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THE IMPACT OF A LOW INDUCTION MAGNETIC FIELD ON BRAIN WAVE RHYTHMS IN YOUNG WOMEN AND MEN WITH AND WITHOUT DISTURBANCES OF LOGICAL-MATHEMATICAL THINKING

S. Maria B. Pecyna[1(A,B,C,D,E,F)],
Bożena Grochmal-Bach[2(A,B,D,E F,G)]

[1] Department of Clinical Psychology, Faculty of Education, College of Management and Administration, Opole, Poland
[2] Institute of Applied Psychology, Jagiellonian University in Cracow, Cracow, Poland

SUMMARY

Background We studied the impact of a low induction magnetic field on alpha, beta, theta, SMR and delta brain wave rhythms, registered in RT mode by means of an expert system ProComp+/BioGraph V2.1 from the F^3-C^3 and F^4-C^4 leads.

Material/Methods: The research involved 70 women and 70 men aged 19-23 with and without manifest difficulties in solving logical-mathematical problems, divided into four groups of 35. The examinations were performed at the Psychophysiology Laboratory in Warsaw.

Results: Statistical analysis shows that, regardless of cerebral hemisphere, IQ and sex, low induction magnetic fields can be used to modify the amplitude values of particular brain wave rhythms in chosen directions, which means they can be used to increase the capacity of one or both cerebral hemispheres. These effects were not obtained with a placebo, which excludes a psychological factor being responsible for increasing the ability to make analytic-synthetic distinctions.

Conclusions: More specific interpretation of the results presented here requires longitudinal observation.

Key words: *cerebral asymmetry, learning impairments, psychophysiology*

INTRODUCTION

Psychophysiologists looking for the difference between sexes of the human brain do not claim that the smaller size of the female brain has an impact on mathematical-logical thinking, especially on its level characteristic for the pattern of the left hemisphere. However, the majority of them are convinced that female thinking differs significantly from the male's (Grabowska et al, 2001, Lewandowska 2001, Grabowska, 2004). These differences are supposed to be situated in sex hormones because the female brain, periodically stimulated by estrogens, progesterone or oxytocin – popularly called maternity love hormone (the lack of which leads to child's rejection), perceives the world a bit differently than the male brain, which is stimulated by testosterone. There is even a concept, originating from this theory, assuming the existence of two separate species: *homo estrogeniensis* and *homo testosteroniensis*, therefore Brizendine (2006) claims that there is no such a thing as *a brain without sex.* He finds these differences in the hypothalamus-pituitary gland relation, which is why a male's brain points towards homeostasis, whereas a female one is periodically modulated. The evidence for this difference, according to Landsell (1964) and Kimura (2006), may be the number of words uttered daily or internal demand for contact with the opposite sex. They have estimated the number of words uttered by a woman daily as 20,000, whereas a man is happy with only 7,000, but women think about sex only once a week, whereas men – every 58 seconds, i.e. minimum 850 times during a day.

Grabowska (2001, 2004), Landsell (1964) and Osborn et al (2004) explain these sex differences by means of line-of-sight spatial functions, which are located in both cerebral hemispheres of the female brain but in the male brain – only in the right one. This asymmetry, according to them, is responsible for a higher level of functioning. By contrast, women's hemispheres are less asymmetric but they are more efficiently connected so information travels faster from one hemisphere to another and, comparing to men's, female hemispheres cooperate better. As a result of these different connections, men actually confine to using only one hemisphere when analysing the problem from a few points in order to understand or to explain it, when they have to move about in space they think only with the right hemisphere. In other words, sex differences are mostly conditioned by anatomic structure of cerebral hemispheres and the degree of asymmetry to men disadvantage (this asymmetry results from a larger amount of grey matter). In women usually both hemispheres control the processes connected with task performing, whereas in men only one of them. It also appeared that in women, a brain centre responsible for language mechanisms is located in the frontal lobes, whereas in men it can be found both in the frontal lobes *and* in the occipital lobes. Owing to such anatomical and functional structure of the brain, women's brains, comparing to men's, represent better language skills such as grammar, orthography and phonetics because all verbal and visual functions are controlled by both hemispheres (their functions are scattered), whereas in men they are more specialised, and the right hemisphere is responsible for verbal activities and the left for visual ones. What is more, in women brain centres responsible for language mechanisms are concentrated in the front, whereas in the case of men, in the front and back of the left hemisphere.

Already in the 1960's Landsell (1968) discovered that damage done to the same areas of the brain has different results in both men and women. So, damaging the right hemisphere of the male brain resulted in profound loss of spatial orientation and language skills, whereas in women the same areas of damage caused only slight deterioration. It means, in psychophysiological interpretation, that female verbal and visual functions are controlled by both hemispheres (functions are scattered), but male ones are more specialized, hence their left hemisphere is responsible for visual functions, the right one for verbal functions.

Taking into account the process of coding the information, men organize it and store it to their memory, whereas women only contemplate the information so it comes back to them many times during the day and the only way to finish this contemplation is to share the information with another person. However, when a woman confides her problem to a man she does not expect a solution from him but she needs someone to listen to her. Obviously there are more such differences and they are far more complex, especially when considering the undeniable truth that 10% of women have a male type of brain and 15-20% of men have a brain shaped in female way, it means that a certain proportion of men and women are partially programmed for behaviour and thinking typical for the opposite sex (Szatkowska et al 2003, Ulatowska et al, 2003).

Recapitulating, it is possible to describe a type of cognitive functioning typical for each sex. So, according to Herman-Jeglińska (1999), the female pattern can be characterized by great language competence, smaller functional asymmetry of cerebral hemispheres in stimuli processing, both verbal and line-of-sight spatial functions, stronger preference of right hand and possibly better manual skills. By contrast, the male pattern – high mathematical skills and line-of-sight spatial functions, visible lateralization of verbal and nonverbal functions in the brain and a greater tendency for left-handedness. Obviously, full interpretation of these processes is multidimensional, therefore its competence lies also in the area of neurophysiology, neurobiology and even psychiatry, biochemistry, and it may also concern the molecular structure of the brain, so psychophisiologists are supposed here to become acquainted with the achievements of these sciences in order to compile the obtained knowledge into coherent and practically useful for psychophysiology concept.

In order to see the value of low induction magnetic fields in leveling of partially or entirely disturbed psychic functions differentiating the IQ level, depending on sex, the following question has been formulated:

What is a direction and trend, for young man and women with difficulty in memorizing and recalling mathematical formulas based on synthetic-analytic solution, for particular amplitudal values of five cerebral waves rhythms with a division into hemispheres and sex, registered in three different extreme situations: before an exposition to low induction magnetic fields (control research), after evoking placebo effect and after their real exposition?

The answer to this question, although on the present level of knowledge its character is only cognitive, may prove the relevance of the application of low induction magnetic fields in young men and women with logical and analytic reasoning problems, characteristic for the left hemisphere pattern.

DESCRIPTION OF THE EXAMINED GROUP AND THE RESEARCH METHODS

A group of 432 young people studying humanities have been differentiated into two groups; A (women) and B (men), by means of specially prepared by the authors for the sake of this research *Binomials and Trinomials Distribution Sheet,* with an instruction: “give a solution to the following problems”. There were 35 people in each group, aged 19-23, with difficulties in memorizing and recognition of signs and numbers in the process of analytic-synthetic thinking. For the purpose of comparison another two groups have been selected: C (women) and D (men) out of the Sciences Department. They were homogenous as far as age and number of people was concerned and did not report any logical-mathematical problems. In the statistical analysis they have been treated as reference groups. The sheet included the following tasks: $(a + b)^2$ =; $(a - b)^2$ =; $(a + b)^3$ =; $(a – b)^3$ =; $(a + b)^4$ =; $(a – b)^4$ =; $(a + b)^5$ =; $(a – b)^5$ =; $a^2 + b^2$ =; $a^2 – b^2$ =; $a^3 + b^3$ =; $a^3 – b^3$ =; $a^4 + b^4$ =; $a^4 – b^4$ =; $a^5 + b^5$ =; $a^5 – b^5$ =; $(a + b + c)^2$ =; $(a + b + c)^3$ = according to the following grading scale: correct solving binomial problem – 1 point, trinomial – 2 points. With a maximum score of 20 points, in groups A and B the score ranged from 2 to 7, in groups C and D – from 16 to 20. IQ of the selected groups was measured by means of TMZ test (Raven’s Progressive Matrices) – the advanced version (Jaworska et al, 1999) with the application of 20 min time pressure. In groups A and B the score ranged from 85-111, and in groups C and D from 126-135.

In further research procedure all the participants had their cerebral wave behaviour (alpha, beta, SMR, theta and delta) controlled six times by means of ProComp+/BioGraph V2.1 expert system produced by Thought Technology Ltd., equipped with functional meters and full computer analysis. Since the transition from analogue electroencephalographic recording to automatic quantitative analysis of the values of cerebral waves amplitude rhythms in a graphic form has become possible owing to sampling method taking into account the Fast Fourier Transform (FFT)[2] algorithm – with frequency: 256 samples per minute (this sampling frequency has been considered in Bio-

Graph V2.1 computer programme). In compliance with "10-20" arrangement instructions, recommended by the International Federation of Electroencephalography and Clinical Neurophysiology, cerebral activity described by wave rhythms: alpha (8-13 Hz), beta (15-20 Hz), theta (4-8 Hz), SMR (13-15 Hz) and delta (1-4 Hz) will be registered in RT (Real Time) mode from F_3 – C_3 lead (left hemisphere) and F_4 – C_4 (right hemisphere).

The recording was done to each hemisphere separately in three different experimental situations (before their exposition (control research), after evoking placebo effect and after five minutes since their actual exposition) connected with magnetic field exposure, generated by Viofor JPS magnetostimulator produced by Med&Life Polska. Generated magnetic fields had the following parameters:

- application with increasing intensity of the field in the sequence of the polarization switching for 2-6-6-2 for the programme using ionic cyclotronic resonance (P2),
- 12-minute magnetic fields exposition,
- four grade saltatory regulation of magnetic induction level from 0.5 to 6.

According to the laboratory experiment convention, in the second stage of research a placebo function was included, which allowed for the entire stimulation by magnetic fields because every examined person was convinced that his/her body had been exposed to these fields. The whole set of programmed tests was performed in controlled conditions in Psychophysiology Laboratory in Warsaw. In the statistic analysis not only were amplitude files taken into account, but also t-Student and Wilks' lambda values.

RESULTS AND DISCUSSION

According to laboratory experiment convention – six times (three times for each hemisphere), in each of 140 participants, belonging to one of four differentiated groups (A, B, C, D) cerebral wave rhythms were registered by the above-mentioned ProComp+/BioGraph expert system, in 390 seconds time each. Consistently with this convention, particular recordings have been performed in the following situations: before exposition to low induction magnetic fields (control research), after evoking placebo effect and after actual exposition to these fields.

In the comparative analysis between groups: A-B and C-D very interesting results have been observed which have been visualised in Tables: I-IV.

According to Table I, in comparative analysis, sex differences of the left hemisphere within the groups of men and women with average IQ, have been observed in beta wave rhythms on the 0.05 (t=2.01) level to men advantage and SMR wave rhythms on $p<0.01$ (t=3.49) to significant women advantage, which in psychophisiological interpretation means that the examined men were more concentrated on external consciousness, whereas women showed statistically essential higher memory capacity.

In the same groups, interesting differences have also been observed in the right hemisphere (com. Table II)

Looking for psychophisiological sex differences in right hemispheres (com. Table II) a level of 0.01 in alpha waves was found (t=3,02) with women advantage, and theta waves (t=3.69) with men disadvantage and with a slightly lower significance in SMR wave rhythms (t=2.19, p<0.05) with women advantage. Therefore, we can think about the right hemisphere advantage in women referring to **their/its** maturity, better relaxation ability and information coding and also innate tendency to positive thinking, relaxation, creative inspiration and better acquisition of learned material, extrasensory perception supporting visualization and imagination and the need for peace and relaxation (because alpha rhythm, above all, triggers meditation and sleepiness), which is why women often prefer meditation and a short-term sleep.

Table 1. Comparison of averaged mean values of cerebral wave rhythms amplitudes (alpha, beta, theta and delta) registered in groups A and B from T^3–C^3 lead before the exposition to low induction magnetic fields

Variables	$\overline{x}$	SD	Result	SD of the Result	t	p
Alfa Alp	3.65	1.63				
Alfa BLp	4.31	1.44	0.66	0.19	0.97	n.i.
Beta AlLp	5.49	1.95				
Beta BLp	9.23	2.52	3.74	0.57	2.01	0.05
SMR ALp	8.72	4.99				
SMR BLp	2.48	2.38	6.24	2.61	3.49	0.01
Theta ALp	16.36	6.40				
Theta BLp	14.42	5.18	1.94	1.22	1.01	n.i.
Delta ALp	4.49	1.83				
Delta BLp	5.42	2.01	0.93	0.18	1.07	n.i.

Legend:
Alfa ALp – Alpha wave rhythm of left hemispheres registered in group A before exposition to low induction magnetic field.
Alfa BLp – Alpha wave rhythm of left hemispheres registered in group B before exposition to low induction magnetic field.
Beta ALp - Beta wave rhythm of left hemispheres registered in group A before exposition to low induction magnetic field.
Beta BLp – Beta wave rhythm of left hemispheres registered in group B before exposition to low induction magnetic field.
SMR ALp – SMR wave rhythm of left hemispheres registered in group A before exposition to low induction magnetic field.
SMR BLp – SMR wave rhythm of left hemispheres registered in group B before exposition to low induction magnetic field.
Theta ALp – Theta wave rhythm of left hemispheres registered in group A before exposition to low induction magnetic field.
Theta ALp – Theta wave rhythm of left hemispheres registered in group B before exposition to low induction magnetic field.
Delta ALp – Delta wave rhythm of left hemispheres registered in group A before exposition to low induction magnetic field.
Delta BLp – Delta wave rhythm of left hemispheres registered in group B before exposition to low induction magnetic field.

Table 2. Comparison of averaged mean values of cerebral wave rhythms amplitudes (alpha, beta, theta and delta) registered in groups A and B from T^4–C^4 lead before the exposition to low induction magnetic fields

Variables	$\bar{x}$	SD	Result	SD of the result	t	P
Alfa APp	7.83	3.39				
Alfa BPp	3.47	1.33	4.36	2.06	3.02	0.01
Beta App	4.29	1.85				
Beta BPp	3.43	1.98	0.86	0.13	1.02	n.i.
SMR App	5.27	3.02				
SMR BPp	2.11	1.04	3.16	1.98	2.19	0.05
Theta App	11.27	7.26				
Theta BPp	16.34	9.19	5.07	1.93	3.69	0.01
Delta APp	9.42	4.67				
Delta BPp	11.27	8.83	1.85	4.16	1.08	n.i.

Legend:
Alfa APp – Alpha wave rhythm of right hemispheres registered in group A before exposition to low induction magnetic field.
Alfa BP_p – Alpha wave rhythm of right hemispheres registered in group B before exposition to low induction magnetic field.
Beta APp - Beta wave rhythm of right hemispheres registered in group A before exposition to low induction magnetic field.
Beta BPp – Beta wave rhythm of right hemispheres registered in group B before exposition to low induction magnetic field.
SMR APp – SMR wave rhythm of right hemispheres registered in group A before exposition to low induction magnetic field.
SMR BPp – SMR wave rhythm of right hemispheres registered in group B before exposition to low induction magnetic field.
Theta APp – Theta wave rhythm of right hemispheres registered in group A before exposition to low induction magnetic field.
Theta BPp – Theta wave rhythm of right hemispheres registered in group B before exposition to low induction magnetic field.
Delta APp – Delta wave rhythm of right hemispheres registered in group A before exposition to low induction magnetic field.
Delta BPp – Delta wave rhythm of right hemispheres registered in group B before exposition to low induction magnetic field.

To exclude psychic factor modifying these magnetic fields influence on the behaviour of cerebral waves' rhythms, differentiated in the research, before their application psychological *placebo* effect has been used. After a 12-minute simulated exposition to magnetic fields cerebral wave rhythm has been controlled again by the above-mentioned ProComp+/BioGraph expert system. The obtained sex differences, with a division into hemispheres, have been specifically presented in Tables III and IV.

According to Tables III and IV, the introduced placebo effect slightly modified the values of registered wave rhythms however, these differences were not statistically essential when considering both hemispheres of both men and women. So this intervention of the psyche was not an element determining the desired therapeutic effect characteristic for the physiological picture of the controlling of the correctness of reasoning pictured in the terms drawn from mathematics, especially from algebra. Interesting results have

Table 3. Comparison of averaged mean values of cerebral wave rhythms amplitudes (alpha, beta, theta and delta) registered in groups A and B from T^3–C^3 lead after evoking placebo effect

Variables	$\overline{x}$	SD	Result	SD of the result	T	p
Alfa ALx	4.89	2.03				
Alfa BLx	4.35	1.84	0.54	0.19	0.32	n.i.
Beta Alx	7.09	4.28				
Beta BLx	9.71	3.52	2.62	0.76	1.23	n.i.
SMR ALx	9.32	7.53				
SMR BLx	4.16	4.72	5.16	2.81	2.09	0.05
Theta ALx	17.30	6.53				
Theta BLx	14.47	8.08	2.83	1.55	1.84	n.i.
Delta ALx	3.56	1.89				
Delta BLx	4.38	2.22	0.82	0.33	0.47	n.i.

Legend
Alfa ALx – Alpha wave rhythm of left hemispheres registered in group A after evoking placebo effect.
Alfa BLx – Alpha wave rhythm of left hemispheres registered in group B after evoking placebo effect.
Beta ALx - Beta wave rhythm of left hemispheres registered in group A after evoking placebo effect.
Beta BLx – Beta wave rhythm of left hemispheres registered in group B after evoking placebo effect.
SMR ALx – SMR wave rhythm of left hemispheres registered in group A after evoking placebo effect.
SMR BLx – SMR wave rhythm of left hemispheres registered in group B after evoking placebo effect.
Theta ALx – Theta wave rhythm of left hemispheres registered in group A after evoking placebo effect.
Theta ALx – Theta wave rhythm of left hemispheres registered in group B after evoking placebo effect.
Delta ALx – Delta wave rhythm of left hemispheres registered in group A after evoking placebo effect.
Delta BLx – Delta wave rhythm of left hemispheres registered in group B after evoking placebo effect.

Table 4. Comparison of averaged mean values of cerebral wave rhythms amplitudes (alpha, beta, theta and delta) registered in groups A and B from T^4–C^4 lead after evoking placebo effect

Variables	$\overline{x}$	SD	Result	SD of the result	t	P
Alfa PAX	6.45	3.43				
Alfa BPx	3.92	1.48	2.53	1.95	1.92	n.i.
Beta PAx	7.53	4.15				
Beta BPx	5.67	3.92	1.86	0.23	0.99	n.i.
SMR PAx	7.35	4.62				
SMR BPx	4.32	1.53	3.03	3.09	1.97	0.05
Theta APx		7.86				
Theta BPx	14.63	11.91	2.05	4.05	2.16	0.05
Delta APx	11.84	8.07				
Delta BPx	10.21	7.13	1.63	0.94	1.83	n.i.

Legend
Alfa ALx – Alpha wave rhythm of right hemispheres registered in group A after evoking placebo effect.
Alfa BPx – Alpha wave rhythm of right hemispheres registered in group B after evoking placebo effect.
Beta APx - Beta wave rhythm of right hemispheres registered in group A after evoking placebo effect.
Beta BPx – Beta wave rhythm of right hemispheres registered in group B after evoking placebo effect.
SMR APx – SMR wave rhythm of right hemispheres registered in group A after evoking placebo effect.
SMR BPx – SMR wave rhythm of right hemispheres registered in group B after evoking placebo effect.
Theta APx – Theta wave rhythm of right hemispheres registered in group A after evoking placebo effect.
Theta APx – Theta wave rhythm of right hemispheres registered in group B after evoking placebo effect.
Delta APx – Delta wave rhythm of right hemispheres registered in group A after evoking placebo effect.
Delta BPx – Delta wave rhythm of right hemispheres registered in group B after evoking placebo effect.

Table 5. Comparison of averaged mean values of cerebral wave rhythms amplitudes (alpha, beta, theta and delta) registered in groups A and B from T^3–C^3 lead after exposition to low induction magnetic fields

Variables	$\overline{x}$	SD	Result	SD of the result	t	p
Alfa ALm	9.83	4.26				
Alfa BLm	6.54	3.35	3.29	0.91	1.99	0.05
Beta ALm	9.86	4.79				
Beta BLm	11.49	8.02	1.63	3.23	0.51	n.i.
SMR ALm	7.31	4.53				
SMR BLm	8.74	4.90	1.43	0.37	0.39	n.i.
Theta ALm	11.80	8.46				
Theta BLm	14.07	9.72	2.27	3.26	2.08	0.05
Delta ALm	9.23	6.59				
Delta BLm	5.58	3.80	3.65	2.79	2.43	0.05

Legend
Alfa ALm – Alpha wave rhythm of left hemispheres registered in group A after exposition to low induction magnetic field.
Alfa BLm – Alpha wave rhythm of left hemispheres registered in group B after exposition to low induction magnetic field.
Beta ALm - Beta wave rhythm of left hemispheres registered in group A after exposition to low induction magnetic field.
Beta BLm – Beta wave rhythm of left hemispheres registered in group B after exposition to low induction magnetic field.
SMR ALm – SMR wave rhythm of left hemispheres registered in group A after exposition to low induction magnetic field.
SMR BLm – SMR wave rhythm of left hemispheres registered in group B after exposition to low induction magnetic field.
Theta ALm – Theta wave rhythm of left hemispheres registered in group A after exposition to low induction magnetic field.
Theta ALm – Theta wave rhythm of left hemispheres registered in group B after exposition to low induction magnetic field.
Delta ALm – Delta wave rhythm of left hemispheres registered in group A after exposition to low induction magnetic field.
Delta BLm – Delta wave rhythm of left hemispheres registered in group B after exposition to low induction magnetic field.

been observed after the real application of low induction magnetic fields (com. Tables V and VI).

Although the research environment was the same, the obtained picture of sex differences was completely different for the left hemisphere (com. Table V) after it had been activated by low induction magnetic fields. The differences have been observed on 0.05 level in three wave rhythms: alpha (t=1.99) and delta (t=2.43) to women advantage and theta (t=2.08) – to men advantage. Right hemispheres wave rhythms (comp. Table VI) reacted similarly to the application of these fields, additional differences also appeared on the same level in beta wave rhythms (t=2.09).

The quoted results confirmed the opinion that beta and SMR wave rhythms, which describe the ability to concentrate and memory capacity level, are responsible for the ability level to memorize and recognize numbers in logical-analytic reasoning. Moreover, the observed intergroup statistic essen-

Table 6. Comparison of averaged mean values of cerebral wave rhythms amplitudes (alpha, beta, theta and delta) registered in groups A and B from T^4–C^4 lead after exposition to low induction magnetic fields

Variables	$\overline{x}$	SD	Result	SD of the result	t	p
Alfa APm	9.05	5.67				
Alfa BPm	5.21	3.24	3.84	2.43	2.31	0.05
Beta APm	6.49	4.81				
Beta BPm	9.54	6.79	3.05	1.98	2.09	0.05
SMR APm	10.23	6.02				
SMR BPm	9.84	8.53	0.39	2.51	0.17	n.i.
Theta APm	13.99	9.06				
Theta BPm	11.66	8.22	2.33	0.84	1.95	n.i.
Delta APm	13.84	9.61				
Delta BPm	9.42	5.29	4.22	4.32	3.03	0.01

Legend
Alfa ALm – Alpha wave rhythm of right hemispheres registered in group A after exposition to low induction magnetic field.
Alfa BLm – Alpha wave rhythm of right hemispheres registered in group B after exposition to low induction magnetic field.
Beta ALm - Beta wave rhythm of right hemispheres registered in group A after exposition to low induction magnetic field.
Beta BLm – Beta wave rhythm of right hemispheres registered in group B after exposition to low induction magnetic field.
SMR ALm – SMR wave rhythm of right hemispheres registered in group A after exposition to low induction magnetic field.
SMR BLm – SMR wave rhythm of right hemispheres registered in group B after exposition to low induction magnetic field.
Theta ALm – Theta wave rhythm of right hemispheres registered in group A after exposition to low induction magnetic field.
Theta ALm – Theta wave rhythm of right hemispheres registered in group B after exposition to low induction magnetic field.
Delta ALm – Delta wave rhythm of right hemispheres registered in group A after exposition to low induction magnetic field.
Delta BLm – Delta wave rhythm of right hemispheres registered in group B after exposition to low induction magnetic field.

tiality of the differences confirmed their correct selection by means of the same, properly matched, Binomials and Trinomials Distribution Sheet, prepared by the authors for the sake of this research.

Generally, all the analyzed amplitudes values of differentiated cerebral wave rhythms were much higher at 0.001, and in the case of alpha, beta and SMR waves they reached even 20, and 30 in case of SMR – μV after exposition to low induction magnetic field.

Summing up, the obtained sex differences concerning one's sensitivity to magnetic fields were correlated with intelligence level. In men the cerebral wave rhythms' amplitudes values, at p<0.01), were higher in all analysed amplitudes when comparing to women. It means that their mental patterns were more mature and presented a higher tendency to relaxation and meditation (alpha waves), significantly increased attention concentration correlated with a stronger need for active thinking (beta waves) and memory capacity (SMR rhythm) and more creative thinking (theta waves) with a lack of deepened meditation (delta waves).

When looking for the features the most strongly discriminating the examined cerebral wave amplitudes values obtained in groups A & B and C & D, in further statistic analysis Wilks' lambda method was applied. As a result of these analyses it appeared that among 120 variables, the factors discriminating the four examined groups before their exposition to low induction magnetic fields (p), after evoking placebo effect (x) and after 12-minute exposition to them (m), turned out to be:

I. Variant

Factors		Wilks' lambda statistics value
I	II	
SMR DLm	Theta CLm	0.0864923
Alpha CPm	SMR APx	0.0836104
Beta BLp	Theta DPm	0.0795206
Alpha BPm	Delta CLm	0.0587689
SMR DLp	Beta CPm	0.0460165
Theta APx	SMR BLp	0.0373891
Delta CLm	Alpha DLp	0.0221487

When SMR DLm factor, the most strongly discriminating the examined groups, has been forced out from the above mentioned set, the following specification has been observed:

II. Variant

Factors		Wilks' lambda statistics value
I	II	
Delta CPx	Theta DLp	0.3482132
Theta BLp	Alpha APx	0.3102843
Beta CPx	Theta BPm	0.2858210
Alpha ALx	SMR APp	0.2519165
Beta DLp	Delta APm	0.2173104
Delta ALx	SMR BPx	0.1945017
Alpha BPp	Theta CLm	0.1631865

Taking Variant I into account, the most differentiating factors turned out to be SMR and Theta wave rhythms of left hemispheres observed in groups C and D. This rhythm in the learning process constitutes an essential basis for collecting knowledge about the surrounding world and man himself, is also called *sensory information store* or/and *sensory memory* (Thansey 1984, Pecyna 2001a, 2001b, 2002a, 2002b). Subsequently, theta wave rhythm occupied the second position, it may function in only one dimension of deepened meditation level, whereas in full consciousness it gives a possibility of physiological alleviation of physical pain and it supports the growth of proficiency and efficiency of psycho- and immunological system functioning and at the same time it inhibits the ageing processes.

As quoted above, the most discriminating values of cerebral wave rhythms confirmed the hitherto prevailing observational data that low frequency and low induction fields support and accelerate the activity of both hemispheres, and especially the left hemispheres of the examined men and women with high IQ of generalizing psychophysiological fragmentary phenomena (Pecyna 2002c, 2004).

As a result of these different connections, men actually confine to using only one hemisphere when analysing the problem from a few points in order to understand or to explain it, when they have to move about in space they think only with right hemisphere. In other words, sex differences are mostly conditioned by anatomic structure of cerebral hemispheres and the degree of asymmetry to men disadvantage (this asymmetry results from greater amount of grey matter). In women both hemispheres usually control the processes connected with task performing, whereas in men, only one of them. It also appeared that in women, a brain centre responsible for language mechanisms is located in the frontal lobes, in men it can be found in both the frontal lobes and in the occipital lobes. Owing to such anatomical and functional structure of the brain, women's brains, comparing to men's, represent better language skills such as grammar, orthography and phonetics because all verbal and visual functions are controlled by both hemispheres (their functions are scattered), whereas in men they are more specialised, and the right hemisphere is responsible for verbal activities and the left for visual ones. What is more, in women brain centres responsible for language mechanisms are concentrated in the front, whereas in men, in the front and back of the left hemisphere (Pecyna 2006).

The obtained results may be interpreted by means of microgenetic theory of brain function (Brown 2004; Brown and Pąchalska 2003; MacQueen et al 2004), because short functional characteristics describing a differentiated activity and at the same time mutual complementation of cerebral hemispheres, fully confirms the essentiality of undertaken research in the context of the recognition of the behaviour of their wave rhythms values – alpha, beta, SMR, theta and delta after exposition low induction magnetic fields.

CONCLUSIONS

It may be concluded that:

- the attempts to release the ability of logical-mathematical thinking and signs and numbers recognition by means of low induction magnetic fields have cognitive value because the regularities observed here have a real position in bioelectric signals of the hemispheres which have been presented by five cerebral wave-rhythms.

- these fields have an ability to modify the amplitude values of particular cerebral wave rhythms in the directions intended by the researcher, which means that they can be used for increasing of the functioning of one or/and two cerebral hemispheres.
- these relationships have not been obtained after evoking placebo effect which automatically excludes psychic factor modifying the degree of the ability to intensify analytic-synthetic thinking.

The obtained encouraging results seem to be important premises for the amendment of contemporary methods of psychotherapy of young women and men with problems with logical analysis and maths formulas synthesis, and at the same time they may be helpful for improving the quality and amount of fast acquisition of new information.

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Correspondence address:
S. Maria B. Pecyna
Wydział Pedagogiczny Wyższej Szkoły Zarządzania i Administracji
w Opolu, Zakład Psychologii Klinicznej
ul. Ozimska 63,
45-368 Opole, Poland
Tel. (0-77) 402-16-00; fax.(0-77) 402-16-02
e-mail: sje@o2.pl