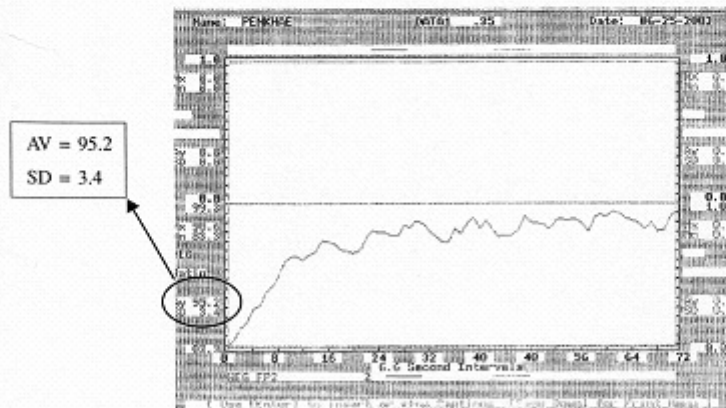


Figure 14

III. The reports of the parents, the subjects if they could write the reports, the report cards from the teacher and clinical reports from the therapists and psychiatrists.

Those whose graph show regular patterns with an increased average value of oxygenation show improved behavior and increased learning abilities as follows :-

1. Concentration and attention.
2. Understanding.
3. Listening and following instructions.
4. Improved reasoning, show more patience and better self control.
5. Improvement in speech and communication.
6. Able to show appropriate emotions and understand the feeling of others.

IV. The grade point average of the subjects who were learning in the public school.

Table 4 Number of children by age group, sex, education and grade point average after 40 sessions HEG treatment. (N=81; Male =69, Female = 12)

Education Age group Sex	Grade point average		
	Increase 0.5 -1.39 (mean=0.94)	No change 0	Decrease 0.5 - 0.7 (mean=0.57)
GRADE 1-6			
Age 6-12			
Male	35	6	2
Female	6	1	1
Age 12-18			
Male	7	1	-
Female	2	-	-
GRADE 7-9			
Age 6-12			
Male	1	-	-
Female	-	-	-
Age 12-18			
Male	17	-	-
Female	2	-	-
Total	70	8	3
%	86	10	4

Table 4 shows that there were 81 subjects who could learn in the public school (grade 1-9), 86% of them could get increased grade point average after 40 sessions HEG treatment.

Example of the subject's report

Fang was diagnosed to be autism when he was 4 years old.

He started HEG on 28 November 1999 when he was 14 years old, studied in year 9 of private school in Bangkok. After trying to do blood brain exercise at the prefrontal areas for 40 sessions, he wrote this report on 14 September 2002.

Before I used the "machine" my grades at school were not so good, especially in mathematics, because I did not quite understand the subject. I just did not feel like studying it and so I just let it go by until the course finished.

I have some understanding of the other subjects while almost all of the other students understand those subjects well. When there were reports to do, I was always lazy and would only do them when they piled up a lot. I didn't want to fail because my family would blame me if my report card came out with any "0" and I would have to take the examination again. But I didn't know if I could pass it. Also I would be blamed for not paying attention to my studies. My grades were not so satisfactory.

At the beginning of using this machine, I didn't feel much change, but my grades started changing a bit. After I used the machine more than 30 sessions, my examination results changed from failing in many subjects to just only one subject. My grade point average improved gradually from 2.0 up to 2.79 and higher until finally I could pass all the subjects, especially mathematics which changed to grade 2, 3 and 4. Now my overall grade point has reached 3.26 which made me the first in my class. My family and myself are very proud of it. I think that all of this must be due to the use of the "HEG machine".

Fang used HEG at the prefrontal areas (FP1, FP2) 20 minutes per session once a week for 20 sessions then gradually change to twice a month for 20 sessions and then every 3 weeks and now maintenance only once a month.

Report of Fang's mother on 14 September 2002.

After using the machine for almost two years, we noticed the following change in Fang "our son".

(1) He is more independent knows how to choose the type of dress he likes. He pay more attention to his surroundings and behaves more like other teenagers, for example listening to music, knowing the singers and bands.

(2) He expresses his emotions more by showing both anger and happiness appropriately. In the past he never showed his emotions to people around him and didn't pay attention to whatever people said. He was always in his own world. In school he walked alone and didn't pay attention to the other students. Now he can even tell jokes to other people. He is now interested in people, likes to know who they are, what he's going to do, Now he know how to communicate more with people and wants to make friends.

(3) His learning skills are improving noticeably. Before he couldn't understand arithmetics at all. He was confused and couldn't even memorize the "multiplication table". He had difficulty with mathematics calculation. His grade were around 0 to 1 only. Now he can understand this subject well, he isn't afraid of it anymore. His current grade average in this subject is 3 to 4.

(4) He has more reasonable, mature thinking.

(5) He resembles the other children of the same age group. He was knows the tricks and how to avoid and get himself out of occasional problems.

Parent's report (25 August 2003)

Pop, a boy 9 years old with problems of restless, sensitive, fearful, absent - minded, attention deficit, talk and act repetitively, lack of thinking and imagination, deficiency in social functions and learning ability.

He was an autistic child received treatment and care from medical doctor since he was two and half years old. He started talking when he was 4 years old. He could attend regular class in school when he was 6 years old , but he used memory rather than understanding in his study.

He started the HEG treatment program since December 1999. Now he studies in grade 7 in private school. He could gain more grade of 65-70% instead of 50% in each subject. He was improved his learning because he could understand the lesson better. His mathematic and arithmetic problem solution was also improved. He had more attention in listening and reading. His impulsive behavior was lessen. He could chat and play with his friends.

I believed that the HEG treatment apparently evidence my son's development in all aspects greatly, so our family was very happy.

Conclusion

Voluntary control of blood flow using HEG; an additional treatment in the prefrontal area of autistic persons is quickly learned. It is very easy to use and very resistant to movement artifact and does not respond to eye movement. The results are quantifiable as a growth in vascularity between exercise sessions. We believe that the patients who suffered with brain hypoperfusion can hope for relief with this new technique.

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