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# INFLUENCE OF EEG RHYTHMS ON EXTRAVERSION-INTROVERSION INDICATORS AND SMILES TEST

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## Abstract

**Urgency.** Currently, the diagnosis of personality disorders is subjective and depends on the classifications used, the choice of the diagnostic method. **The objective:** to establish the probable regulatory effects of the functional state of the central nervous system according to electroencephalographic research (EEG) data in healthy individuals in providing individual psychological traits (features) of the personality, determined using Eysenck's and SMIL tests, using multivariate analysis - by methods of multiple regression and correlation analysis in extroverts and introverts, in order to diagnose the norm. **Materials and methods.** The psychological methods of G. Eysenck (EPI) and SMIL were carried out in electronic form and had a standard form. EEG was studied on 48 practically healthy people, students, average age 20 ± 0.5 years for 2 minutes in a state of psychosensory rest - eyes closed. The analysis of EEG files was carried out after the end of the experiments using the "Analist2" program. EEG segmentation was performed using the method of fixed intervals. The indicators of the EPI and SMIL tests were considered as the target feature (Y-s), and the indicators of the amplitudes of the EEG rhythms were considered as influencing variables (sets of X-s) and the equations of multiple linear regression were built. **Results.** It was shown that, in both extroverts and introverts, during periods of desynchronization, the number of statistically

significant regression coefficients from the amplitudes of EEG rhythms to the indicators of Eysenck and SMIL tests was determined to be greater than during periods of synchronization.

The greatest number of regression connections-relationships in **extroverts** under conditions of **desynchronization** was determined by the indicator "psychopathy", and in introverts the influence from EEG indicators along all six channels was determined by the indicators "extro-introversion" and "depression". The greatest number of regression relationships-relationships among extroverts under synchronization conditions was determined by the indicator "psychopathy", and among introverts the relationships-relationships from EEG indicators to indicators of psychological tests were evenly distributed in the amount of 2-3.

**Conclusions**. 1. In extraverts, the number of regression relationships-relations from the EEG amplitude indicators to the indicators of Eysenck's and SMIL tests was determined to be greater than in introverts. This indicates that in extraverts the formation of individual-typological personality traits to a greater extent than in introverts depends on neurophysiological mechanisms. 2. The realization of mental acts and states, verified by the indicators of the EPI and SMIL tests, is carried out mainly during periods of desynchronization. It can be assumed that periods of desynchronization, to some extent, reflect episodes of consciousness, and periods of synchronization are episodes of the unconscious. 3. The beta-2 rhythm indicator is an actual control element in the formation of individual-typological personality traits in extroverts. 4. The theta rhythm indicator is a fairly relevant control element in the formation of individual-typological personality traits in both extroverts and introverts.

**Key words: electroencephalogram; multiple linear regression; polycyclic multigraph; synchronization and desynchronization of EEG rhythms; indicators of psychological tests.**

**Introduction.** Currently, the diagnosis of personality disorders is subjective and depends on the classifications used (DSM-IV-TR, ICD-10, etc.), the choice of the diagnostic method (clinical interviewing, various tests) [5]. The prevalence of personality disorders in the population is in the range of 10-12% [5, 17].

According to modern concepts, a person’s personality is on average 50% determined by genetic factors [10]. The remaining 50%, according to G.G. Knyazev [4], depends on the neurophysiological and neurochemical processes by which these factors are realized [18].

This determines the importance of deciphering the neurophysiological and neurochemical mechanisms underlying the personality.

Comparison of the psychological characteristics of the subjects with their physiological characteristics, in addition to the theoretical value, has practical application, as it allows to develop methods for the objective diagnosis of mental disorders in the borderline between normal state and disease [10, 12].

We (6) used the methods of multiple regression and correlation analysis, as well as two-dimensional correlation analysis to study the connections-relations between the amplitudes of EEG rhythms and the scores of Eysenck and SMIL tests in right-handed and left-handed persons.

However, there is a number of approaches to the typology of people based on psychological and psychophysiological characteristics [1]. One of the most frequently used and physiologically grounded concepts is the so-called two-factor personality model developed by the English psychologist Eysenck [13]. According to this concept, among the personal characteristics there are two basic parameters - the level of neuroticism and extra/introversion. The first of them characterizes the emotional mobility of an individual and is largely determined by a greater or lesser degree of activation of the emotiogenic structures of the brain, in particular the amygdala [16].

The second parameter in the psychological aspect characterizes the orientation of the individual to receive information from the outside world (extraverts) or the preference of internal processes associated with imagination and reflection (introverts) [13]. In the physiological aspect, this characteristic correlates primarily with the level of activation of the ascending activating system of the brain [15].

**The aim** of the study is to establish the possible regulatory effects of the functional state of the CNS according to electroencephalographic research (EEG) in healthy individuals in providing individual psychological traits (characteristics) of a person, determined with Eysenck and SMIL tests, using multidimensional analysis – using methods of multiple regression and correlation analysis in extroverts and introverts.

**Research methods.** EEG was studied on 48 practically healthy people, students, average age 20 ± 0.5 years. EEG recording on a computer hard disk was performed using an analog-digital converter at a sampling frequency of 256 per second for 2 minutes in a state of psycho-sensory rest (PR) - the eyes are closed. EEGs were recorded bipolarly in the following leads: 1-forehead-temple (F-T), 2-temple-sinciput (T-S), 3-sinciput-occiput (S-O), left and right, with a time constant value of 0.1 sec. The analysis of EEG files was carried out after the

end of the experiments using the “Analist2” program according to the algorithm of amplitude-interval (half-period) analysis. Five physiological rhythms were distinguished: beta-2 - 21-32 Hz, beta -1 - 14.22-18.3 Hz, alpha - 8.0-12.8 Hz, theta - 4-7.53 Hz and delta - 0 5-3.87 Hz. For each of the ranges, the following parameters were determined: 1) amplitude in microvolts, 2) frequency in hertz, 3) time index in percent. During statistical analysis average values, standard (average quadratic) deviation and the error of the average value were calculated.

Segmentation was performed using method of fixed intervals [3] based on the following order of procedures: half-period analysis of fixed short epochs (fragments of recordings) of EEG of 2 sec long – classification of these epochs using cluster analysis and performing algorithm of k-average, as a result 2 clusters were distinguished – statistical analysis of EEG indicators, corresponding to these clusters. During statistical analysis of EEG fragments indicators, which got into one cluster, average value of parameters, standard deviation and average value errors were calculated for these fragments.

Psychological techniques were carried out in electronic form and had a standard form. For the study of the individual psychological characteristics of the personality, the following methods were used: Personal Questionnaire by H. Eysenck (EPI) and SMIL (9).

Indicators of EPI and SMIL tests were considered as a target trait (Y), and the EEG rhythm amplitude indices were considered as influencing variables (X set) and the equations of multiple linear regression were constructed:

$Y_1 = a_0 + b_1X_1 + b_2X_{2\ldots} + b_nX_n$

where $a_0$ is intercept term, the coefficients $b_1$, $b_2$ ..., $b_n$ are regression indicators reflecting the measure of influence on the analyzed indicator of the remaining elements of the set $x_1$, $x_2$ ..., $x_n$ indicators.

The probability of influence, i.e. the adequacy of the regression coefficients was assessed using sigma deviations of the regression coefficients, and the effectiveness of the regression in whole was evaluated by calculating the multiple correlation coefficient [7].

Geometrically, multiple linear regression equations were interpreted using graphs trees [2].

Because of the procedure outlined, a mathematical model is formed, which allows the use of methods and categories of control theory when analyzing data.

**Original research.** In multiple regression analysis under desynchronization conditions, the largest number of connections-relations with the EEG amplitude indices (Table 1) were determined by the Eysenck and SMIL tests scores in the sinciput-occiput in left (23 for extraverts and 21 for introverts) and right (21 and 17 respectively) hemispheres.

Table 1

Statistically significant regression coefficients
reflecting the influence of EEG indicators on the Eysenck and SMIL tests scores

| Leads | Extraverts | | Introverts | |
|---|---|---|---|---|
| | Desynchronization | Synchronization | Desynchronization | Synchronization |
| Right hemisphere | | | | |
| Forehead-temple | 10 | 6 | 7 | 1 |
| Temple-sinciput | 16 | 8 | 9 | 0 |
| Sinciput-occiput | 21 | 5 | 17 | 11 |
| Total | 47 | 19 | 33 | 12 |
| Left hemisphere | | | | |
| Forehead-temple | 12 | 5 | 11 | 5 |
| Temple-sinciput | 15 | 1 | 14 | 1 |
| Sinciput-occiput | 23 | 5 | 21 | 8 |
| Total | 50 | 11 | 46 | 14 |
| Total sum | 97 | 30 | 79 | 26 |

Both in extraverts and introverts, during periods of desynchronization, more regressive connections-relations were determined in all leads than in periods of synchronization.

**Extraverts, desynchronization.** In total, in terms of desynchronization in extraverts 97 regression connections-relations from EEG indicators to test scores were determined. The greatest number of regression connections-relations in extraverts in terms of desynchronization were determined to the indicator “psychopathic deviance” - 14 (Table 2). From the amplitudes’ values of the beta-1 rhythm to the indicator “paranoia” four positive regressive connections-relations were determined, and from the amplitudes of other rhythms – there were 1-2. There were determined five negative regressive connections-relations from theta rhythm amplitude indicator to the “schizophrenia” score.

There were determined 12 regressive connections-relations to the indicator of extra/introversion, five of them were negative influences from the beta-2 rhythm indicator. By the neurotic indicator, only 4 regressive relations-relationships were determined (Table 2).

In the forehead-temple lead on the right, the largest number of regressive connections-relations to test scores was determined from the delta rhythm rate and they were positive. In the lead temple-sinciput of the right hemisphere, the largest number of regressive connections-relations was observed from the indicators of beta-2 (positive) and theta rhythm

(negative). In the lead sinciput-occiput of the right hemisphere the largest number of connections-relations was determined by the indicators of tests from the delta rhythm indicator — six negative influences and the theta rhythm indicator — five negative influences.

Table 2

Statistically significant regression coefficients oriented from the amplitudes of EEG rhythms to the indicators of psychological tests in extroverts in terms of desynchronization

| Tests scores | BETA-2 | | BETA-1 | | ALPHA | | TETHA | | DELTA | | ***SUM*** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | «–» | «+» | «–» | «+» | «–» | «+» | «–» | «+» | «–» | «+» | |
| Extra/introversion | 5 | 1 | 0 | 0 | 1 | 3 | 0 | 2 | 0 | 0 | 12 |
| Neuroticism | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 4 |
| Hypochondriasis | 0 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 5 |
| Depression | 0 | 1 | 1 | 2 | 0 | 1 | 1 | 0 | 1 | 0 | 7 |
| Hysteria | 1 | 3 | 0 | 1 | 1 | 2 | 1 | 0 | 2 | 0 | 11 |
| Psychopatic Deviance | 1 | 1 | 0 | 3 | 0 | 2 | 5 | 0 | 2 | 0 | 14 |
| Paranoia | 0 | 1 | 0 | 4 | 0 | 2 | 2 | 1 | 1 | 2 | 13 |
| Psychasthenia | 1 | 3 | 0 | 3 | 0 | 2 | 2 | 0 | 1 | 0 | 12 |
| Schizophrenia | 0 | 2 | 0 | 2 | 0 | 1 | 5 | 0 | 2 | 0 | 12 |
| Hypomania | 0 | 2 | 0 | 0 | 1 | 1 | 3 | 0 | 0 | 0 | 7 |
| ***Sum*** | 9 | 15 | 3 | 16 | 3 | 15 | 20 | 3 | 10 | 2 | 97 |
| **Total** | | 24 | | 19 | | 18 | | 23 | | 13 | |

When analyzing the characteristics of the orientation of the EEG rhythms indicators to the test indicators in desynchronization conditions, it draws attention to the extraversion/introversion indicator for all six channels, the effects from the beta-2 rhythm were determined, while influence in sinciput-occiput was positive, and in the other leads – negative. To the indicator of “psychasthenia,” the preferential influence of the theta and delta rhythms of the EEG was determined. It can also be noted that to the indicators “extraversion/introversion”, “hysteria”, “paranoia”, “psychasthenia”, “schizophrenia” the effects were determined from all EEG leads.

**Extraverts, synchronization.** In total, under the conditions of synchronization in extraverts from EEG indicators to test scores 30 regressive connections-relations were determined (Table 1).

From the EEG indicators of the right hemisphere, 19 regressive connections-relations were determined, and 11 from the left.

The greatest number of connections-relations from EEG indicators was determined to the scores of “psychopathy” – 14, “paranoia” – 13, “extra/introversion”, “psychasthenia” and “schizophrenia” – 12 to each (Table 3). The largest number of regressive connections-relations was determined from the EEG beta-2 rhythm, mostly positive and theta rhythm, mostly negative (Table 3).

When analyzing the characteristics of the orientation of the EEG rhythms indicators to the tests scores under synchronization conditions, it draws attention that the influence of EEG rhythms on the indicator “psychopathy” was determined in five channels, while the other indicators of the tests scores were determined in 2-4 channels.

Table 3

Statistically significant regression coefficients oriented from the amplitudes of EEG rhythms to the indicators of psychological tests in extraverts in synchronization terms

| Tests scores | BETA-2 | | BETA-1 | | ALPHA | | TETHA | | DELTA | | ***SUM*** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | «–» | «+» | «–» | «+» | «–» | «+» | «–» | «+» | «–» | «+» | |
| Extra/introversion | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 2 |
| Neuroticism | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 2 |
| Hypochondriasis | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 3 |
| Depression | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Hysteria | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 4 |
| Psychopatic Deviance | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 4 |
| Paranoia | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 3 |
| Psychasthenia | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 3 | 0 | 5 |
| Schizophrenia | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 2 | 0 | 0 | 4 |
| Hypomania | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 3 |
| **Sum** | 1 | 5 | 3 | 1 | 2 | 4 | 2 | 7 | 3 | 1 | 30 |
| **Total** | | 6 | | 4 | | 6 | | 9 | | 4 | |

**Introverts, desynchronization.** Under the conditions of desynchronization, introverts from EEG indicators to test indicators determined 79 regressive connections-relations, and 46 regressive connections-relations were determined from the left hemisphere, and 33 from the right hemisphere. The largest number of connections-relations from EEG indicators was determined to the indicator “schizophrenia” – 11. The largest number of regressive connections-relations was determined from the EEG alpha rhythm indicators, mostly negative and from theta rhythm, mostly positive (Table 4).

In introverts, the effects of EEG indices across all six channels were determined by the indices of “extra/introversion" and "depression".

Table 4

Statistically significant regression coefficients oriented from the amplitudes of EEG rhythms to the indicators of psychological tests in introverts in terms of desynchronization

| Tests scores | BETA-2 | | BETA-1 | | ALPHA | | TETHA | | DELTA | | ***SUM*** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | «–» | «+» | «–» | «+» | «–» | «+» | «–» | «+» | «–» | «+» | |
| Extra/introversion | 4 | 0 | 1 | 0 | 1 | 0 | 2 | 0 | 1 | 0 | 9 |
| Neuroticism | 0 | 1 | 0 | 3 | 0 | 0 | 0 | 2 | 0 | 1 | 7 |
| Hypochondriasis | 0 | 3 | 0 | 1 | 3 | 0 | 0 | 0 | 2 | 0 | 9 |
| Depression | 0 | 0 | 2 | 0 | 0 | 0 | 2 | 3 | 0 | 0 | 7 |
| Hysteria | 0 | 0 | 0 | 0 | 3 | 0 | 2 | 2 | 2 | 0 | 9 |
| Psychopatic Deviance | 0 | 0 | 1 | 0 | 3 | 0 | 2 | 1 | 1 | 0 | 8 |
| Paranoia | 0 | 3 | 1 | 1 | 3 | 0 | 0 | 0 | 1 | 0 | 9 |
| Psychasthenia | 0 | 2 | 1 | 0 | 3 | 0 | 0 | 2 | 0 | 0 | 8 |
| Schizophrenia | 0 | 1 | 1 | 1 | 3 | 1 | 1 | 2 | 1 | 0 | 11 |
| Hypomania | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| Sum | 4 | 11 | 8 | 6 | 19 | 1 | 9 | 12 | 8 | 1 | 79 |
| Total | | 15 | | 14 | | 20 | | 21 | | 9 | |

**Introverts, synchronization.** In terms of desynchronization, in introverts from EEG indicators to test indicators 26 regressive connections-relations were determined, from the left hemisphere 14 regressive connections-relations were determined, and 12 from the right hemisphere. Connections-relations from EEG indicators to psychological tests scores were distributed evenly in the amount of 2-3. The largest number of regressive connections-relations was determined by the theta and delta EEG rhythms (Table 5).

It should be noted that no effect from any EGG indicator to the “schizophrenia” indicator was determined in introverts in terms of synchronization, and to the indicators “neuroticism” and “hypomania” the effects from only one EEG channel were determined – 3 and 4, respectively.

**Discussion.** In extraverts, the number of regressive connections-relations from the indicators of the EEG amplitudes to the indicators of Eysenck and SMIL was determined to be greater than in introverts.

As in extraverts so in introverts, during periods of desynchronization, the number of statistically significant regression coefficients from amplitudes of EEG rhythms to Eysenck and SMIL tests scores was determined to be greater than during synchronization periods.

Table 5.

Statistically significant regression coefficients oriented from the amplitudes of the EEG rhythms to the indicators of psychological tests in introverts under synchronization conditions

| Tests scores | BETA-2 | | BETA-1 | | ALPHA | | TETHA | | DELTA | | ***SUM*** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | «–» | «+» | «–» | «+» | «–» | «+» | «–» | «+» | «–» | «+» | |
| Extra/introversion | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| Neuroticism | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 3 |
| Hypochondriasis | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 3 |
| Depression | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 2 |
| Hysteria | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 3 |
| Psychopatic Deviance | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 2 |
| Paranoia | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 2 |
| Psychasthenia | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 3 |
| Schizophrenia | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Hypomania | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 5 |
| Sum | 3 | 2 | 3 | 0 | 1 | 2 | 2 | 6 | 4 | 3 | 26 |
| Total | | 5 | | 3 | | 3 | | 8 | | 7 | |

When studying the effect of EEG rhythms on extraversion-introversion indicators and SMIL test scores in right-hemispheric and left-hemispheric (6) also during periods of desynchronization, the number of statistically significant regression coefficients from amplitudes of EEG rhythms to Eysenck and SMIL tests was greater than in synchronization periods.

This may indicate that the implementation of mental acts and states, verified by the indicators of the applied tests, is performed mainly during periods of desynchronization, regardless of the method used to classify the subjects. It can be assumed that the periods of desynchronization, to some extent, reflect the episodes of consciousness, and the periods of synchronization – the episodes of the unconsciousness.

The largest number of statistically significant regression coefficients from the amplitude indicators of EEG rhythms to the psychological tests scores under the desynchronization conditions of extraverts was determined from the amplitude indicators of theta and beta-2 rhythms. Similar results were obtained for the right-hemisphere (6). Under the conditions of synchronization in extraverts, the largest number of statistically significant regression coefficients from the amplitude indicators of EEG rhythms to the psychological

tests scores were determined from the theta rhythm index, as well as beta-2 and alpha rhythms of the EEG.

In introverts, in terms of desynchronization, the largest number of regressive connections-relations was determined from theta and delta rhythms of the EEG, and under synchronization conditions from the theta rhythm of the EEG.

It was shown that when there is difficulty in working, the theta rhythm prevails on the EEG, and when working effectively, the high-frequency beta rhythm prevails, which is associated with emotional intensity [8].

It can be assumed that the theta rhythm indicator is a rather relevant controlling element in the formation of individual-typological personality traits in both extraverts and introverts.

In extraverts, in terms of desynchronization, the indicators of “extra-introversion”, “hysteria”, “paranoia”, and “schizophrenia” the effects were determined from EEG indicators in all six channels.

In introverts, the effects from EEG indicators in all six channels were determined to the scoress of “extra-introversion" and "depression".

This may indicate that in extraverts the formation of individual-typological personality traits to a greater extent than in introverts depends on neurophysiological mechanisms.

In extraverts, in terms of desynchronization, the effects from beta-2 rhythm to the extra/introversion score were determined in all six channels. This may indicate a special value of the beta-2 rhythm in the formation of this indicator.

It can also be assumed that the indicator of beta-2 rhythm is a relevant controlling element in the formation of individual-typological personality traits in extraverts.

In extraverts, in terms of desynchronization, five negative regressive connections-relations to the indicator “schizophrenia” were determined from the indicator of theta rhythm amplitudes. This may indicate a limiting effect of this rhythm on the manifestation of the indicator "schizophrenia".

**Conclusions.** 1. In extroverts, the number of regression connections-relations from the EEG amplitude indicators to the indicators of Eysenck's and SMIL tests was determined more than in introverts. This indicates that in extraverts the formation of individual-typological personality traits to a greater extent than in introverts depends on neurophysiological mechanisms.

2. The realization of mental acts and states, verified by the indicators of the EPI and SMIL tests, is carried out mainly during periods of desynchronization. It can be assumed that

periods of desynchronization, to some extent, reflect episodes of consciousness, and periods of synchronization are episodes of the unconscious.

3. The beta-2 rhythm indicator is an actual control element in the formation of individual-typological personality traits in extroverts.

4. The theta rhythm indicator is a fairly relevant control element in the formation of individual-typological personality traits in both extroverts and introverts.

**References:**

1. Gulenko V.V. Man as a system of types. The problem of diagnosing the Ego and the Person. Socionics, Mentology and Psychology of Personality, № 6, 9-12 (2000).

2. Zykov A.A. Fundamentals of graph theory / A.A. Zykov. - M .: "University Book", 2004. - 664s.

3. Kaplan A. Ya., The problem of the segmental description of the electro-encephalogram of a person, Human Physiology, 25, No. 1, 125-133 (1999).

4. Knyazev G.G. Extraversion, psychotism, and sensitivity to reward: the neurophysiological basis of two personality constructs. Psychology. Journal of the Higher School of Economics. 2007. Vol. 4, No. 1. S. 47–78.

5. Korolenko C.P. Dmitrieva NV Personality and dissociative disorders: expanding the boundaries of diagnosis and therapy: A monograph. Novosibirsk: NGPU Publishing House, 2006. 448 p.

6. Lobasyuk B.A., Bodelan M.I., Babaenko T.P. Influence of EEG rhythms on indicators of extraversion-introversion and SMIL test in right-hemisphere and left hemisphere. The unity of science. June 2016 p. 94-98.

7. Mannheim J.B. Political science. Research methods / J.B. Mannheim, R.K. Rich: [Trans. with English. / Prev A.K. Sokolova]. - M .: Publishing House "All the World", 1997. - 544 p.

8. Novikov L.A. Electroencephalography and its use for the study of the functional state of the brain // Natural science basics of psychology / Under. ed. A.A. Smirnova, A.R. Luria, VD Nebylitsyn. - M .: Pedagogy, 1978. P. 155-177

9. Standardized multifactor method of personality research: a methodological guide [Text] / LN Sobchik.-M., 1990.-76 p.

10. Boutros N.N., Torello M., McGlashan T.H. , (2003). Electrophysiological Aberrations in Borderline Personality Disorder: State of the Evidence // Journal of

Neuropsychiatry and Clinical Neuroscience, V. 15, №2, P. 145-154. PMID:12724454 DOI: 10.1176/jnp.15.2.145

11. Caspi A., Roberts B.W., Shiner R.L *(*2005). Personality development: Stability and change// Annual Review of Psychology.. 56. 453–484. DOI: 0066-4308/05/0203-0453

12. Cazard P., Pollak V., Jouvent R., Leboyer M., Grob R., Lesevre N. (1989), Hemisphere asymmetry of alpha burst sequential organization in depression // International Journal of Psychophysiology, V. 8, №2, P. 169-183.

13. Eysenck H.J., Eysenck S.G.B. (1964) Manual of the Eysenck personality inventory. – London: University of London Press,.DOI https://doi.org/10.1007/s10862-005-3262-2

14. Gray J.A. (1995) The contents of consciousness: A neuropsychological conjecture // Behavioral and Brain Sciences", V. 18, №4, P. 659-722.

15. Hageman D., Hewig J., Walter C., et al., (2009). Positive evidence for Eysenck's arousal hypothesis: A combined EEG and MRI study with multiple measurement occasions. Person. Individ.Diff., 47, No. 7, 717-721).

16. Harenski C.L., Kim S.H., Hamann S. (2009). Neuroticism and psychopathy predict brain activation during moral and nonmoral emotion regulation.Cogn Affect Behav Neurosci. 9(1):1-15. PMID:19246323 DOI: 10.3758/CABN.9.1.1

17. Heller W. (1993). Neuropsychological Mechanisms of Individual Differences in Emotion, Personality, and Arousal. Neuropsychology, *7*(4), 476-489. https://doi.org/10.1037/0894-4105.7.4.476

18. McCrae R.R. (2000) Trait psychology and the revival of personality_and_culture studies // American Behavior Scientist.. 44. 10–31. https://doi.org/10.1177/00027640021956062

19. McCrae R.R., Costa P.T.Jr., Ostendorf F., Angleitner A., Hřebičková M., Avia M.D.,Sanz J., Sanchez_Bernardos M.L., Kusdil M. E.,Woodfield R., Saunders P.R., Smith P.B. *(*2000). Nature over nurture: Temperament, personali ty and lifespan development // Journal of Personality and Social Psychology. 78. 173–186. PMID:10653513 DOI: 10.1037//0022-3514.78.1.173