

EEG AND THE SENSE OF BALANCE IN 12-14 YEAR OLD BOYS AND GIRLS

by

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The study attempts to assess the sense of balance depending on the regularity of the EEG graphic record. The research was conducted on 64 girls and 45 boys. The EEG record was made in resting position and during activation (hyperventilation, opening and closing of the eyes). Sense of balance was assessed with the "flamingo balance" test according to "Eurofit" Test. Analysis of balance results was based on individual valuation expressed in points corresponding with the calendar age norms of persons subjected to examination. Abnormal EEG was stated in 13.3% of the boys and 15.6% of the girls. Worse results were obtained by persons with an abnormal EEG record. Girls with a normal EEG showed a statistically higher difference in the state of balance in relation to boys with normal EEG ($d=7.9$; $t\text{-test}=2.33$) and abnormal EEG ($d=16.2$; $t\text{-test}=3.42$). The obtained results confirm the influence of even the slightest brain dysfunction on the level of coordinational abilities, in this case of sense of balance.

Key words: EEG, sense of balance.

Introduction

The nervous system is the dominating biological base for coordinational abilities. Structural and functional maturation of the central nervous system takes place slowly and lasts till the age of 18-20 years. Bioelectric phenomena in particular phases of ontogenesis are characterised by certain stability. Recording of bioelectric functions of the brain (EEG) going through the child's cranium allows to assess the development and maturity level of the nervous system in relations to the recording „norms” accepted for a given age group.

Examination of coordinational abilities include many specific predispositions (Lumaye 1983, Viatleva 1991, Raczek 1992, 1996, Gutnik and Hyland 1997a, 1997b, Jahanshahi et al. 1997). One of them is balance, a

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process depending on many factors, among others on the proper functioning of the central nervous system.

The aim of the study was to attempt assessing the sense of balance depending on normal or abnormal EEG record.

Material and Methods

The studies were carried out on a group of 64 girls and 45 boys in the 12-14 age group, who did not practice any sport disciplines.

The following test methods were used:

1. Graphic record of EEG was made with the use of the Medicor 16-S apparatus:
 - setting of electrodes according to the international 10-20 diagram,
 - recordings at rest and after activation - hyperventilation and opening and closing of the eyes (recording time - 15 minutes).
2. The “flamingo balance” test carried out according to „Eurofit” (1988) in the modified version by Žak (1991).
3. The statistical evaluation of the sense of balance in boys and girls with normal and abnormal EEG. Mean, SD and the essence of average value difference was calculated in the examined groups.

The EEG examinations were carried out in the Neurological Laboratory of the Municipal Specialist Dispensary. As the percentage of abnormal EEG records in the group of healthy persons can amount to approximately 10%, the examinations were conducted twice (Tyner et al. 1983). The description of EEG results and their interpretation was carried out by a neurologist. The EEG records were classified into normal and abnormal according to Johannesson (1988).

The “flamingo balance” test results obtained in seconds were converted into points corresponding to norms of calendar age and sex according to Žak’s tables (1991). Presentation of results in the form of points enabled the comparison of the sense of balance of persons with a normal and abnormal EEG record.

Results

The frequency of normal and abnormal EEG records was similar in the group of girls and boys (Tab. 1). The majority of changes in the abnormal EEG concerned the basic dysfunction, i.e. the alpha rhythm and manifested itself in the presence of theta waves, particularly in the occiput leads, as well as in the dominance of beta waves overlapping the basic function. Paroxysmal pathologic function was stated in 3.8% of the examined persons, which consisted in the appearance of the spike-and-wave complex and slow waves with frequency of 3-5 Hz in the rhombencephalon. Examples of normal and abnormal EEG records have been presented in Figure 1, 2.

Table 1. Frequency of normal and abnormal EEG records in individualssubjected to examination

SUBJECTS	EEG			
	Normal		Abnormal	
	n	%	n	%
Girls	54	84,4	10	15,6
Boys	39	86,7	6	13,3

A worse sense of balance was found in persons with an abnormal EEG record (Tab. 2). Girls had a better sense of balance than the boys. Particularly the group with a normal EEG record obtained results which differed significantly from both the boys groups (Tab. 3). The individual "flamingo balance" test results in groups of boys and girls with abnormal EEG record against a background of arithmetic mean in the group with normal EEG readings has been presented in Figure 3.

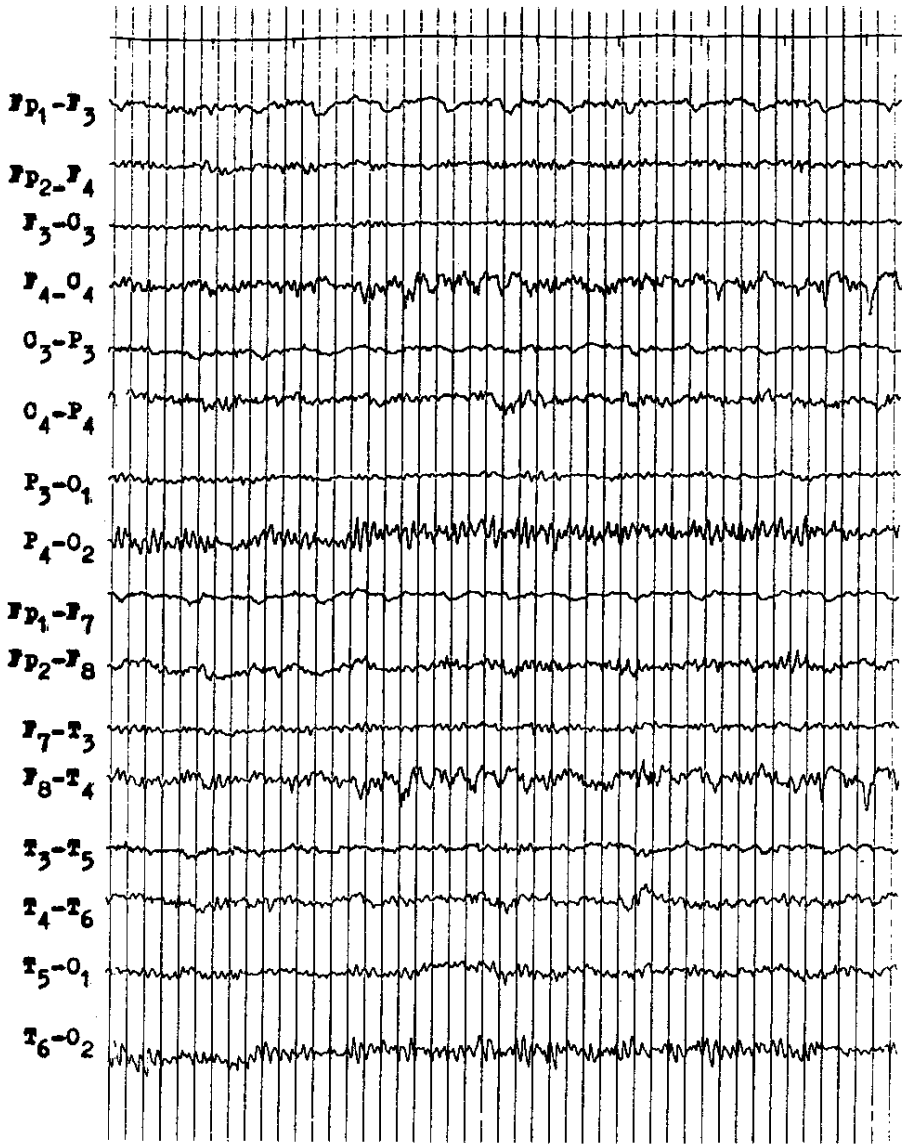


Figure 1. Normal EEG record of 13 year old girl

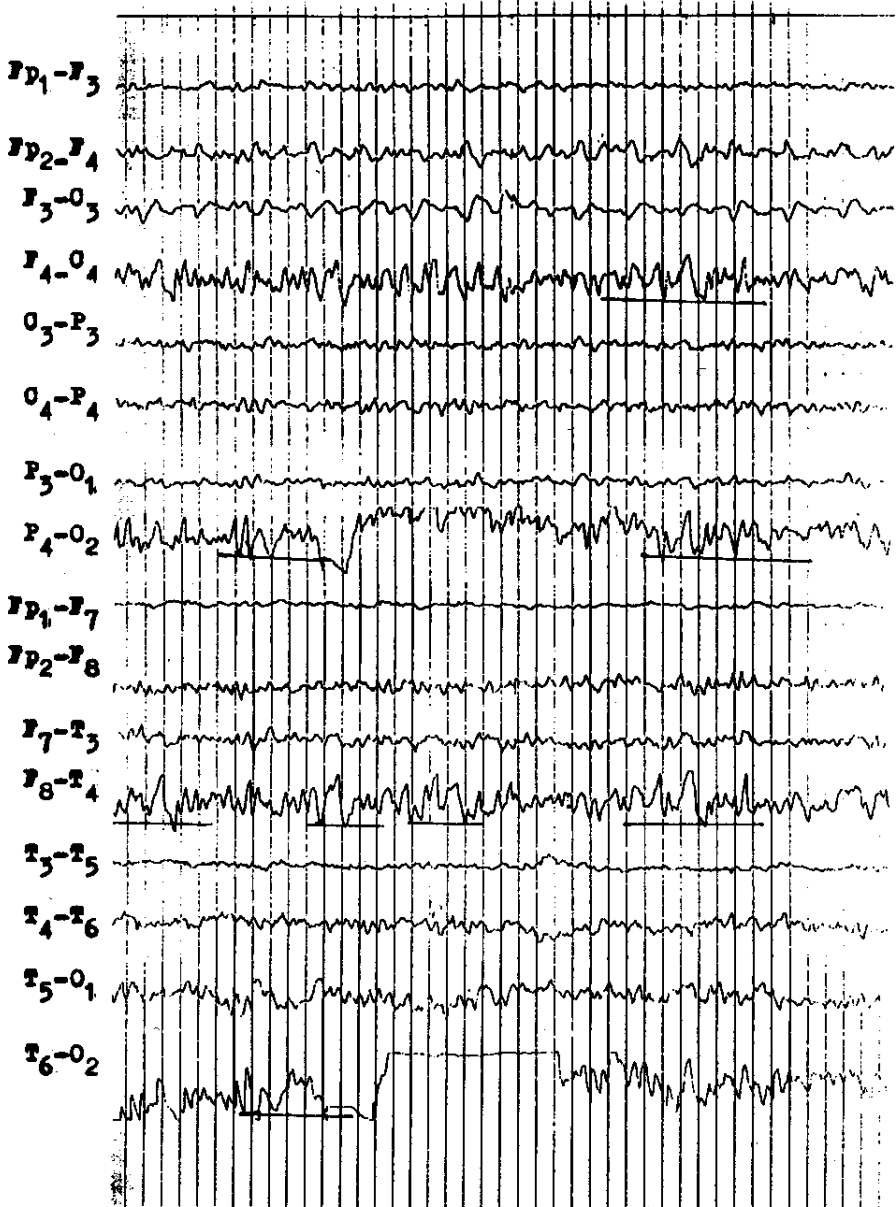


Figure 2. Abnormal EEG record of 14 year old boy (interpretation by Dr. K. Michałowska)

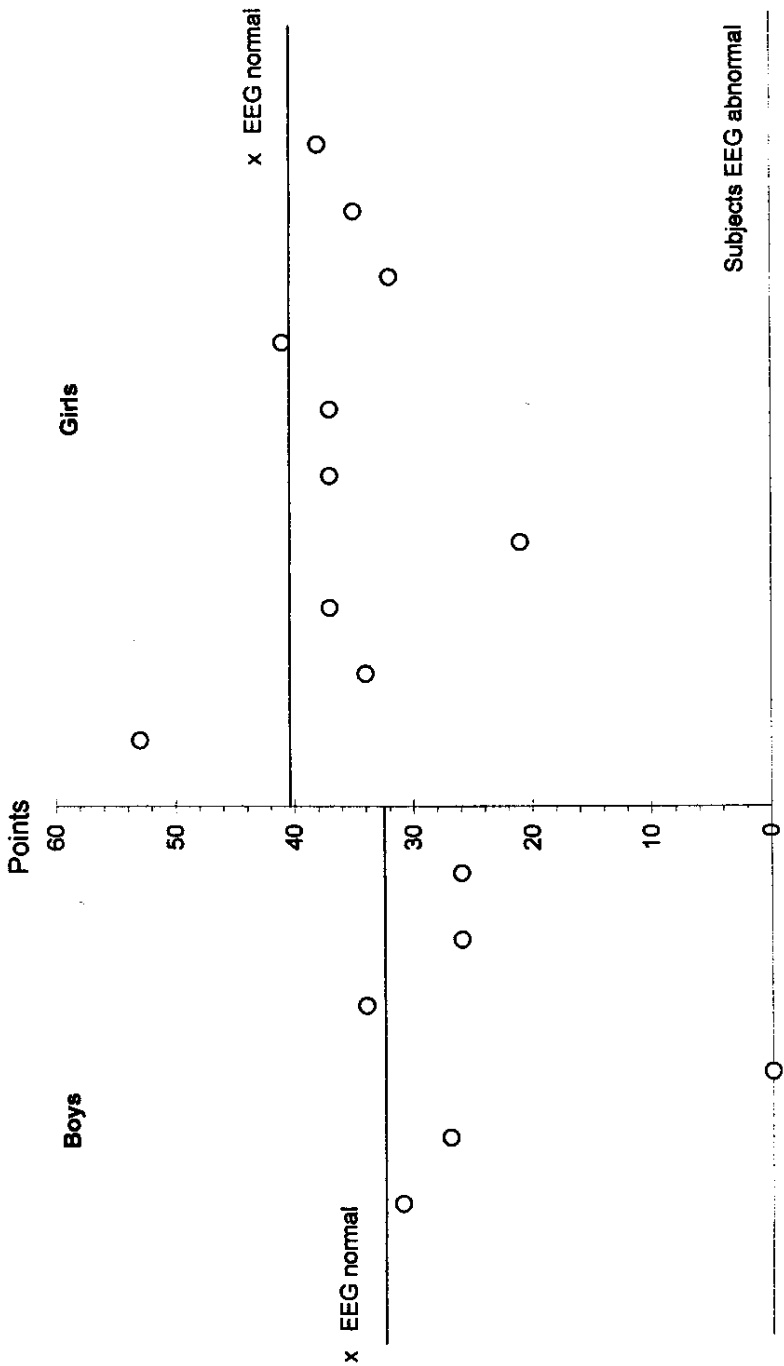


Figure 3. Individual „flamingo balance” test results of persons with abnormal EEG against the background of a group (x) with normal EEG

Table 2. Balance results (points) in the examined groups

SUBJECTS	EEG			
	Normal		Abnormal	
	n	x ± SD	n	x ± SD
Girls	54	40,2 ± 10,7	10	36,5 ± 7,9
Boys	39	32,2 ± 21,7	6	24,0 ± 12,2

Table 3. Statistical assessment of arithmetic mean difference of the sense of balance of examined individuals depending on EEG recordings

SUBJECTS	ABNORMAL EEG				NORMAL EEG	
	Girls		Boys		Boys	
	d	t-test	d	t-test	d	t-test
Girls EEG						
Normal	3,7	1,03	16,2	3,42*	7,9	2,33*
Abnormal	–	–	12,5	2,35*	4,3	0,60
Boys EEG						
Normal	4,3	0,60	8,2	0,89	–	–

* p<0,05

Discussion

The EEG examinations, apart from diagnosing specific illness syndromes, is carried out among children when „Specific Learning Difficulties/Disabilities” (SLD) appear (Leong 1987). These difficulties concern motion, among others, and are manifested in disturbances of motor fitness, particularly in the coordinational area.

The worse balance results in a group of persons with abnormal EEG records, shown in our own results, confirm in a certain sense the data contained

in literature (Rozelle and Budzynski 1995, Travis et al. 1996). The relation between EEG wave activity and sense of balance and coordination has been stated during the application of a neurological therapy in a patient and through physical exercises in healthy individuals.

Examination of coordinational abilities of children and teenagers carried out by Žak (1991) showed that the sense of balance achieved its maximum value for both sexes at the age of 14, whereas in the girls' group it was higher till the age of 12. In our own tests for joint age groups from 12-14 years girls obtained better results, which conforms with the earlier results of Raczek (1996).

The applied "flamingo balance" test requires the choice of a leg, on which the person stands, therefore at the same time it is a test which defines lateralization of the lower limbs. Lumaye's (1983) studies show that there are no significant differences in the lack of equilibrium depending on the dominant hand or leg. The author did not state any dimorphic differences in this range (exclusively qualitative analysis - R or L side). In our own studies dimorphic differences were statistically significant, however, they pertained to the time of maintaining balance, without taking in consideration which limb prevailed.

Some of the studies present asymmetry of alpha rhythm in the right and left hemisphere lobes depending on the type of stimulus affecting it and anatomical asymmetry of the brain structure which accompanies certain abilities (Galín and Ornstein 1972, Persinger and Richards 1994, Schlaug et al. 1995, Iwaki et al. 1997). This allows us to presume that application of somatosensory evoked potentials (SSEP) will enable the analysis of functions in the cortex centres connected with balance and tracts which convey impulses to them.

In the presented study the EEG record consisted in carrying impulses away from the cranium surface and did not reflect the full cortex function and its connections with subcortical structures, and yet the stated EEG abnormalities were accompanied by a lower sense of balance. Perhaps the examination of the parietal lobe, where changes are manifested in the disturbance of lateralization, will at least partially explain the complex problems of coordinational abilities (Warlow 1991).

Conclusions

1. Persons with abnormal EEG obtained a worse average in the “flamingo balance” test results than individuals in the same age group with normal EEG records.
2. Among those examined who had abnormal EEG records, the worse results were obtained by those whose record included waves with frequency of 4-7 Hz and slow delta waves. This confirms the fact that even the smallest brain dysfunctions affect the level of coordinational abilities.
3. The “flamingo balance” test results were better among the girls than in the boys group, irrespective of the normal or abnormal EEG record, which conforms with the course of ontogenetic development of balance.

REFERENCES

- Eurofit – European Test of Physical Fitness* 1988. Brussels.
- Galin D., Ornstein R. 1972. *Lateral Specialization of Cognitive Mode: An EEG Study* *Psychophysiology*, 9: 412-418.
- Gutnik B., Hyland B. 1997a. *Spatial coordination in a bimanual task related to regular switching of movement vectors*. *Perceptual & Motor Skills*, 84: 371-384.
- Gutnik B., Hyland B. 1997b. *Lateralized spatial strategies in oscillating drawing movements*. *Perceptual & Motor Skills*, 84: 435-451.
- Iwaki T., Hayashi M., Hori T. 1997. *Changes in alpha band EEG activity in the frontal area after stimulation with music of different affective content*. *Perceptual & Motor Skills*, 84: 515-526.
- Jahanshahi M., Ridding M.C., Limousin P., Profice P., Fogel W., Dressler D., Fuller R., Brown R.G., Brown P., Rothwell JC. 1997. *Rapid rate transcranial magnetic stimulation – a safety study*. *Electroencephalography & Clinical Neurophysiology*, 6: 422-429.
- Johannesson G., Gudmundsson G. 1988. *EEG and Dementia in Hereditary Cerebral Haemorrhage with Amyloidosis*. Pp. 66-74. (In:) Giannitrapani, Murri (eds.), *The EEG of Mental Activities*, Basel.
- Leong C.K. 1987. *Children with specific reading disabilities*. Amsterdam, Swets and Zeitlinger.

- Lumaye J. 1983. *Etude de l'influence de la dominance latérale sur l'équilibration examinée par le „Balance TV System”*. Rév. Educ. Phys., 23: 33-35.
- Persinger M.A., Richards P.M. 1994. *Quantitative electroencephalographic validation of left and right temporal lobe signs and indicators in normal people*. Perceptual & Motor Skills, 79: 1571-1578.
- Raczek J. 1992. *The problem of sensitive and critical periods in motor development*. Antropomotoryka, 7: 55-67.
- Raczek J. 1996. *Changes in motor fitness in the school population of upper Silesia 1965- 95*. In: Kovař (ed.), Sport Kinetics'95, Praha.
- Rozelle G.R., Budzynski T.H. 1995. *Neurotherapy for stroke rehabilitation: a single case study*. Biofeedback & Self Regulation, 20: 211-228.
- Schlaug G., Jancke L., Huang Y., Steinmetz H. 1995. *In vivo evidence of structural brain asymmetry in musicians (see comments)*. Science, 267: 699-701.
- Steinmetz H. 1992. *Structure, functional and cerebral asymmetry: in vivo morphometry of the planum tempotale*. Neuroscience & Biobehavioral Reviews, 20: 587-91.
- Travis F., Blasdel K., Liptak R., Zisman S., Daley K., Douillard J. 1996. *Invincible Athletics program: aerobic exercise and performance without strain*. International Journal of Neuroscience, 85: 301-308.
- Tyner F.S., Knott J.R., Mayer W.B.Jr. 1983. *Fundamentals of EEG Technology*. Vol. 1. Raven Press, New York.
- Viatleva O.A. 1991. *Osobennosti elektricheskikh reaktivnosti sensomotornoi kory na realnoe i myslennoe dvizhenie u levshoi i ambidekstroy s narusheniami rechi 6-7 let*. Zh. Nevropatol. Psikiatr. Im. S.S. Korsakova. 3: 68-71.
- Warlow CH. 1991. *Handbook of Neurology*. Oxford Blackwell Scientific Publications.
- Żak S. 1991. *Physical fitness and coordination abilities of children and youth living in a big city with regard to chosen somatic features and motor activity*. Monogr. Edit. Ac. Phys. Educ., Kraków, 43. (In Polish, Engl. Summ.).