ST. PETERSBURG STATE UNIVERSITY

As a manuscript

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THE EVOLUTION AND PECULARITIES OF THE NATURAL-SCIENTIFIC DOMAIN IN THE ST. PETERSBURG (LENINGRAD) PSYCHOLOGICAL SCHOOL

Scientific speciality: 5.3.2. Psychophysiology

Translated from Russian

PhD THESIS
in Psychology

Thesis supervisor:
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St. Petersburg – 2023

Content

Abstract

This study is devoted to the investigation of the evolutional development of the natural-scientific domain in the St. Petersburg (Leningrad) Psychological School. Three diverse researches were conducted. The first one directed towards the investigation of the modern development stage of the natural-scientific domain in the St. Petersburg Psychological School. The research was done on the sample of theses from collections of the international scientific conference “Ananyev’s readings” published since 2015 to 2020. The method of semantic analysis was used to investigate topics of the theses. The results have shown that the main research fields in the St. Petersburg Psychological School are history and methodology of psychology, psychophysiology and study of stress and coping behaviour.

The second research is devoted to the semantic analysis of publications in journals of two main psychological schools in Russia (Moscow and St. Petersburg ones) since 1949 to 2019. The method used in this study is the author’s “inciampata” model that consists in classification of scientific terms found in the articles in three groups according to three aspects of studied domain: biological, physical and mathematical ones; Pearson's correlation coefficient, P. Terentyev’s method and L.Vykhandu’s method were used for statistical data processing. The results of the study show that the authors of the Moscow Psychological School used the elements of sciences in particular studies, and the main aspect of natural-scientific domain is the physical one, not biological one; the authors of the St. Petersburg (Leningrad) Psychological School used natural science in the whole, not the elements of particular disciplines, because they were focused on the integration of sciences.

During the mathematical analysis some phase oscillations of all the figures were noticed, and an additional research of phase change phenomenon on the individual level was made. The oscillations of psycho-physiological functions were used as an example. In the study participated 566 people of both sexes, all of them were second-year students of St. Petersburg State University, Faculty of Psychology. Followed characteristics were measured: EEG figures (α-index, mean and dominant frequencies), blood pressure, breathing frequency and volume, heart rate frequency, lung vital volume, dynamometry, static and dynamic tremor. The investigation showed that all these figures change periodically, and the change period is equal one semester. The received data can be collated with the data of the second research and later used for studying phase regularities of scientific work of the St. Petersburg (Leningrad) Psychological School authors.

Introduction

Nowadays there is a question about the influence of natural-scientific theories, concepts and principles on psychology. It should be noted that from the very beginning there were two most important domains in psychology: the natural-scientific and humanity ones. Indicative in this sense are the most important works of W. Wundt – "Physiological Psychology" and "Psychology of the Peoples". This trend can be traced, in particular, in the Soviet and Russian psychological science. The two leading domestic psychological schools seem to have "divided the spheres of influence" – it is known that the Moscow school is more focused on the humanity (philosophical) domain, and the St. Petersburg school is more focused on the natural-scientific one.

This leads to the following question about the significance of various aspects of natural-scientific principles in Russian psychology in general and in the St. Petersburg (Leningrad) psychological school in particular. It is important to establish and investigate not only the features of the application of each aspect of this paradigm in modern psychological science, but also to trace the path of its evolutionary development within the chosen research school. This will help to better understand the role of natural scientific theories, approaches and principles in psychological science and, ultimately, to answer the question of the place of psychology in the system of sciences - one of the most pressing issues of modern theoretical psychology.

The St. Petersburg (Leningrad) psychological school originates from the reflexology of V.M. Bekhterev, which, in turn, arose within I.M. Sechenov – I.P. Pavlov school of higher nervous activity physiology. If we use the terms of W. Wundt, then it can be argued that the studies of the authors of this school were carried out in line with physiological psychology, i.e. from the very beginning, different natural-scientific (in particular, physiological) principles were used to put forward and to test hypotheses, to conduct research and to develop the scientific thought. The main representatives of the St. Petersburg (Leningrad) psychological school, such as A.F. Lazursky, M.Y. Basov, V.N. Myasishchev, B.G. Ananyev, B.F. Lomov, L.M. Wecker, V.A. Ganzen, G.V. Sukhodolsky, used a variety of natural-scientific principles for the construction of their theories.

The relevance of the thesis research. An important condition for solving the problem of the position of psychology in the system of disciplines is the solution of the question of its relationship with other sciences, primarily natural ones. At the same time, it is important not only to establish the relationship, but also to trace its historical development. This will make it possible to get a complete picture of the relationship of psychology with other sciences.

In this paper, the task is to trace the evolution of the natural-scientific domain using the example of one of the most important Russian psychological schools – the St. Petersburg (Leningrad) one. It is necessary not only to study the history of the application of natural science principles within the traditions of this school, but also to create a general concept of the role of the natural science paradigm in psychology.

The main three aspects of the natural-scientific domain are the biological, physical and mathematical ones. The first of them, the biological one, allows us to explore the natural base in the human mind, its biological, evolutionary side. Another aspect, the physical one, is the most fundamental and states that the mind is subject to the general basic laws of the universe. Finally, the mathematical aspect makes it possible to model mental phenomena and carry out a statistical analysis of the results of psychological research. For a school oriented towards the natural-scientific domain, such as the St. Petersburg one, it may be important that all three of its aspects are equally developed, but this statement needs to be verified.

There is also a need to compare the St. Petersburg School with a school that is not oriented towards the natural-scientific domain, for example, with the Moscow School, whose authors traditionally work within the philosophical paradigm.

The subject of the study: the development of the natural-scientific domain in the St. Petersburg (Leningrad) psychological school.

The object of the study: the natural-scientific domain in the St. Petersburg (Leningrad) psychological school.

The purpose: to investigate the historical development of the natural-scientific domain in the St. Petersburg (Leningrad) psychological school.

The objectives:

- to study the development of the natural-scientific domain in the St. Petersburg (Leningrad) psychological school at different stages;
- to compare the evolution of the natural-scientific domain in the Moscow and St. Petersburg (Leningrad) psychological schools;
- to explore the relationship of various aspects of the natural-scientific domain in the St. Petersburg (Leningrad) psychological school.

Research methods: semantic analysis of publications, psycho-physiological methods (electroencephalography, measurement of blood pressure and pulse rate, pneumography, spirometry, dynamometry, tremor measurement).

Research hypotheses:

The research of collections of abstracts of the scientific conference "Ananyev's Readings" since 2015 to 2020. In connection with the orientation of the authors of the St. Petersburg (Leningrad) psychological school on the natural-scientific domain, neuro- and psycho-physiological topics prevail, as well as theses on the methodology and history of psychology.

The comparative study of the development of the natural-scientific domain in the Moscow and St. Petersburg (Leningrad) psychological schools (based on Moscow State University and St. Petersburg State University Bulletin). Throughout its development, the St. Petersburg (Leningrad) psychological school is more focused on the natural-scientific domain than the Moscow one; the leading aspect in the Moscow school is the physical one (along with the philosophical domain), and in the St. Petersburg school the most important is the systemic approach (the integration of the three aspects).

The study of the phase dynamics of psycho-physiological functions as an example of the operation of the law of phases at the individual level:

1. Psycho-physiological parameters of the three parts of the nervous system (central, autonomic and somatic ones) change periodically (they are harmonic oscillations)
2. The total scores for the three blocks of the nervous system are more or less invariant

Statements for the examination:

- All three aspects of the natural-scientific domain are developed equally in the St. Petersburg (Leningrad) psychological school: biological, physical, and mathematical.
- In the studies of the authors of the St. Petersburg (Leningrad) psychological school, there is a clear focus on stability and the use of time-tested research and data interpretation methods.
- An important part of the natural-scientific domain that is characteristic of the St. Petersburg (Leningrad) psychological school are the holistic and the systemic approaches.
- Some branches of psychology (psychophysiology, engineering psychology, sports psychology), based on natural-scientific principles, are significant for the St. Petersburg (Leningrad) school.
- Scientific activity of scientists of the St. Petersburg (Leningrad) psychological school changes according to the general phase change law.
- In scientific activity of the authors of the St. Petersburg (Leningrad) psychological school, phase changes are traced, connected, firstly, with

educational cycles, and secondly, with changes of the direction of scientific activity of the Faculty of Psychology of St. Petersburg State University.

Scientific novelty of the research. Noowadys there is a question about the influence of natural-scienific theories, concepts and principles on psychology. It should be noted that from the very beginning there were two most leading domains in psychology: natural-scientific and humanistic. Indicative in this sense are the most important works of W. Wundt - "Physiological psychology" and "Folk psychology". This trend can be traced, in particular, in the Soviet and Russian psychological science. We can say the two leading Russian psychological schools “divided the spheres of influence”: it is known that the Moscow school is more focused on the humanistic (philosophical) domain, and the St. Petersburg school is on the natural-scientific one.

This raises the question of the significance of various aspects of natural-scientific principles in Russian psychology in general and in the St. Petersburg (Leningrad) psychological school in particular. It is important to establish and investigate not only the features of the application of each aspect of this domain in modern psychological science, but also to trace the path of its evolutionary development within the chosen research school. This will help to understand the role of natural-scientific theories, approaches and principles in psychological science better and, finally, to answer the question of the place of psychology in the system of sciences, which is one of the most relevant issues of modern theoretical psychology.

The St. Petersburg (Leningrad) psychological school has its origins in V.M. Bekhterev’s reflexology, which, in turn, arose within I.M. Sechenov – I.P. Pavlov school of higher nervous activity physiology. If we use W. Wundt’s terms, it can be admitted that the studies of the authors of this school were carried out within physiological psychology, i.e. natural-scientific (in particular, physiological) principles were used for putting forward and testing hypotheses, conducting research and developping scientific thought from the very beginning. Leading representatives of the St. Petersburg (Leningrad) psychological school, such as A.F. Lazursky, M.Y. Basov, V.N. Myasishchev, B.G. Ananyev, B.F. Lomov, L.M. Wecker, V.A. Hansen, G.V. Sukhodolsky, used a variety of natural-scientific principles to construct their theories.

Theoretical significance of the study. An original three-aspect concept of the natural-scientific domain which allows a more complete study of the scientific activity of authors applying natural-science principles was created. A method of semantic analysis which makes it possible to assess both the degree of each of the aspects and the general commitment of the authors of the studied direction to this domain was also developed.

Practical significance of the study. The conducted research can serve as a significant help in conducting experimental research, primarily in the field of psychophysiology.

Assessment of the reliability of the obtained results. The results of all three conducted studies are statistically significant.

Chapter 1. The natural-scientific domain in psychology

In this chapter the theoretical aspects of the evolutionary development of the natural-scientific domain are dicsussed. The author's original three-aspect concept of the natural-science paradigm is described, the advantages and disadvantages of this approach are considered. Also the development of the natural-scientific domain at different stages is considered, both in psychological science in general and in the St. Petersburg (Leningrad) psychological school, considered on the example of St. Petersburg State University. In addition, the question of the relationship between natural-scientific and humanistic domains is touched upon.

1.1 Classification of psychological concepts

To date, there are many classifications of psychological concepts based on different principles (for example, the classifications of B.G. Ananyev, V.A. Ganzen, B.M. Kedrov, etc.). Each psychological concept (attribute) has three components:

1) *A category* is an extremely broad concept, including essential properties, connections and relations of objects, phenomena of the objective world.
2) *A mental phenomenon* is a form of manifestation of the mind as a natural phenomenon.
3) *The content* is information that contains a certain concept.

Thus, psychological concepts include these three components. Then the content of psychology can be reduced to three blocks:

1. Categorical psychology, in which the mind acts as an instrument of knowledge, and categories are intermediaries. There are six levels of psychological categories:
    - General scientific (space-time, matter-energy, information);
    - Protopsychological (action, motive, image);
    - Metapsychological (personality, activity, communication);
    - Macropsychological (image, action, motive, attitude, experience);
    - Basic (forms of mental reflection, mental phenomena, consciousness, personality, activity, mental development);
    - Private (categories that make up the basic ones). Also include six levels:
        1) sensations, perception, memory, thinking, emotions and will
        2) mental processes, mental states and mental properties of a person
        3) experience, knowledge and attitude
        4) temperament, character, abilities, orientation, experience and features of mental processes
        5) actions, goals, motives, mental acts

6) maturation and formation, phylogeny, anthropogenesis, socio-historical development, ontogeny of the

2. Psychology of mental phenomena. Mental phenomena can be classified on the basis of belonging to one of the areas of the mind: endomind (innate genetic programs, skills and habits acquired during human life, mental states, basic emotions, feelings, self); exomind (sensation, perception, representation, imagination, attention, consciousness); mesomind (thinking, will, speech, self-consciousness); metamind (socio-psychological phenomena).
3. Content-value psychology studies the content aspect of the mind. This approach is typical for such areas of psychology as psycho-semantics, psychoanalysis, psychology of meanings. But it should be noted that content-value psychology also studies psychological categories and mental processes from the position of value (Balin V.D., 2016).

1.2 The natural-scientific domain and the natural-scientific picture of the world

The natural-scientific (early called biological) domain explains the evolutionary, genetic and psycho-physiological prerequisites for personality traits (Larsen R.J., Buss D.M., 2008). This domain was subsequently called natural-scientific, because physical and mathematical principles were added to biological principles. Currently, it is used not only in personality psychology, but also in other areas of theoretical and experimental psychology, for example, in general psychology and psychophysiology (Balin V.D., 2001; Balin V.D., 2012). The natural-scientific domain is based on *the natural-scientific picture of the world*.

The natural-scientific picture of the world is a systematised and reliable knowledge about nature, which was formed in the course of the development of natural science. It includes knowledge derived from all natural sciences, their fundamental ideas and theories.

The natural-scientific picture of the world is in constant development. During its long history, it has undergone several scientific revolutions, during which qualitative changes took place in it, and a new picture of the world replaced the old one. Three pictures of the world can be distinguished (more precisely, three stages of the historical development of the natural-scientific picture of the world):

- essential pre-scientific
- mechanistic
- evolutionary (modern)

A feature of the natural-scientific picture of the world is the use of the language of mathematics and chemical formulas. Mathematics is not a natural science, it is precisely the language of communication for scientists. Chemical formulas are used not

only in chemistry, but also in nuclear physics and in some branches of biology. *Thus, they can be considered another "language" of the natural scientific domain* (Gorelov A.A. 2011; Karpenkov S.K. 2018; Mikhaylov L.A. 2012; Romanov V.P. 2011; Sadokhin A.P. 2011; Ursul A.D., Los V.A. 2005).

1.3 The relationship between natural-scientific and philosophical (humanistic) domains

At present, the natural-scientific domain in psychology is subject to considerable criticism. It is argued that objective experimental methods are not enough to explain the mental and spiritual life of a person and society from the standpoint of integrity. Moreover, the natural-scientific idea that the subject of psychology (psychological reality) is a reflection of "mental being" independent of cognition is untenable in psychology due to the inapplicability of the postulate of "objectivity of an object" to the mind. This sets a certain situation of psychological cognition, which leads to the fact that the mental reality of a person is deontologised (Fakhrutdinova L.R., 2014; Teplykh D.A., Teplykh M.S., 2018). The task of the humanistic domain is to study a person in his integrity, which the natural-scientific domain cannot achieve.

A.V. Yurevich and then V.A. Mazilov note a significant degree of confrontation between the natural-scientific domain and the humanistic (philosophical) one. According to a number of authors, these domains represent two polar points of view on the subject of psychology. The main features of the natural-scientific domain are:

- Psychology has an object and subject of study similar to the objects and subjects of other sciences
- The subject of psychology lies to explain
- In psychology, a causal explanation must be used
- In psychology, reduction is assumed (reducing the mental to the non-mental ones)
- In psychology, general research schemes developed in sciences are applicable.

The humanistic domain (also called philosophical or hermeneutic) postulates that the object of psychology is qualitatively different from the objects of the natural sciences. A.V. Yurevich and V.A. Mazilov distinguish the following characteristics of the philosophical domain:

- Rejection of the cult of empirical methods
- Recognition as scientific is not only knowledge confirmed by empirical experience
- Legalization of intuition and common sense of the researcher
- Possibility of generalizations based on the study of particular cases
- Unity of research and practical impact

- The study of a holistic personality (Mazilov V.A., 2013)

A.V. Yurevich identifies the following criteria for the definition of domains:

- The natural-science paradigm is mainly focused on explaining psychological phenomena, while the humanistic domain is focused on understanding them.
- Causal explanations dominate in the natural-scientific domain, while teleological explanations dominate in the humanistic one.
- The humanistic domain is more closely related to psychological practice
- The humanistic domain corresponds to the postmodern image of science
- The humanistic domain lacks the methodological rigor that is a characteristic of the natural-scientific domain, which is oriented towards positivistic research standards.

The history of domain confrontation comes from a broader confrontation between descriptive and explanatory psychology. V. Dilthey believed that the methods of explanatory psychology, based on the principles of the natural natural-scientific domain, are ineffective, and its hypotheses are unreliable. Therefore, he proposed replacing explanatory psychology with a descriptive one based on the humanistic domaion (Ebbinghaus G., 2014). The following features of descriptive psychology are distinguished:

- Descriptive psychology is focused on the description, analysis and classification of the phenomena of a person's psychological life.
- Descriptive psychology calls for the development of its own descriptive nomenclature in psychology and for bringing to clarity, consistency and adequacy of psychological concepts.
- Descriptive psychology uses as sources of descriptions, mainly the subjective self-reports of the subjects and the observations of the researcher.
- Descriptive psychology recognises the principle of evidence as the guiding principle of description: reliance on what is given directly in observation or is reported by the subjects themselves.
- Descriptive psychology seeks to avoid unclear statements, loaded deductive constructions, assumptions and interpretations (Ulanovsky A.M., 2012)

However, neither in the principles of the methods, nor in the reliability of the hypotheses between the explanatory psychology and the descriptive psychology of W. Dilthey, there is a real contradiction, it is only apparent (Ebbinghaus G., 2014). Thus, this contradiction is meaningless. A.F. Kornienko comes to the same conclusion. She argues that when arguing that in addition to the natural-scientific domain there should be a humanistic domain, two problems arise. First, the ontological concept "object of reality" is mixed with the epistemological concept "object of research". Secondly, the thesis that the humanistic domain is focused on understanding is erroneous

(understanding is the result of mental activity, indicating the existence of links between knowledge within a certain set of knowledge, and explanation is just a verbal form of understanding). Therefore, there is no need to add or oppose the natural-scientific domain to a humanistic one, which is attributed to a specific focus on understanding (Kornienko A.F., 2014).

Special mention should be made of the work of N.I. Chuprikova, in which it is proved that the subject of psychology (the mind) can be studied within the natural-scientific domain (Chuprikova N.I., 2004). In addition, one of the controversial aspects of the transition from the natural sciences to the humanistic domain is the tendency towards anthropomorphism in animal psychology. Sometimes such anthropomorphism becomes the dominant idea, and although it fits into the "understanding" method of post-non-classical psychology, it requires serious critical reflection (Nikolskaya A.N., 2014).

The confrontation between natural science and humanitarian paradigms is also manifested at the level of scientific schools. N.A. Loginova notes that the focus the natural-scientific domain historically characterises the St. Petersburg (Leningrad) psychological school, in contrast to the Moscow psychological school, which works mainly within the philosophical domain (Loginova N.A., 2006).

The confrontation between the natural-scientific and philosophical domains is rooted in the "schism" of theoretical and practical psychology. It is known that theoretical, university psychology is more focused on the natural-scientific domain, and practical on the humanistic one (Bratus B.S., 2005). Some authors, such as F.E. Vasilyuk and A.S. Karmin, express fears that in the absence of a proper theoretical basis, pseudoscientific ideas will begin to penetrate into practical psychology, which will lead to an even greater "schism" (Karmin A.S., 2005; Vasilyuk F.E., 1996). At the same time, as T.D. Martsinkovskaya, sometimes there is a symptomatic clause "scientific and humanistic domains" (instead of "natural-scientific and humanistic domains"), indicating a clear underestimation of the scientific nature of the latter one (Martsinkovskaya T.D., Yurevich A.V., 2007).

Recently, however, psychologists have come to the conclusion about the need for inter-paradigm dialogue and the integration of various approaches. This is indicated by V.A. Yanchuk, G.A. Ball, A.N. Krichevets, V.A. Mazilov et al. (Mazilov V.A., 2007; Krichevets A.N., 2008; Ball G.A., 2011; Yanchuk V.A., 2012; Martsinkovskaya T.D., Yurevich A.V., 2007). The theoretical foundations for the synthesis of natural-scientific and humanistic domains are:

- Probabilistic philosophy of V.V. Nalimov
- Provisions of synergetics on self-organising systems
- Psychosocial dissonance (Khalitov R.G., 2010)

- Four-dimensional model of the world (Vasina V.V., Khalitov R.G., 2014)

1.4 The aspects of the natural-scientific domain

The analysis of scientific publications, which touches upon the application of various natural-scientific principles in psychological research, allows us to conclude that there are three aspects of the natural-scientific domain – biological, physical and mathematical. The biological aspect includes evolutionary theory, the laws of genetics and the laws of phylogenesis and ontogenesis. He explores the biological, natural beginning of the human mind. The physical aspect includes fundamental physical laws and theories, such as conservation laws, the second law of thermodynamics, the relativity theory, etc., which make it possible to identify the basic laws of the functioning of the mind based on fundamental physical laws. The mathematical aspect includes methods of statistical data processing, methods of mathematical modelling (sets, matrices, vectors, graphs, etc.) and computer modelling methods that help in building models of the mind and mental phenomena.

1.4.1 The biological aspect of the natural-scientific domain

The biological aspect of the natural-scientific domain in psychology includes the following components:

- The systematic position of man as a biological species *Homo sapiens* (Gayvoronsky I.V., Nichiporuk G.I. et al., 2009)
- The evolutionary theory (evolution of the Universe and the Earth, biogenesis, anthropogenesis) (Chebyshev N.V., 2014)
- Laws of genetics (Chebyshev N.V., 2014)
- The concept of phylogenesis and ontogenesis, von Baer's laws of embryology and the biogenetic law (Chebyshev N.V., 2014)

Examples of application of the biological aspect of the natural-scientific domain in psychology. The biological aspect of the the natural-scientific domain is widely used in modern psychology. The analysis of scientific publications made it possible to identify the following areas of application of this aspect:

- The study of brain mechanisms and the physiological basis of mental phenomena
- Researches in animal psychology
- Psycho-physical and psycho-physiological issues
- Computer modelling of behaviour of living systems
- Psychopharmacological study of the influence of nootropic drugs on mental processes
- Application of evolutionary theory in psychology

- Environmental psychology

The main psychological disciplines based on the biological aspect of the the natural-scientific domain are psychophysiology and neuropsychology, which study the brain mechanisms and the physiological basis of mental phenomena. The theoretical aspects of these sciences are considered in review articles by G.G. Arakelov, S.S. Zorin, T.A. Rataeva and Y.E. Shelepin. For example, G.G. Arakelov, questioning the significance of the psychophysiological problem, notes that psychophysiology should become the first discipline that should join the family of neurosciences (Arakelov G.G., 2014). S.S. Zorin and T.A. Rataeva in their articles analysed the significance for the psychophysiology of the concepts of V.M. Bekhterev and I.P. Pavlov. In the article by S.S. Zorin discusses the history of brain research, while emphasizing the importance of the work of V.M. Bekhterev for child psychology and diagnostics of the mental development of children (Zorin S.S., 2014). The work of T.A. Rataeva is devoted to the development of the ideas of I.P. Pavlov about the properties of the nervous system in the studies of the B.M. Teplov's and V.D. Nebylitsyn's school and also N.I. Chuprikova (Rataeva T.A., 2014). The article by Y.E. Shelepin is devoted to neuroiconics, a new scientific direction that studies the brain mechanisms of visual perception, and its relationship with other sciences (Shelepin Y.E., 2014).

An important section of psychology is animal psychology, a discipline that studies the mental activity of animals of various systematic groups. Animal psychology, as well as psychophysiology, is based on the biological aspect of the natural-scientific domain. Most researches in animal psychology are devoted to the study of animal behaviour, for example, the study of the effect of the experience of the first skill on the induction of c-Fos expression in neurons of the barrel field of the somatic-sensory cortex of rats during learning the second skill, which was carried out by O.S. Svarnik, K.V. Anokhin and Y.I. Alexandrov. As a result of the experiments, it was found that during the formation of a skill (for example, food-procuring without the use of vibrissae), the expression of the transcription factor c-Fos is induced in the neurons of the barrel field of the somatic-sensory cortex if, in the preliminary experiment, the animal has learned another skill (instrumental drinking behaviour, requiring the use of vibrissae). It can be concluded that with the sequential formation of the second skill, the neurons responsible for the first skill are activated (Svarnik O.S., Anokhin K.V., Aleksandrov Y.I., 2014).

From a methodological point of view, the article by G.V. Shukova devoted to the paradigmatic aspects of interspecies interaction. The results of the literature review given in this article allow us to raise the question of what experimental procedure will solve the problem of transition from the epistemological level to the ontological one (Shukova G.V., 2014).

Psycho-physical and psycho-physiological issues are one of the most important issues facing modern psychological science. However, studies devoted to these issues are very controversial, for example, studies by E.A. Yumatov. In his review article, he gives a definition of the subjective (brain state that occurs during the interaction of structural-molecular and specific field processes in the living brain) (Yumatov E.A., 2014). In the article “Direct registration of the subjective state of the brain”, the author gives a study of the subjective state of the brain remotely using a special indicator (Yumatov E.A., 2010). In a study published in the article “Mental activity of the brain: a “key” to knowledge”, a vessel with blood was used as an indicator, to which the tester approached in a certain subjective state, and ESR and blood pH were used as the analysed parameters (Yumatov E.A. , 2013). As a result of both studies, conclusions that are very doubtful from the point of view of the natural-scientific domain about the existence of a “biological field” of a person and the possibility of its remote registration were made.

One of the newest directions in this aspect is the modelling of the behaviour of living systems based on the principles of mathematical biology (see the section "The mathematical aspect of the natural-scientific domain"). In such studies, with the help of computer programs, a model of populations of organisms in a certain habitat is created. Each "organism" of the population, called an agent, can perform a number of specified operations (feeding, movement, reproduction, etc.). For example, M.S. Burtsev, R.V. Gusarev and V.G. Redko declare that the purposeful behaviour of agents has rarely been modelled in this way. It was found that the behaviour controlled by a two-level hierarchical system (the level of simple reflexes and the meta-level conditioned by motivation) is more effective than the behaviour conditioned only by reflexes (Burtsev M.S., Gusarev R.V., Redko V.G., 2002). Another study by M.S. Burtsev is devoted to studying the influence of motivation on adaptive behaviour. The results showed that the hierarchy of goals gradually becomes more complex in the process of evolution; at the same time, its formation leads to the need for a mechanism for choosing current subgoals, motivations act as such a mechanism (Burtsev M.S., 2002).

Psychopharmacological studies of the effect of nootropic drugs on the central nervous system are of interest. Their practical significance lies in the possibility of applying the results for the prevention and treatment of neurodegenerative diseases, such as Alzheimer's disease, as well as in some forms of education. Three striking examples can be given. R.U. Ostrovskaya et al. studied the effect of the nootropics TGS-20 and GVS-111 on the formation of conditioned reflex freezing in rats, using two training options - massed and spaced. It was found that the studied preparations show a positive mnemotropic effect only with massive training (Ostrovskaya R.U. et al., 1999).

Another study by R.U. Ostrovskoy, A.P. Tsaplina and T.A. Gudasheva is devoted to the prospects for the use of noopept for the prevention of Alzheimer's disease. It was

found that this drug affects the severity of pathomorphological changes in the brain tissue, and, according to the authors of the article, its use can help reduce the severity of symptoms already at the stage of mild cognitive decline (Ostrovskaya R.U., Tsaplina A.P., Gudasheva T.A., 2009).

T.A. Gudasheva et al. studied the possibility of creating nootropic dipeptides related to the vasopressin family using an evolutionary genetic approach. The results of the study showed the possibility of expanding the group of nootropic dipeptides based on pyroglutamic acid (Gudasheva T.A. et al., 2006).

Of particular note is the article by A.N. Kharitonov on the application of the doctrine of the evolution of the organic world in psychological science. He draws attention to the difficulties of conducting paleo-psychological studies (reconstructions) and interpreting data. At the same time, the author draws attention to the fact that for the reconstruction of the mind it is necessary to use both paleontological and archaeological data, then this will make it possible to more fully recreate the features of mental processes in organisms of past geological epochs. A.N. Kharitonov also points to the important role of models (computer, natural, physical) in the study of the phylogenesis of the mind (Kharitonov A.N., 2005).

Another important approach is environmental psychology: the study of mental processes in those environmental conditions in which experience and behaviour occur without the intervention of the researcher. V.I. Panov singles out such areas of ecological psychology as psychological ecology, ecological approach in psychology, psychology of the environment, psychology of ecological consciousness (Panov V.I., 2005). At the same time, the application of the biological aspect varies from analogy, as in the ecological approach, to the study of the subjective attitude of the individual to the natural environment in the psychology of ecological consciousness.

From the analysis of the literature, it can be seen that the biological aspect of the natural-scientific domain allows us to study the biological nature of a man. In the future, it is he who will make it possible to find a solution to such important issues of psychology as psychophysical, psycho-physiological and the issue of psychogenesis.

1.4.2 The physical aspect of the natural-scientific domain

The components of the physical aspect of the natural-scientific domain in psychology are:

- Physical picture of the world (Gorelov A.A. 2011; Karpenkov S.Kh. 2018; Mikhailov L.A. 2012; Romanov V.P. 2011; Sadokhin A.P. 2011; Ursul A.D., Los V.A. 2005).
- Conservation laws, the invariance principle and E. Noether's theorem (Ibragimov N.K., 1969; Kuznetsov B.G., 2010; Lutsenko E.V., 2013; Mikhailov L.A., 2012;

Romanov V.P., 2011; Brading K., Castellani E., 2014; Brown H. R., Holland P., 2005; Salvador Alcaide A., Molero Aparicio M., 2008; Strickland E. 2018; Gobbi C., 1991; Torretti R., 1996).

- The concept of space and time (Balin V.D., 2000)
- Elements of quantum physics and high energy physics (Kasyanov V.A., 2017; Kasyanov V.A., 2018; Kuznetsov B.G., 2010; Kuhn T., 1975; Spassky B.I., 1977)
- The special relativity theory (SRT) and the general relativity theory (GRT) by A. Einstein (Sadokhin A.P., 2011)
- Synergetics (Balin V.D., 2001; Gorelov A.A., 2014; Stepin V.S., 2011)
- The second law of thermodynamics (Maksimov L.A., 2012; Romanov V.P., 2011)
- Harmonic oscillations (waves) (Kasyanov V.A., 2017)
- Phase transitions (Kasyanov V.A., 2017; Kasyanov V.A., 2018; Kuznetsov B.G., 2010; Spassky B.I., 1977)

Examples of the application of the physical aspect of the natural-scientific domain in psychology. The results of the analysis of scientific research have shown that there are the following areas of application of the physical aspect of the natural-scientific domain in psychological science:

- The application of the principles of synergetics in psychology
- The systemic approach
- Modelling of mental phenomena based on the principles and laws of physics (including computer modelling)
- Studies of the influence of physical factors on the human mind
- Psycho-physical researches
- Methodology of psychology

First of all, the physical aspect of the natural-scientific domain should be discussed in those cases when it comes to the application of the principles of synergetics and a systematic approach in psychology. For example, modern psychological science makes extensive use of the synergetic principles of non-linearity and self-organization. So, M.M. Basimov in his article cites 6 specific studies demonstrating examples of non-linear psychological systems. The review given by him allows us to speak about the need for a synergistic approach in psychological science, aimed primarily at studying the nonlinear properties of psychological systems (M. M. Basimov, 2014).

In the work of A.A. Mitkin considers a synergistic approach to the problem of determinism in psychology. The author considers the main provisions of synergetics, such as the concepts of self-organisation, chaos and bifurcation. At the same time, he is rather sceptical about the proposal of the supporters of this approach to transfer its

principles to the explanation of psychological, social and cultural phenomena (Mitkin A.A., 2005).

Another article by A.A. Mitkin is devoted to a critical analysis of the principle of self-organisation by I. Prigogine. Agreeing with the applicability of this concept to the study of the man's biological nature, the author asks the question of the possibility of applying these ideas to the study of his social nature. As an argument in favour of applying the principle of self-organisation to the social side of the mind, A.A. Mitkin gives the general structural laws of the history of P. Teilhard de Chardin (Mitkin A.A., 1998).

The systemic approach introduced into psychology by B.F. Lomov is one of the most significant areas of application of the physical aspect of the natural science paradigm. In more detail, the teachings of B.F. Lomov will be discussed further, attention should be paid to the article "The systemic approach and the problem of determinism in psychology", published in the Psychological Journal in 1989. In this article, the author aims to characterize the state of psychological science, to trace the logic of its development, leading to the need to develop new approaches in psychological research and their synthesis based on the principle of consistency. It is especially noted that the systemic approach is not a theory, but a method of cognition in the philosophical sense of the word. Further B.F. Lomov analyses the problem of determinism in psychology. According to the author, the ratios between different types of determinants change depending on specific circumstances (replaceable determination). The problem of determinism has two inextricably linked sides: the study of the determination of mental phenomena themselves and the determining role of these phenomena in various real processes in which a person is included. The systemic approach, primarily the idea of the systemic nature of determination, opens up new opportunities for their study (Lomov B.F., 1989).

V.P. Kuzmin in two parts of his work analyses the historical development and phenomenology of the systems approach. The first part of the study is devoted to the history of the systems approach in the natural and social sciences. It is concluded that system concepts are already working for scientific cogntion, they serve the actual needs of modern qualitative analysis (Kuzmin V.P., 1982). In the second part of V.P. Kuzmin explores the system approach as a methodological tool for studying integration (integrated objects and integral dependencies and interactions). The author proves that the systemic approach today is one of the active components of the process of scientific cognition (Kuzmin V.P., 1982).

Article by T.F. Bazylevich is devoted to systemic research in modern differential psychophysiology, which has been ongoing for a long time. The author concludes that the cognition of the typological foundations of a holistic individuality, as shown by the experience of systemic research of the past decade, has access to practical psychology,

since the identified patterns are formulated on the basis of psychological modelling of the natural dynamics of actions. Systemic studies through experiments and controlled observations have proved the systemic nature of a regular combination of individuality properties in behaviour (Bazylevich T.F., 2005).

A.V. Karpov in his work raised the question of the possibility of applying the principle of consistency as a methodological basis for the study of integral abilities. The author concludes that integral abilities are one of the levels (meso level) of an integral system of abilities along with general (macro level) and special (micro level) abilities (Karpov A.V., 2005).

You should also pay attention to the works of Y.P. Povarenkov on a systematic study of the professional development of the individual. One of the articles indicates that the development and implementation of an integrated approach was largely facilitated by the widespread introduction into the practice of psychological research on the psychology of work of the principles of a systematic approach. The author argues that to give an adequate description of the process and results of a person's professional development means to describe it as a polysystemic process, which is regulated by the subject of labour based on a complex of heterogeneous factors. The article also analyses the crises of professional development and the periodicity of professional development from a systemic standpoint (Povarenkov Y.P., 2005).

In another article by Y.P. Povarenkov provides a systemic analysis of the professional development of the individual. The author pays special attention to professional destructions – changes in the existing structure of activity and personality, which negatively affect labour productivity and interactions with other participants in this process. It was concluded that the professional development of a personality is a complex and controversial process that is almost impossible to study outside the methodology of a systemic approach (Povarenkov Y.P., 2017).

An important aspect of the application of the physical aspect of the natural-scientific domain is the modelling of mental phenomena based on the principles and laws of physics. It should be noted that, like models based on the application of the biological aspect, these models are built using special computer programs. So, V.N. Nosulenko and E.S. Samoylenko analysed a number of models of interpersonal communication: the Shannon-Weaver model; R. Jacobson's component model; D. Berlo's communication model; the "Speaking" model; intentional models (the principle of cooperation by H. Grice and the theory of speech acts by J. Searle); the theory of social interaction by K. Dodge; the concept of communication as a collaboration by G. Clark; information processing model J. Bodichon; the concept of a personal communication plan by D. Anzier and J. Martin; the concept of communication as a type of activity (A.A. Leontyev, M.I. Lisina); a systematic approach to communication (B.F. Lomov, E. Mark and D. Picard). The authors consider the most promising

campaigns that are systemic in nature and aimed at analysing the structure and dynamics of communication (Nosulenko V.N., Samoylenko E.S., 2005).

A.A. Oboznov in his article considers a situational model of mental regulation of operator activity. This model is based on a generalised scheme of mental regulation of operator activity, which reflects its invariant functional, structural and dynamic characteristics. The author claims that the concept developed by him can become a scientific basis for solving a wide range of practical problems in the psychological support of professional activity (Oboznov A.A., 2005).

In the work of S. Lalu and V.N. Nosulenko, the question of "experimental reality" as an approach to the study and design of extended environments (spaces in which physical objects are united by a digital information system that mediates their use by a person) is consecrated. In this concept, special attention is paid to the analysis of individual and collective tasks that determine the features of using tools in extended environments. An important place in the concept under consideration is occupied by the concept of a physical model, introduced to describe complex objects (a set of events that form the real environment of a person). The authors note that the domain of experimental reality, which is fundamentally systemic, seems promising, but requires additional interdisciplinary research in the field of social sciences and the development of methods and language for interaction between social science researchers, engineers and users (Lalu S., Nosulenko V.N., 2005). It should be noted that these studies use such principles from the field of physics as the creation of physical models and the principle of invariance, which allows creating more accurate models of mental phenomena.

It is interesting to study the influence of various physical factors on the human mind. An example is the study of the effect of radiation on brain activation and the integrity of the individual, published in an article by T.F. Bazylevich et al. The goal was to study integral syndromes of individuality related to the complex "strength – activation – sensitivity" and having a backbone value in the structure of a person's typological characteristics. The results of the study made it possible to detect shifts in EEG parameters, the typological meaning of which is associated with the possibility of generalised and local effects of nonspecific activity on the brain in general and on the formal-dynamic side of behaviour in particular. This syndrome can be considered as a weakening of the nervous system, manifested in a decrease in ergicity against the background of an increase in neuroticism. The authors suggest that further development of this direction will reveal the typological features of a person who is highly sensitive to radiation factors (Bazylevich T.F. et al., 1993). Research of this kind is the development of the ideas of the I.M. Sechenov’s and I.P. Pavlov’s school about the HNA.

Psycho-physical studies that study the characteristics of primary mental processes (sensations and perceptions) under various experimental conditions deserve special attention. A number of studies of this kind are described in D.A. Oshanin, devoted to the study of the formation of an operational image. Experimentally studied such aspects of this problem as: the dependence of the content of the operational image directly on the very purpose of the action; functional deformation; functional mechanisms of operational reflection (on the example of the phenomenon of decreasing the apparent magnitude of an unfixed object); operational images in identifying the information content of signals; the function of operational images in the process of making a diagnosis (on the example of radioisotope diagnosis of thyroid diseases); the process of isolating the motor scheme of action from the presented partial structures; the process of tracking with extrapolation of the target moving along the trajectory of a sinusoid; the process of formation of dynamic images of space-time structures (Oshanin D.A., 1973).

In the study of A.V. Zhegallo tested a new experimental technique that allows diagnosing individual differences in the difficulty of distinguishing transitional images. During the experiment, one group of subjects was presented with a discriminatory ABX task, while the other group was presented with the Same – Different task. The results of the study showed that the Same – Different task is more suitable for assessing the difficulty of differentiating transient facial expressions (Zhegallo A.V., 2012).

The purpose of the article by V.N. Nosulenko, dedicated to the psychophysics of a complex signal, was to show, using the example of research in the psychophysics of hearing, that the multidimensional and multilevel nature of mental processes, which determines the nonlinearity of the reflection of physical reality in mental images, is confirmed by the entire course of research in experimental psychology and most clearly in experimental psychophysics. Requirements were put forward for the structure of psychophysical research. Firstly, it is necessary to procedurally ensure in the experiment that the subject receives the most complete free verbal descriptions of the image from the subject. Secondly, a theoretically substantiated approach is needed to the organization of specific situations in the communicative plan, modelling individual activity and joint discussion, where the superposition and transformation of two judgments takes place. Thirdly, special methods and techniques are needed for such an analysis of verbal material that could meet the tasks set (a correct and informative comparison of the psychophysical and speech series of experimental data with constant consideration of the communicative aspect of the problem under study) (Nosulenko V.N., 1985).

Research by V.A. Barabanshchikov and A.A. Demidov was devoted to the analysis of the perception of individual psychological characteristics of a person by the expression of his face in micro time intervals. The research procedure consisted in the fact that the subjects evaluated the presented photographic images of sitters according to

the "Personal Differential" method. The main result is to identify the stages of interpersonal perception, i.e. formation or actualisation of the He-concept, which are invariant in nature (Barabanshchikov V.A., Demidov A.A., 2008).

Finally, works from the field of psychological methodology deserve attention. By analysing different research methods, theories and concepts, one can find the application of the physical aspect of the natural-scientific domain. For example, Y.I. Alexandrov and A.K. Krylov studied the role of systems methodology in psychophysiology. The authors analyse the teachings of R. Descartes, A.R. Luria, P.K. Anokhin, B.V. Shvyrkov, K. Levin. It was concluded that a consistent systemic approach and the rejection of the reactivity domain also forces us to abandon the consideration of culture as a set of instructive stimuli acting on the subject, and the subject as responding to stimuli and assimilating culture. Within these ideas, it turns out that psychology, molecular biology, psychophysiology, sociology, cultural studies and other disciplines consider patterns that characterise different links and sides of a single closed cycle. According to the authors, as an interdisciplinary methodology for these interrelated and interdependent disciplines, systemic methodology and, in particular, the methodology of systemic psychophysiology can be used (Aleksandrov Y.I., Krylov A.K., 2005).

V.A. Bodrov analyses the methodology of the system, as well as the subject-activity approach in the study of professional activity. The results of the theoretical and experimental studies conducted by the author on the basis of the stated methodological principles and provisions indicate that the problem of determining and forming a professional is associated with the patterns of professionalization of the subject of labour and the mental development of the individual, and is also a dynamic procedure that is implemented at various stages of the professional path and social economically significant in modern society (Bodrov V.A., 2005).

Article by V.A. Barabanshchikov is dedicated to the contribution of B.F. Lomov in the development of the theory and methodology of psychology. It was concluded that the principle of consistency developed by the author is an important basis for the study of the mind and human behaviour (Barabanshchikov V.A., 2007). In another article by V.A. Barabanshchikov explores the place of a systemic approach in the structure of psychological cognition. The author comes to the conclusion that B.F. Lomov managed to develop the structures of the original version of the systemic approach, which is based on the idea of the polysystemic nature of human existence and the integrity of its qualities and properties (Barabanshchikov V.A., 2007).

In the work of A.L. Zhuravlev and N.E. Kharlamenkova discusses the connection between the ideas of the dynamic approach to the study of personality, developed by L.I. Antsyferova, with modern ideas about personal development. It was concluded that the concepts of progressive mental development and post-traumatic growth are not

identical. These processes differ, at least in the succession of stages of development and its reversibility. The psychological mechanisms and developments between them were also discussed during the implementation of mental development in the norm and in the case of its deployment as a process of post-traumatic growth (Zhuravlev A.L., Kharlamenkova N.E., 2016). In this paper, the application of the phase law is traced.

Also, the concept of L.I. Antsyferova was studied by S.K. Nartova-Bochaver and N.E. Kharlamenkov. The purpose of the article by S.K. Nartova-Bochaver discussed the implementation of the ideas of L.I. Antsyferova about personal development in the modern practice of psychological counselling. An attempt was made to connect the philosophical and psychological ideas of the author with the current state of the methodology of practical psychology. It can be concluded that natural being is a powerful source of self-support and self-development (Nartova-Bochaver S.K., 2014). In the article by N.E. Kharlamenkova the professional path of L.I. Antsyferova as a scientist is analysed. The scope of her scientific interests included, in particular, the methodology of scientific psychology and a dynamic approach to the study of personality (Kharlamenkova N.E., 2014).

V/I. Morosanova in her article analyses the problem of image and action in the scientific work of D.A. Oshanin. The author's ideas about the psychological functional system of objective action are investigated. We are talking about a system of operational images, each of which performs a specific function when converting information about the current state of the object into appropriate effects on the object (Morosanova V.I., 1998).

The results of the review showed that the physical aspect of the natural-scientific domain makes it possible to analyse mental processes at the most fundamental level. It provides researchers with a number of methodologically important analysis tools, such as a systemic approach and the synergetic principle of nonlinearity. Thanks to their use in psychology, more modern and accurate methods of scientific cognition appear.

1.4.3 Mathematical aspect of the natural-scientific domain

The use of the mathematical apparatus is currently considered one of the signs of the nomothetic approach inherent in the natural sciences. In psychology, the application of mathematics is not limited to the statistical processing of data. G.V. Sukhodolsky created a new discipline: mathematical psychology. The mathematical aspect of the natural science paradigm includes the following teachings, theories and sections of mathematics:

- Methods of mathematical statistics (Nasledov A.D., 2004; Grima P., 2014)
- The probability theory (Corbalán F., Sanz J., 2014)

- The set theory, the graph theory, matrices and vectors (Maslova T.N., Sukhodsky A.M., 2006; Alcina C., 2014; Kurosh A.G., 2021)
- Functions and differential equations (Maslova T.N., Sukhodsky A.M., 2006)
- Fractal geometry (Binimelis Bassa M.I., 2014)
- The information theory, algorithms and artificial intelligence (Pospelov D.A., 1998; Wiener N., 1968; Kuhn T., 1975; Eremenko V.T. et al., 2010; Torra B., 2014; Belda I., 2014)
- Mathematical biology (biomathematics) (Laos Beltra R., 2014)
- Topology elements – geometric invariants (GI) of space and measuring scales by S. Stevens (Muñoz V., 2014; Balin V.D., 2001; Balin V.D., 2012; Druzhinin V.N., 2002; Nasledov A.D., 2007).

Examples of the application of the mathematical aspect of the natural-scientific domain in psychology. An analysis of the literature allows us to conclude that the most significant areas of application of the mathematical aspect of the natural-scientific domain in psychology are:

- Application of the probability theory
- The analysis of statistical criteria for testing hypotheses
- Mathematical modelling (including computer modelling)
- The geometric approach

The application of probability theory to assess the possibility of the occurrence of certain mental phenomena is one of the most significant areas of application of the mathematical aspect of the natural-scientific domain in psychology. This direction was explored by S.L. Artemenkov in his article on the role of scientific norms and heuristics in assessing the probability of co-represented events. The author confirms that although decision-making under uncertainty is often mediated by simplified heuristics, heuristics are more often opposed to scientific cognition. The article describes experiments to estimate the probability of two events. The results showed a wide range of individual ratings. It was concluded that the association error is not so much a heuristic estimation error as an error of judgment of scientists who erroneously compare psychological methods for estimating the probability of independent events in the traditional probability theory (Artyomenkov S.L., 2014). The comparison of the probability estimation of jointly occurring events presented in this article confirms the importance of various estimation methods.

Another important area of application of the mathematical aspect of the natural-scientific domain is the statistical criteria for testing hypotheses. Among the analysed works, two types of studies stand out: studies containing examples of the application of statistical criteria for psychological research, and comparisons of various statistical criteria. So, A.V. Zhegallo and P.A. Marmalyuk studied the image characteristics that

determine the effectiveness of their discrimination. Statistical analysis was carried out in two stages: first, the Pearson correlation coefficient was used, and then the results of the study were subjected to the wavelet decomposition procedure (Zhegallo A.V., Marmalyuk P.A., 2014).

In the work of A.A. Semyashkin considers the importance of descriptive statistics (median and arithmetic mean) as criteria for separating the poles of cognitive styles. It was concluded that if it is necessary to assign subjects to one or another cognitive-style pole, it is necessary to use the calculation of the median and sample mean criteria (Semyashkin A.A., 2014).

A.A. Korneev and A.N. Krichevets analysed the conditions of applicability of the Student and Mann-Whitney criteria and described in detail the differences in the field of their application (Korneev A.A., Krichevets A.N., 2011).

In two articles B.Y. Lemeshko, S.B. Lemeshko and A.A. Gorbunova considers the application and power of criteria for testing the homogeneity of variances. The first part analyses the parametric Bartlett, Cochran, Hartley, Levene and Fisher tests; the second part analyses the nonparametric Ansari-Bradley, Mood, Siegel-Tukey, Capen and Klotz tests. Based on the results of the first study, it was concluded that in most cases the Cochran test has the highest power (Lemeshko B.Y., Lemeshko S.B., Gorbunova A.A., 2010). The results of the second study showed that among the considered non-parametric criteria, the Mood test has the highest power (Lemeshko B.Y., Lemeshko S.B., Gorbunova A.A., 2010).

Finally, in another analysed study by B.Y. Lemeshko, the following criteria for the homogeneity of means were considered: the test for comparing two sample means with known variances; the Student's test for comparing two sample means with unknown but equal variances; the test for comparing two sample means with unknown and unequal variances; the *t*-test; the Mann-Whitney test; the Kruskal-Wallace the. The results of this study confirmed the stability of parametric criteria for checking the homogeneity of mathematical expectations (Lemeshko B.Y., 2008).

Another option for applying the mathematical aspect of the natural science paradigm in psychology is the mathematical modelling of mental phenomena. Modern psychological science is actively introducing elements of information theory into its methodology. The analysed studies used various types of models, including computer models. For example, in the article by S.L. Artemenkov and S.I. Popkov describes a graphic designer that is proposed for use in tachistoscopy studies. The constructor model proposed by the authors is a convenient universal software tool for developing psychological experiments and other procedures (Artemenkov S.L., Popkov S.I., 2014).

The work of V.E. Dubrovsky and A.V. Garuseva is devoted to the use of multichannel models (in particular, wavelet transforms) in the psychophysical study of the visual system. The theory of frames developed by the authors, firstly, allows for

each multichannel model to evaluate the quality and reliability of image coding and compare different models, and secondly, it makes it possible to correlate the psychophysical data obtained using two different methods (Dubrovsky V.E., Garusev A.V. 2014).

In another study by S.L. Artemenkov and S.I. Popkov, the goal is to develop a graphic designer of experimental procedures for a computer tachistoscope – a software system for hierarchical graphical frame-by-frame editing of experimental procedures. The program developed by the researchers is designed to build experimental procedures in a graphical way in the absence of the user's skills in working with programming languages (Artyomenkov S.L., Popkov S.I., 2014).

The article by S.L. Artemenkov, devoted to the development of the methodology of experimental research in the field of transcendental psychology and, in particular, the development of an experimental method that makes it possible to test the formation of symmetrical-binary relations in the process of visual perception. The theoretical and experimental study conducted by the author demonstrated the fundamental possibility of testing the transcendental principles and models of the formation of symmetrical-binary relations in visual perception (Artyomenkov S.L., 2010).

The geometric approach presented in the article by V.E. Dubrovsky, is a kind of mathematical modelLing. The author applies this approach to the study of sensory discrimination, based on the idea of the visual system as a set of channels operating in parallel. The study used such methods of geometric analysis as differential geometry, convex analysis and Finsler geometry. The results of the study showed that the representation of discrimination using a linear multi-channel model is equivalent to passing to the Hamiltonian space. Also V.E. Dubrovsky confirms that this mathematical theory is a convenient means of analysis for psychologists and psycho-physiologists who do not have fundamental mathematical training (Dubrovsky V.E., 2009). Thus, the geometric approach is a method of mathematical modelling of mental phenomena using geometric principles.

The results of the analysis of scientific works allow us to conclude that there are two main areas of application of the mathematical aspect of the natural science paradigm in psychology. The first and most commonly used is the statistical analysis of psychological research data. The second field of application, which appeared relatively recently, is the modelling of mental phenomena using computer technology. Thus, the mathematical aspect is an important tool in any psychological research.

1.5 Disadvantages of the natural-scientific domain in psychology

Despite the fact that the natural-scientific domain is an important part of psychological science, psychologists face a number of problems with excessive enthusiasm for it. Let's consider the most important of them.

The natural-scientific approach leads to the emergence of such unfavourable options for explaining mental reality as:

- Biologising is the reduction of the mind to physiological processes, in particular to reflexes and instincts (this includes Z. Freud's psychoanalysis, which reduces even the most complex psychosocial phenomena to sexual attraction, and V.M. Bekhterev's reflexology, which applies the term "reflex" even to personality traits).
- Physicalism, sometimes turning into mechanism. For this, in particular, the behaviourism of B.F. Skinner, who declared people being "complex machines".

Such views often lead to a simplification of understanding the mind and ignoring the social essence of a person.

Another disadvantage of the natural science paradigm is its categorical or classificatory nature. Psychology is either categorical or psychology of mental phenomena within this approach (Balin V.D., 2016). That is, in this case, psychology turns into a science that has a form, but is devoid of content.

There is also the problem of total simplification and substitution of concepts, leading to ignoring the internal content of the mind (including consciousness). Such a psychology most often develops exclusively in scientific classrooms and laboratories and is not practice-oriented. Here are some examples:

1. The natural-scientific approach does not give development to applied areas of psychology, such as crisis psychology. No diagnostic tests or mathematical models will help the bereaved. Theoretical knowledge will only make it possible to determine the certain stage of grief, the personality traits of the grieving person and his attitude towards the deceased, but will not help him survive, for example, the death of a loved one. Only a practicing psychologist-consultant can help a person in such a situation.
2. Recently, it has been proposed to replace sports psychology with sports psychophysiology. But in this case, the psychological support of athletes becomes impossible. For example, a psycho-physiologist will be able to determine the strength of the nervous system using a computerised LS technique, but will not be able to prepare an athlete for competitions, nor to carry out psychological rehabilitation of an athlete who has received a serious injury. In the psychological support of athletes, an integrated

approach is needed: psychophysiology should be combined with applied psychology.

1.6 The evolution of psychology within science

Before considering the directions of research in the St. Petersburg (Leningrad) psychological school, it is necessary to briefly describe the history of the development of psychology within the natural sciences. This line of evolution of psychological science is no less well known than the philosophical one. But, nevertheless, it is necessary to take into account that this direction in the development of psychology has much deeper roots and originates in those areas of science that at first glance have nothing to do with psychology. Let us take as a basis the review conducted by E.S. Kuzmin and V.A. Yakunin.

1.6.1 Natural scientific prerequisites for the formation of psychological science

Throughout the development of psychological science, it has been influenced by various natural science disciplines. It is important to note that psychology borrowed principles not only from disciplines like psychiatry and physiology. At certain stages, principles from such sciences as physics and astronomy came to psychology. Here is a list of the main natural science disciplines that influenced the development of psychology as a science:

- astronomy ("personal equation");
- biology (the evolutionary doctrine of C. Darwin);
- physiology (neuromuscular physiology and reflex theory);
- physics (acoustics and optics associated with the emergence of sensory physiology);
- anatomy and physiology of the brain;
- psychiatry (Kuzmin E.S., Yakunin V.A., 1985).

Astronomy. It would seem that astronomical observations and calculations are extremely far from psychology, but astronomers were the scientists who made one of the most important discoveries in the field of psychology.

In 1796, the astronomer N. Maskline fired his assistant because he began to systematically record the time of the passage of a star through the meridian of the telescope with a delay. The famous astronomer F. Bessel became interested in this case. Comparing a number of observations of different researchers, he found significant discrepancies in the testimony of various astronomers. F. Bessel called these discrepancies "personal equation". Later it was found that even for the same researcher in different periods of observation, the personal equation is subject to change;

moreover, the magnitude of the personal equation for sudden stimuli is much smaller than for slow moving objects. This allowed F. Bessel to conclude that the cause of variations in the personal equation is the human factor. To determine personal equations, a chronometric method was introduced, and special devices were invented for this purpose – a chronograph and a chronoscope.

In 1850 G. Helmholtz began the physiological analysis of the personal equation by determining the rate of excitation in the muscle nerve of the frog using myographic and galvanometric techniques. Somewhat later, G. Helmholtz and the Russian physiologist N.N. Bakst used the chronometric method to measure the rate of excitation of a human sensory nerve. These studies opened the way to measuring the reaction time (Kuzmin E.S., Yakunin V.A., 1985).

The evolutionary doctrine of C. Darwin. According to Charles Darwin, there are three factors of biological evolution: heredity, variability and selection. Based on observations of animals in natural conditions and experiments in the field of selection, Charles Darwin discovered the principle of divergence: for survival, it is more profitable for organisms to differ than to be similar.

The creation of evolutionary theory was of revolutionary importance not only for biology, but also for psychology. The following aspects of Charles Darwin's theory influenced psychological science:

- genetic principle in psychology;
- a new approach in the interpretation of mental phenomena;
- continuity in the mental organization in humans and animals;
- the importance of studying the mind of animals;
- development of the problem of psychogenesis;
- the ground for the creation of comparative, child, genetic and differential psychology;
- an objective approach to the study of mental phenomena (Kuzmin E.S., Yakunin V.A., 1985).

Neuromuscular physiology. In neuromuscular physiology, the reflex principle of R. Descartes dominated, considering the reflex as an absolutely machine-like, involuntary act (reflex atomism). R. Witt opposed this idea. He was convinced that, on the one hand, it is impossible to consider all movements machine-like, but on the other hand, it also makes no sense to consider any neuromuscular act as arbitrary.

The next step was to isolate the group of spinal reflexes and separate them from voluntary actions, which should be studied not by physiology, but by psychology (P. Cabanis, F. Blaine). But at the same time, there was another point of view: the reflex

mechanism extends to all levels of neuro-cerebral activity. The result of these discussions was the understanding of the need for a "bridge" between physiology and psychology (Kuzmin E.S., Yakunin V.A., 1985).

Physics and sensory physiology. Such areas of physics as optics and acoustics played an important role in the development of the physiology of the sense organs (sensory physiology). In the first half of the XIX century. the study of sensory systems was no longer carried out by physicists, but by physiologists. But the most studied aspects of sensory physiology were still vision and hearing. A great contribution to the development of sensory physiology was made by E. Weber, who took the first step towards the creation of the first experimental section of psychology: psychophysics (Kuzmin E.S., Yakunin V.A., 1985).

Anatomy and physiology of the brain. Since ancient times, philosophers, doctors and natural scientists have been searching for the material substratum of the mind. Various hypotheses about the localization of psychic phenomena have been put forward. The main mistake of these trends was that they projected mental functions onto the brain without taking into account the functional level of analysis of its work. Only thanks to the efforts of a number of prominent domestic scientists (I.M. Sechenov, V.M. Bekhterev and I.P. Pavlov) was it possible to overcome psycho-morphology in the ideas about the brain mechanisms of mental activity (Kuzmin E.S., Yakunin V.A., 1985).

Psychiatry. The development of knowledge about mental disorders and the causes of their occurrence has played an important role in the development of psychology as a science. In some countries (primarily in Russia and France), psychiatrists initiated the development of psychology as an experimental science.

The reformer of psychiatry is the French doctor F. Pinel. He proposed to humanize the treatment of mental disorders, turn psychiatry into an experimental science modeled on other areas of natural science, and create objective methods for studying the causes of mental illness.

In Russia, the "founding fathers" of experimental psychology were neurologists and psychiatrists. The founder of Russian psychiatry is I.M. Balinsky, founder of the Department of Psychiatry and the Psychiatric Clinic in St. Petersburg. Thanks to the experience of these scientists, psychiatric centres began to open in other cities of Russia, at which the first psychological laboratories were created. Known psycho-physiological laboratory in Kazan, founded in 1886 by V.M. Bekhterev on the basis of the Department of Psychiatry of Kazan University. Having moved to St. Petersburg, V.M. Bekhterev in 1894 opened another psychological laboratory at the Department of Psychiatry of the Military Medical Academy. V.M. Bekhterev and S.S. Korsakov also deserve credit for establishing an objective approach to the study of the mental and

transforming psychology into an experimental science (Kuzmin E.S., Yakunin V.A., 1985).

1.6.2 The first experimental sections of psychology

Psychology as a science originated in the second half of the 19th century. At the same time, three experimental sections of psychology appeared within science: psychophysics (G. Fechner), experimental psychophysiology (G. Helmholtz) and isichometry (F. Donders and Z. Exner). These areas of psychology are united not only by the orientation towards the experimental method, but also by the fact that their creators were not only psychologists, but also specialists from the field of natural sciences (Kuzmin E.S., Yakunin V.A., 1985).

Psychophysics. G. Fechner defined psychophysics as the science of the relationship between the physical world and the mental. He proceeded from the ideas of panpsychism and psychophysical parallelism. According to the author, psychophysics includes two sections: external and internal psychophysics. One of the main achievements of G. Fekhner is the establishment of the basic psychophysical law (Kuzmin E.S., Yakunin V.A., 1985).

Psychophysiology. Simultaneously with the research of G. Fechner, a group of physiologists headed by G. Helmholtz developed the problem of the psychophysiology of the sense organs. The central place in these studies belonged to the problems of vision and hearing (Kuzmin E.S., Yakunin V.A., 1985).

Psychometry. F. Donders and Z. Exner continued the studies begun by astronomers on measuring the personal equation, and Z. Exner suggested replacing this term with the concept of “reaction time”, since this problem acted as a physiological and even psycho-physiological one (Kuzmin E.S., Yakunin V.A., 1985).

1.6.3 The transition of psychology to an independent path of development

In the second half of the XIX century, psychology gradually became an independent experimental science, standing out from philosophy and natural science. But both the sciences and philosophy continued to influence psychology. The early stage of the development of psychology within the natural-scientific domain includes two periods: the creation of psychological theories and the opening of experimental psychological laboratories (Kuzmin E.S., Yakunin V.A., 1985).

Theoretical programs of natural restructuring of psychology. Since the transformation of psychology into an independent science, there has been a need to systematise the accumulated knowledge. Programs for the restructuring of psychology began to be developed. The most significant of them are programs I.M. Sechenov and

V. Wundt. I.M. Sechenov is the ideological inspirer of experimental psychology, the first of the Russian naturalists to come up with a proposal for the development of psychological science. Another program for the development of psychology was developed by the German scientist W. Wundt. He considered psychology as a science about the phenomena of consciousness directly given to the subject, and proclaimed introspection (self-observation) as the main method. (Kuzmin E.S., Yakunin V.A., 1985).

The first psychological laboratories. The creation of research laboratories was the next stage in the development of psychology. Experimental studies were necessary for the implementation of the developed theoretical programs and the complete transition of psychology into the field of accurate and reliable cognition. Laboratories in Germany, Russia, USA, England and France gained the greatest importance. Along with laboratories and research institutes, various scientific publications and journals began to appear (Kuzmin E.S., Yakunin V.A., 1985).

1.6.4 The first experimental studies

At an early stage in the development of psychology, within the natural-scientific domain, the first experimental studies began. First of all, the main mental processes were studied: sensations, perception, emotions, associations, memory and thinking (Kuzmin E.S., Yakunin V.A., 1985).

Study of sensation and perception. At the end of the 19th century, the main problem of most psychological laboratories was the study of elementary mental processes: sensations and perceptions. Examples of this can serve as research conducted in the Leipzig laboratory of W. Wundt and psychological laboratories in Russia. Two-thirds of all research in W. Wundt's laboratory of was occupied by psychophysical measurements, psycho-physiological studies of sensations and perception, as well as chronometric measurements of reaction time. Numerous psychological studies were also carried out in the laboratories of Russia (Kuzmin E.S., Yakunin V.A., 1985).

Study of emotions. At the origins of this area of research was the James-Lange motor theory of emotions. According to her, emotions represent the awareness of physiological changes caused by the perception of a situation. This concept was supported by the studies of C. Bell and C. Darwin. The main value of the James-Lange theory was that it contributed to the introduction of physiological methods for studying emotions in experimental psychology (Kuzmin E.S., Yakunin V.A., 1985).

Study of associations and memory. At the end of the 19th century, associative psychology still retained its influence, so the study of associations played a large role in

the psychological science of that time. Thus, the English scientist F. Galton conducted a series of experiments to measure the time of associative processes and the meaningful composition of associations. He owns the idea of creating a method of free associations. Experimental studies have shown the need to build a new classification of associations. The study of associations became a transitional bridge to the study of memory. W. Wundt's colleague G. Ebbinghaus set out to apply psychophysical methods to the study of memory. G. Ebbinghaus established the forgetting curve known in psychology, which reflects the logarithmic dependence of forgetting on time (Kuzmin E.S., Yakunin V.A., 1985).

Study of thinking. The qualitative originality of thought processes was practically denied within associative psychology. The first steps towards the experimental study of thinking were made at the beginning of the 20th century by representatives of the Würzburg school headed by O. Külpe (Kuzmin E.S., Yakunin V.A., 1985).

1.7 History of the St. Petersburg (Leningrad) School of Psychology

It should be noted that the history of the St. Petersburg (Leningrad) psychological school is considered on the example of the scientific work of psychologists at St. Petersburg State University (SPbSU). The review includes the following aspects:

- The Sechenov-Pavlov school of physiology of higher hervous activity
- Directions of development of the St. Petersburg (Leningrad) psychological school
- Directions of research of the St. Petersburg (Leningrad) psychological school
- Theories of the most important representatives (the classics) of the St. Petersburg (Leningrad) psychological school

1.7.1 The natural-scientific domain in the Sechenov-Pavlov school of physiology of HNA

The Sechenov-Pavlov school of physiology of higher nervous activity is the direct predecessor of the St. Petersburg (Leningrad) school of psychology. Its most prominent representatives are I.M. Sechenov, I.P. Pavlov, N.E. Vvedensky, A.A. Ukhtomsky, P.K. Anokhin, N.A. Bernstein and M.N. Livanov.

Since the physiology of HNA in the USSR was even more developed than psychology (after the Pavlov session of 1950 there was an attempt to replace psychology with the physiology of HNA), the Sechenov-Pavlov school was directly connected with the St. just from the school of physiology of HNA. In fact, the St. Petersburg school is the "heir" of the Sechenov-Pavlov school. The same applies to the

use of physical laws in the description of mental (primarily psycho-physiological) phenomena.

I.M. Sechenov. Application of physical laws in the works of I.M. Sechenov is distinguished by its originality. In the work "Physiology of nerve centres" the author describes the results of physiological experiments on various animals. When describing I.M. Sechenov proceeds from the electrical nature of the nerve impulse, and physical (electrical) and chemical stimuli were also used as stimuli (Sechenov I.M., 1952; Sechenov I.M., 1953; Sechenov I.M., 1947). Thus, it was I.M. Sechenov initiated the application of physical laws and principles in physiology (and, more broadly, in psychophysiology).

Another work by I.M. Sechenov, significant from the point of view of the natural-scientific domain ("Elements of the thought") is devoted to an attempt to study the process of thinking (as well as such cognitive processes as perception and memory) from natural-scientific positions. This monograph examines the evolution of the concept of number, counting, arithmetic operations and mathematical operations. According to the author, the simplest counting by enumeration arose in humans due to the rhythm (periodicity) of walking. As various laws of physics were discovered, the list of mathematical operations known to man gradually expanded (Sechenov I.M., 1935).

I.P. Pavlov. I.P. Pavlov considered physical laws to be the ideal of accuracy - he imagined physics to be an ideal science (subsequently, American behaviourists, who considered I.P. Pavlov as an example to follow, reasoned in exactly the same way). In describing his famous experiments on the development of conditioned reflexes in dogs, he adhered to the "mechanistic" principle. He introduced into physiology (and, more broadly, into psychophysiology) such terms as "extinction", "temporal connection", "external energy transformer" (Pavlov I.P., 2008).

Thus, he tried to bring terminology from physics into his field. Refusal of I.P. Pavlov from psychological terminology when describing the results of research can be regarded as a proposal to make the physiology of HNA an exact science. In addition, I.P. Pavlov at the end of the course of lectures convincingly proves that the conditioned reflex and combination reflex V.M. Bekhterev is one and the same phenomenon (Pavlov I.P., 1952). It was the rejection of psychological terminology and the appeal of I.P. Pavlov to natural scientific methods and terms helped him create the concept of HNA types, linking it with the types of temperament identified by Hippocrates (Pavlov I.P., 2001; Pavlov I.P., 1952).

N.E. Vvedensky. N.E. Vvedensky, the author of the doctrine of parabiosis, argued that the application of the laws of physics to physiology caused a scientific revolution, forcing physiologists to abandon vitalistic concepts. But soon the adherents of this

approach faced a problem: physiological processes are much more complicated than physical ones, and simply did not fit into the framework of physical science (Vvedensky N.E., 1952). N.E. Vvedensky often mentions such units of measurement as current strength or induction (Vvedensky N.E., 1952). It is important that the author in his research specifically uses such terms from the field of physics as "rhythm", "periodics", "elasticity", "interference", etc. N.E. Vvedensky considered it possible to compare physical and physiological stimuli in terms of effectiveness for experiments (Vvedensky N.E., 1952).

A.A. Ukhtomsky. A.A. Ukhtomsky, the author of the doctrine of the dominant, applied physical laws in a very special way. In the monograph "Physiology of the motor apparatus" the author explores the musculoskeletal system from the standpoint of mechanics and electrodynamics (using the concept of the electrical nature of the nerve impulse) (Ukhtomsky A.A., 1927).

In the same way, A.A. Ukhtomsky explains the key concept of his teaching: the concept of dominant. The author calls the dominant focus of excitation in the cerebral cortex, which has the following features: increased excitability, the ability to accumulate excitation, the ability to maintain excitation and inertia.

In addition to what the author calls as one of the main properties of the dominant, in fact, the physical phenomenon of inertia, in the study of the dominant, he applies physical laws: Poisel's law, Ohm's law and Le Chatelier's principle (Ukhtomsky A.A., 1966).

In addition to parabiosis, A.A. Ukhtomsky continued to develop another idea of N.E. Vvedensky - the concept of physiological lability, and he developed it based on the physical theory - the nonlinear theory of oscillations (Ukhtomsky A.A., 1978).

Also interesting is the article by A.A. Ukhtomsky "The system of reflexes in the ascending series". In it, the author describes in detail the difference between spinal and cortical reflexes. From the point of view of the natural science paradigm, it is important that A.A. Ukhtomsky compares classical spinal reflexes with a mechanical impulse, pointing to a negligibly small interval between stimulus and response compared to cortical reflexes (Ukhtomsky A.A., 1952).

The value of the works of A.A. Ukhtomsky for the St. Petersburg (Leningrad) psychological school. Works by A.A. Ukhtomsky are of great importance for both domestic and world psychological science. His doctrine of the dominant belongs not only to physiology, but also to psychology and Christian (Orthodox) philosophy. A.A. Ukhtomsky managed to bring together natural-scientific and religious approaches (Zueva E.Y., Zuev K.B., 2015).

According to the author, for the life of a person, the most significant dominant is the face of another person, thanks to which the individual becomes a personality. A.A.

Ukhtomsky considered the dominant on another person as the foundation of culture, inherited from one generation to another. Thus, the author perceived physiology not only as a science, but also as a foundation for many humanities (Smirnova A.A., Shabanova T.L., 2016).

In the theory of A.A. Ukhtomsky, philosophical and methodological provisions are distinguished, which can be considered the forerunners of many ideas of cybernetics and synergetics:

- the irreversibility of time in the life process;
- the presence of two fundamentally different stages of the process: the deterministic phase and the instability phase, i.e. change of dominants;
- integration into a single system;
- holism;
- non-equilibrium of the process (Zueva E.Y., Zuev K.B., 2015).

It should also be noted the article by N.A. Loginova, in which A.A. Ukhtomsky is named among the natural scientists who had a significant impact on the development of the St. Petersburg school of psychology, transferring the model of experimental natural science to the field of psychology (Loginova N.A., 2007).

N.A. Bernstein. This author used natural-scientific principles to create his hierarchy of levels of organisation of movements. He believed that movements could belong to one of five possible levels. Each level corresponds to a certain stage in the evolutionary development of the nervous system. N.A. Bernstein identified the following levels of movement organisation:

- the rubro-spinal level of paleo-kinetic regulation;
- the level of synergies and stamps, or the thalamo-pallidar level;
- the pyramidal-strial level of the spatial field;
- the parieto-premotor level of actions;
- the group of cortical levels (Bernstein N.A., 1990; Bernstein N.A., 1997).

P.K. Anokhin. Another outstanding figure in the Sechenov-Pavlov school of physiology of higher nervous activity, who applied mechanistic and natural-scientific principles, is P.K. Anokhin, author of the theory of functional systems. This theory is itself mechanistic: the functional system is a "mechanical" model of the decision-making process. The process itself in this model is presented by the author as a mechanism that includes four block elements:

- the afferent synthesis
- the programming block
- the decision block
- the acceptor of the result of an action (Anokhin P.K., 1980).

In articles devoted to cybernetics and synergetics, P.K. Anokhin mentioned the significance of the second law of thermodynamics in such theories significant for science as A. Einstein's theory of relativity, the Big Bang theory and the Oparin-Haldane "primordial soup" hypothesis. He then continued his thought in the direction of applying the general laws of physics to explain processes occurring in the brain, such as synaptic transmission. By this, the author emphasised that there are universal laws that operate in the entire Universe without exception (Anokhin P.K., 1978).

P.K. Anokhin considered the theory of the reflex to be a derivative of the materialistic views of the philosophers of the 17th century, who tried to free themselves from religious and mystical ideas about the human mind. They, and then their followers up to the author's contemporaries, built a "physical" model of the nervous system.

In the article “On some controversial issues in the problem of conditional connection closure” P.K. Anokhin applied the physical principle to the theory of the reflex ring. This is evidenced, in particular, by the metaphor of “closure”, which associates the conditioned reflex ring with an electrical circuit (Anokhin P.K., 1979).

M.N. Livanov. M.N. Livanov and his collaborator and co-author T.P. Khrizman investigated the spatio-temporal organization of brain biopotentials. In the course of the study, the authors relied on synergetic ideas about the system as a self-organising whole. The author's method of fixing the synchronous dynamics of electrophysiological processes of a number of brain points was used in the study in order to trace their intercentral interactions.

The results of this study showed that the dynamics of intercentral EEG correlations has a two-phase character.

1. The first phase is the phase of reproducing the image of the upcoming action
2. The second phase is the phase of readiness for action (Livanov M.N., Khrizman T.P., 1978)

1.7.2 Directions of development of the St. Petersburg (Leningrad) psychological school

A scientific school is a specific way of organizing cooperative scientific activity, the essence of which is determined by the unity of the processes of cognition and transfer of scientific experience - the production of new knowledge and the reproduction of people of science. M.G. Yaroshevsky identified three types of scientific schools, differing in the dominance of one of the three groups of functions they perform:

- A scientific-educational school;
- A school as a research team;
- A school as a direction in science (Umrikhin V.V., 2007).

The origins of the St. Petersburg (Leningrad) psychological school lie in the works of psychologists, philosophers, theologians and scientists (doctors and physiologists) of the 19th century, who worked at the Medical-Surgical Academy (the Military Medical Academy since 1881), the Imperial University and the Theological Academy. Lectures on psychology were also given at St. Petersburg University in the departments of philosophy, and from 1850 to 1863 in the departments of theology. Already at the dawn of the formation of the St. Petersburg (Leningrad) psychological school, there were three directions:

1. Academic psychology (F.V. Schelling, D.M. Vellansky, A.I. Galich, D.P. Runich, A.A. Fisher, A.I. Raikovsky, I.L. Yanishev, V.P. Polisadov, I.A. Chistovich, V.N. Karpov, A.E. Svetilin);
2. Physiological psychology (A.P. Zagorsky, I.M. Sechenov, N.M. Yakubovich, I.P. Pavlov, V.M. Bekhterev, I.M. Balinsky, F.V. Ovsyannikov, I.F. Tsion);
3. Scientific psychology (M.N. Karinsky, N.G. Dobolsky, A.P. Vysokoostrovskiy, V.S. Serebrennikov, F.F. Sidonsky, M.I. Vladislavlev, A.I. Vvedensky, A.P. Nechaev , N. O. Lossky, I. I. Lapshin, A. F. Lazursky, I. R. Tarkhanov, N. P. Wagner) (Morozova S. V., 2006).

The founder of the St. Petersburg school of psychology is considered to be V.M. Bekhterev, and his reflexological concept, in fact, is the first example of the use of the natural-scientific domain, therefore it can be argued that this domain was used by representatives of the named direction from the very beginning, despite the fact that each of its representatives used different natural-scientific principles.

There are two main directions within the Leningrad school. The first (early) current includes A.F. Lazursky, M.Y. Basov and V.N. Myasishchev. Representatives of the second (later) branch of the St. Petersburg (Leningrad) psychological school are B.G. Ananyev, B.F. Lomov, L.M. Wecker, V.A. Hansen, I.M. Paley, G.V. Sukhodolsky, L.N. Granovskaya and E.I. Stepanova (Balin V.D., 2012, Levchenko E.V., 2003; Loginova N.A., 2005; Loginova N.A., 2016)

1.7.3 Directions of research of the St. Petersburg (Leningrad) psychological school

The research activities of the St. Petersburg (Leningrad) school of psychology include a number of areas dedicated to solving certain issues of theoretical psychology. Each direction uses certain methods of sciences, the range of which varies from psycho-physiological research methods to the use of mathematical methods. The following areas of research are distinguished within the school:

- The research in the field of neurodynamics
- The issues of psychogenesis
- The study of bilateral asymmetry

- The determination of the psycho-physiological "price" of the body
- Predicting the success of labour activity
- Accumulation of statistical characteristics for different samples
- The study of energy-informational relationships
- The study of the relationship between different forms of activation
- Typological studies
- Sensory systems research
- The search for psychological invariants and the application of mathematical methods in psychology (the mathematical psychology of G.V. Sukhodolsky stands out especially here) (Balin V.D., Stepanova J.V. 2018).

Neurodynamics. Firstly, the search and testing of methods is carried out, with the help of which it is possible to identify the properties of the nervous system (strength, mobility, lability, dynamism). Secondly, a search is being made for a general factor of neurodynamics that determines psychological "success": the level of activation. B.G. Ananyev argued that "... there are not only particular types of sensitivity (as potential properties of individual analysers), but also a general way of sensitivity for a given person, which is a property of the sensory organisation of a person as a whole. This general property in psychology is called sensitivity, which is included in the structure of temperament" [4, p. 75-76].

The ratio of strength, balance and mobility of nervous processes forms the type of the nervous system, which is the basis of temperament and abilities (Ananyev B.G., 1977).

This research program was implemented by I.M. Paley, N.G. Zyryanova, B.S. Oderyshev, V.K. Gerbachevsky, V.P. Mikhaylova, V.F. Shendrik. G.I. also adjoins them. Akinshchikova, who studied the indicators characterising the reactivity of the body (Balin V.D., 2017).

The issue of psychogenesis. The issue of psychogenesis is the search for the physiological mechanisms of mental phenomena. This direction can be seen in almost all the works of the authors of the St. Petersburg (Leningrad) psychological school. It is implemented in the form of a search for physiological correlates of mental phenomena: intelligence, memory, attention, level of claims, motivation, etc. (Balin V.D., 2017).

Exploring bilateral asymmetry. "The theme can be traced in almost all publications of the school representatives. Age and micro-age aspects of the phenomenon, psychological correlates of bilateral asymmetry are studied. To explain this phenomenon, mathematical models of different levels of complexity, the apparatus of information theory are involved" [15, p. 135].

Determination of the psycho-physiological "price" . “A search is being made for equations that make it possible to determine the “price” that the body “pays” for the performance of a certain mental activity. This direction allows reaching such an assessment of the efficiency (efficiency) of different types of labour, which would take into account not only its productivity and quality, but also the “price”, “costs” of the body associated with its (labour) performance” [15, p. 135-136].

Forecasting the success of labour activity. “In a number of studies, regression equations are compiled that can be used to predict the success of the labour activity of representatives of various professions: radio installers, mental workers, actors, salespeople, etc.” [15, p. 136].

Accumulation of statistical characteristics for different samples. Since extensive studies are carried out on a variety of samples (not only students), the data are gradually accumulated, which makes it possible to determine the normative assessments characteristic of different groups of people differing in gender, age, education, etc., obtained using all available methods.

For this reason, it is also necessary to mention the problem of scaling psycho-physiological indicators. Scale scores are necessary so that diverse indicators can be compared with each other. This problem arises in connection with the research of the St. Petersburg school of psychology within the holistic and systemic approaches, since the elements (empirical characteristics) within the whole must be comparable (Balin V.D., 2017; Bodalev A.A., 1976).

The study of energy-informational relationships. In the 1960s – 1970s, the information theory was popular with psychologists. The study of energy-informational relationships is considered to be another aspect of research within the holistic approach. This relationship is implied when the relationship between psychological and physiological indicators is studied (the mental one is “information”, and the physiological one is “energy”), when the problem of bilateral asymmetry is dealt with (the right hemisphere is “energy”, and the left hemisphere is “informational”), when determine the psycho-physiological "price" of the work (how much energy is spent on processing one bit of information) (Balin V.D., 2017).

Studying relationship between different forms of activation. Many publications are devoted to the study of the relationship between different forms of activation: central, autonomic and somatic ones. These are the works of I.M. Paley and K.D. Shafranskaya, N.A. Rose, N.G. Zyryanova, B.S. Oderyshev, G.I. Akinshchikova.

The main motive for such work is the search for a common factor of nervous activation. Typically, the correlations between these measures were random, although they were calculated between activation measures within the same block. The cortical

indicators are highly correlated with cortical ones, the vegetative indicators with vegetative ones, the motor indicators with motor ones. Correlations are enhanced when the subject is included in the activity. This fact is easily explained from the point of view of a functional system that is formed in connection with the activities performed (Balin V.D., 2017).

Typological studies. The issues of the psychological type is quite significant for the researchers of the school. I.M. Paley, G.I. Akinshchikova, V.S. Magun, T.N. Kurbatova, and others were engaged in various aspects of this direction. In particular, in the work of T.N. Kurbatova, 7 types of combinations of neurodynamic properties are described. In other words, the type here is a stable (invariant) combination of physiological parameters. Here we can see the connection with the publications of Perm school psychologists of V.S. Merlin (Balin V.D., 2017).

Study of sensory systems. Sensory thresholds of sensitivity of different modality are investigated. In addition to classical studies of visual and auditory sensitivity, the study of vibration, pain, tactile and temperature, as well as olfactory and taste sensitivity is carried out.

An integrated approach to measuring sensitivity, including measuring the reaction time of each modality, was used by B.G. Ananyev. The data of these studies made it possible to speak about general and partial types of sensitivity and their manifestations in the structure of both individual and personal, subjective-activity and individual properties of a person.

It should also be noted the complex experimental studies of sensory deprivation, carried out under the guidance of B.G. Ananyev. This set of studies, conducted in collaboration with the Military Medical Academy and the Faculty of Psychology of Moscow University, also included the measurement of sensory sensitivity thresholds (Balin V.D., 2017).

The search for psychological invariants. Physical invariants are known: Avogadro's number, Planck's constant, etc. Many physiological parameters (pulse rate, blood pressure, body temperature, etc.) are also treated as invariants. The concept of an invariant was introduced into psychology by J. Piaget. Perceptual constants (invariants) of Koffka are known. According to the law of D.V. Atkinson, the strategies of striving for success (P_y) and avoiding failures (P_n) add up to a constant. Their joint probabilities are equal to one.

The works of L.M. Wecker are widely known, where mental processes are considered from the standpoint of the theory of algebraic invariants. In the above-mentioned work, T.N. Kurbatova's neurodynamic type, in essence, is designated as an

invariant. In all these concepts, the invariant acts as an attractor of a self-organizing system (Balin V.D., 2017).

Psychology and mathematics. A search is being made for methods of mathematical processing of psychological experimental material. It is primarily about mathematical statistics. Examples of the use of various "non-standard" mathematical procedures can be found in the works of L.N. Granovskaya, E.I. Stepanova, N.G. Zyryanova et al., V.F. Fedorov, T.P. Kister. There are works in the field of statistics by G.V. Sukhodolsky. G.V. Sukhodolsky is one of the founders of mathematical psychology at the St. Petersburg (Leningrad) school of psychology. He created a number of original methods for the mathematical modelling of mental objects (Suhodolsky, 1997, Sukhodolsky, 1998).

The mathematisation of psychology contributes to its formation as an exact science, thereby bringing it closer to the natural sciences. Thus, G.V. Sukhodolsky made a significant contribution to the development of the natural-scientific domain in the St. Petersburg (Leningrad) school of psychology.

Another direction of this work is the application of mathematics to mental phenomena modelling. First of all, it is necessary to say about attempts to involve the apparatus of topology for these purposes. In this regard, the works of L.M. Wecker, V.A. Ganzen, and A.I. Naftulyev. At present, there is an assumption that many mathematical concepts are, in fact, psychological theories or parts of them. Thus, works on multidimensional space are consistent with the ideas of psychologists about consciousness, and A. Einstein, outlining SRT, actually gave a general picture of mental perception (Balin V.D., 2017).

1.7.4 Concepts of the main representatives of the St. Petersburg (Leningrad) psychological school

V.M. Bekhterev's reflexology. The classification of reflexes. V.M. Bekhterev, the founder of the reflexological direction in psychology, borrowed the concept of a reflex from the physiology of higher nervous activity and turned it from a purely physiological term into a philosophical concept.

According to V.M. Bekhterev, a reflex is an integral element of any mental act, not just a response of the body to a particular stimulus. The author identified several groups of reflexes, one of which (associative reflexes) corresponds to conditioned reflexes according to I.P. Pavlov, and some others (concentration reflexes, personal reflexes) are not reflexes in the psycho-physiological sense of the word, rather, they can be called mental processes, states and personality traits. But Bekhterev himself, in turn, based the reflexological theory on the famous statement of I.M. Sechenov "All acts of

conscious and unconscious life are reflexes in terms of their mode of origin." The author identified the following groups of reflexes:

- internal reflexes;
- complex reflex acts of standing and walking;
- instincts;
- reproductive reflexes;
- associative reproductive (imitative) reflexes;
- combination reflexes;
- concentration reflexes;
- symbolic reflexes;
- personal reflexes (Bekhterev V.M., 1991).

V.M. Bekhterev's natural-scientific principles. V.M. Bekhterev considered it possible to apply the laws of natural sciences to mental phenomena. He formulated a number of principles that make it possible to adapt the general laws of physics and biology to describe various phenomena of the mind. V.M. Bekhterev singled out the following natural scientific principles: the principle of conservation of energy; the principle of a proportional ratio of the speed of movement with the driving force; similarity principle; the principle of continuous variability; the principle of evolution; the principle of interaction, the principle of periodicity (rhythm); the principle of historical sequence; the principle of saving in energy consumption; the principle of adaptation; the principle of counteraction equal to action; principle of differentiation; the principle of synthesis (combination); the principle of substitution (compensation); the principle of inertia (installations); selection principle; the principle of relativity; the principle of dependent relationships; the principle of individuality (Bekhterev V.M., 1928).

All principles can be conditionally divided into two groups according to the scientific discipline from which this principle came. The first group includes principles based on the laws of physics: the principle of conservation of energy; the principle of a proportional ratio of the speed of movement with the driving force; similarity principle; the principle of continuous variability, the principle of interaction; the principle of counteraction equal to action; the principle of inertia (installations); the principle of relativity; principle of individuality.

The second set of principles came from biology, some of them from Pavlovian physiology: the principle of evolution; the principle of adaptation; the principle of periodicity (rhythm); the principle of historical sequence; the principle of saving in energy consumption; the principle of adaptation; the principle of differentiation ; the principle of synthesis (combination); the principle of substitution (compensation); selection principle; the principle of dependency.

Personality structure by A.F. Lazursky. A.F. Lazursky created a model of personality, reminiscent of the structure of the atom. Thus, he called the "core" endo-mind and the "shell" exo-mind.

Endo-mind includes such psycho-physiological functions as receptivity, memory, attention, thinking, imagination, affective excitability, will, motor skills, etc. The author himself claims that the endo-mind can be identified with the temperament or neuronal organisation of a person. From the point of view of the natural science paradigm, it is important that A.F. Lazursky paid much attention to the psycho-physiological essence of endo-mind, pointing to its natural origin. Therefore, the author emphasised the need to study the anatomical and physiological correlate of the main inclinations.

Exo-mind, in turn, is a system of relations between the individual and the environment, primarily social. The system of relations includes: nature, material things, other people, social groups, spiritual goods (science, art, religion), as well as the spiritual life of the person himself, everything to which an attitude can be formed (Lazursky A.F., 1997; Lazursky A.F., 1995).

The classification of personalities by A.F. Lazursky. A.F. Lazursky based his classification of personalities on the concept of a "two-layer" structure of the minbd. Depending on the degree of development of endo- and exo-mind, as well as their interaction, three levels are distinguished: lower, middle and higher.

Within each level, both “pure” and combined, perverted and transitional personality types are distinguished. "Pure" types are formed when the endo- and exo-mind mutually correspond to each other. Combined types combine in themselves two essentially different groups of basic mental phenomena, and also find applications in life that give their exo-mind wholeness and typicality. A feature of perverted types is that a significant part of their actions and deeds are biologically inappropriate and even harmful either to themselves or to others, and sometimes both together (Lazursky A.F., 1997).

The structure of behaviour according to M.Y. Basov. Like A.F. Lazursky, M.Y. Basov created a structure of behaviour resembling the structure of an atom. He singled out external and internal behavioural reactions. External reactions are divided into external physical and external social (according to the source of the stimulus). Between internal and external behavioural reactions, as well as between exo-mind and endo-mind in A.F. Lazursky’s concept, there should be a relationship, since, according to M.Y. Basov, external and internal stimuli interact with each other (Basov M.Y., 1975).

External categories of behaviour in M.Y. Basov concept. M.Y. Basov developed a method for analysing external categories of behaviour in the process of observing the behaviour of a child (it is known that Basov was a teacher and founder of pedology, the

predecessor science of child psychology, and was engaged in the study of the child's mind). External categories of observation are the categories that make up the child's behaviour, which is the subject of observation (Basov M.Y., 1975).

V.N. Myasishchev on the biological nature of man. Being a clinical psychologist, V.N. Myasishchev considered personality in the context of pathology. Considering the question of the relationship between the biological and the social in the structure of the personality, the author criticised the biologisation approach, which tries to explain complex mental phenomena by reducing them to lower and elementary (physiological) functions.

However, V.N. Myasishchev believed that psychophysiology cannot be divorced from psychology, and psychology, in turn, from the science of society (sociology). In particular, he considered his own theory of relations to be an expression of the physiological A.A. Ukhtomsky's principle, applied to complex mental phenomena (Myasishchev V.N., 2004).

V.N. Myasishchev's concept of personality. According to V.N. Myasishchev, personality is a system of human relations to the surrounding reality. Attitude, in turn, is strength, potential, which determines the degree of interest, the degree of expression of emotion, the degree of tension of desire or need, the driving force of the personality. According to V.N. Myasishchev, personality structure includes the following components: dominant relationships, the mental level of a person, the dynamics of personality reactions (temperament) and the relationship of the main components (general personality structure) (Myasishchev V.N., 2004).

B.G. Ananyev on the sciences studying the biological nature of a man. Discussing the place of psychology in the system of sciences, B.G. Ananyev applied his concept of a comprehensive study of a man to the interdisciplinary connections of psychology. He identified three groups of sciences that study the biological nature of man: *Homo sapiens* sciences, a scientific study of the nature-human and human-nature relationships, sciences of a man as an individual about his ontogeny. To the sciences of man as a biological species *Homo sapiens* include the following disciplines: anthropology, biological sciences, paleo-pathology, anatomy, physiology, endocrinology, biochemistry, biophysics, molecular biology, neurocybernetics, psychophysiology, neuropsychology, general human psychology, medicine. To the sciences that study the connections "nature-human" and "human-nature", according to B.G. Ananyev, include biology, geology, geochemistry, geophysics, biophysics, other branches of physics, molecular biology, the study of the biosphere and noosphere. The study of a man as an individual, according to B.G. Ananyev, should also be interdisciplinary. The system of sciences about a person as an individual includes the following disciplines:

developmental physiology, child psychology, pediatrics, acmeology, gerontology, ontophysiology, developmental biology, comparative ontopsychology, sexology, somatology, HNA typology (Ananyev B.G., 1968).

The structure of a person as an individual in the concept of B.G. Ananyev. In the structure of the individual, according to B.G. Ananyev, It is necessary to highlight the main studied phenomena: age properties, sexual properties, constitutional properties, neurodynamic properties, temperament and inclinations of abilities (Ananyev B.G., 1968).

Sensory-perceptual organization of a person according to B.G. Ananiev . B.G. Ananyev created a new theory of sensory systems (analysers), called the *sensory-perceptual organization of a person* . This concept considered analysers as systems that have developed in the process of evolution and develop in connection with labour activity. The sensory-perceptual organisation includes 11 types of sensations, which are divided into 3 groups:

1. Distant: visual, auditory and olfactory sensations
2. Contact: tactile, taste, temperature, vibration and pain (on the surface of the skin)sensations
3. Sensations related to the body itself: kinesthetic, vestibular (static-dynamic), interoceptive, pain (in internal organs) sensations

Developing the ideas of I.M. Sechenov about the association of sensations, B.G. Ananyev singled out two classes of such associations: intramodal and intermodal interactions (Ananyev B.G., 1977).

Theory of mental development B.G. Ananyev. Within the multi-level concept of personality B.G. Ananyev, a person is considered as an individual, a subject of activity, personality and individuality. This allows us to solve the problem of the biological and social in the human mind. This approach also made it possible to identify 3 main mechanisms of mental activity: functional, operational and motivational ones.

B.G. Ananyev believed that mental development is the result of both external and internal factors: heredity, environment, activity. He also singled out three leading types of activity that determine human development: communication, knowledge, work.

Ananyev also owns the allocation of the main patterns of ontogenesis: unevenness, heterochrony, inconsistency, structurality. The author paid great attention to the correlation of level and structural characteristics of development (Savenysheva S.S., Vasilenko V.E., Strizhitskaya O.Y., 2011).

The development of a person as an individual B.G. Ananiev calls *ontogeny*. The special significance of B.G. Ananiev gave heterochrony to the development of psycho-

physiological functions. Not only development processes, but also involutionary processes are subject to this law (Ananiev B.G., 1968).

B.G. Ananyev's law of heterochronous development of psychophysiological functions in ontogeny. « *The general view.* Part 1. In the process of ontogenetic development, an uneven development of the psycho-physiological functions of a person takes place - the period of rise of one function is accompanied by a period of decline of another, and vice versa. Part 2. In ontogenesis, involutionary processes are compensated by restorative changes, in particular, the relative autonomy of a function is lost, and an integral structure appears on this basis. *Amendment of Granovskaya and Stepanova:* There are two phases in the development of the psycho-physiological function. The first is the progress of the function, the second is the specialisation of the function" [15, p. 40].

B.F. Lomov's classification of laws. B.F. Lomov created a classification of the laws of psychology according to the level of development of their logical structure. He identified seven types of laws:

1. Laws characterising relatively elementary dependencies.
2. Laws that reveal the dynamics of mental processes as diachronic systems.
3. Laws characterising the structure of mental phenomena.
4. Laws that reveal the dependence of the effectiveness of behaviour on the level of its regulation.
5. Laws related to the process of human mental development, considered on the scale of his life.
6. Laws that reveal the foundations of various mental properties of a person.
7. Laws on the relationship between different levels of organisation of mental processes and properties (Balin V.D., 2012).

Anticipation levels according to B.F. Lomov. Anticipation is a mental process that provides the ability to make certain decisions with a certain temporal-spatial anticipation of events ("running ahead"). B.F. Lomov identifies five levels of anticipation:

1. Subsensory level (unconscious neuromuscular presets and movements that ensure the coordinated execution of the upcoming action).
2. Sensorimotor processes that ensure the timeliness of reactions and their ordering according to the criterion of speed.
3. Perceptual anticipation, which allows you to build an image of perception, taking into account its future changes in time and space.
4. Anticipation at the representation level, which provides proactive planning of not only real, but also potential actions.

5. Anticipation at the level of speech-thinking processes, which provides forecasting of events and planning of behaviour (Lomov B.F., 1999).

Signs of mental phenomena according to L.M. Wecker. The presence of these signs should indicate that all mental phenomena exist and develop according to uniform laws. L.M. Wecker identifies the following general criteria for mental phenomena: objectivity, subjectivity, sensory inaccessibility and spontaneous activity (L.M. Wecker, 2000).

The formation of the image of perception according to L.M. Wecker. According to the views of L.M. Wecker, the formation of a perceptual image does not occur at once, but goes through several clearly defined stages, each of which has certain characteristics. The sequence of phases has been identified in a number of experiments using both visual and kinesthetic imagery and under various conditions. This sequence is as follows:

1. Distinguishing the position of an object and a rough estimate of its general proportions (an open loop)
2. Stage of an "amorphous spot" - amorphous and variable structure of a closed contour (a flickering form)
3. The distinction between sharp changes in curvature, expressed, in particular, by the transition from one straight line to another.
4. Globally adequate perception, in which the form is presented correctly, but without distinguishing details (permissible violations of proportions and angles, as well as distortion of details).
5. Adequate reproduction of the form in the fullness of the details of its contour (Wecker L.M., 1964; Wecker L.M., 2000).

The relationship between the stages of perceptual image formation and geometric invariants. L.M. Wecker also associated the stages of perceptual image formation with a system of geometric invariants. Thus, he emphasized that geometric invariants are a kind of psychological "Noether's theorem", which allows one to explain "symmetry" in mental phenomena. Just as according to Noether's theorem in physics there is a connection between conservation laws and properties of time and space, so Wecker connected geometric invariants with phase changes in the perceptual image. The very scheme of connection between the stages of formation of a perceptual image and the system of geometric invariants looks like this:

1. The open loop stage corresponds to the topological invariant
2. The "amorphous spot" stage corresponds to the projective invariant
3. The stage of distinguishing sharp changes in curvature corresponds to the affine invariant

4. The stage of globally adequate perception corresponds to the similarity invariant
5. The stage of adequate reproduction of the form corresponds to the metric invariant (Wecker L.M., 1964; Wecker L.M., 2000)

Physics and psychology in the teachings of L.M. Wecker. The problem of mental norm. L.M. Wecker also actively developed the problem of classifying mental phenomena in general psychological terms. In particular, during his speech at the faculty of psychology (1998), the author paid much attention to the problem of general psychology as the theoretical basis of psychological science. As an example, he cited the fact that the Journal of General Psychology began to lose its subject due to inconsistencies between different departments of psychology, which, as it were, "speak different languages." In addition, L.M. Wecker noted that psychologists are not at all interested in the problem of the norm, being more engaged in the study of an unhealthy person and studying the medical aspects of the mind. General psychology must build a theory of the mental norm.

Also L.M. Wecker argued that it was necessary to build a unified system of the miind, creating a harmonious hierarchy of mental phenomena. As a positive example, the author suggested considering physics. According to L.M. Wecker, first you need to create a single system of units of measure for all cases, similar to the CGS systems existing in physics (centimetre – gram – second) and the later SI (international system). Under update B.G. Ananyev, L.M. Wecker argued that psychology as a science plays the role of an integrator for all natural sciences, and this must be taken into account when creating new textbooks on general psychology (Balin V.D., Stepanova J.V., 2018).

V.A. Hansen's systemic approach. V.A. Hansen was one of the founders of the systemic approach in psychology, which considers the mind as an integral system (a whole). To describe the mind as a whole, the author uses a general scientific system, better known in physics:

Energy		Information
	Substrate	
Time		Space

With regard to the mental whole, V.A. Hansen used not only the general scientific scheme, in addition, he connected the above scheme with a system of the following qualities: subordination, proportionality, unity, repetition, balance. The final scheme looks like this:

Energy subordination		Information Proportionality
	Substrate Unity	
Time Repeatability		Space Equilibrium

Also V.A. Hansen applied this system to various branches of psychological science. He believed that each individual branch of psychology corresponds to one of the general scientific categories described above. The scheme of connection of general scientific categories with branches of psychology is as follows:

Psychology of activity		Psychology of differences
	General psychology	
Developmental psychology		Social Psychology

(Hansen V.A., 1983)

Levels of Hansen and Lomov's needs organisation. V.A. Hansen and L.A. Golovey identified seven levels of organization of human needs, gradually moving from biological to social. This system looks like this: genetic, morphological, physiological, psycho-physiological, psychological, socio-psychological and social levels.
As can be seen already from this diagram, most of the levels (four out of seven) relate to the biological nature of man. Following the natural-scientific domain, B.F. Lomov makes biochemical level the first one. The united hierarchy of levels of needs organisation is following: biochemical, genetic, morphological, physiological, psycho-physiological, psychological, socio-psychological and social levels (Lomov B.F., 1999).

Mathematical psychology at the St. Petersburg (Leningrad) psychological school. An important part of the natural science paradigm in psychology is its mathematisation, i.e. application of mathematical methods and models. This is important primarily because if it is assumed that psychology should follow the path of the natural sciences in its development, then it must acquire a mathematical apparatus, and not only statistical processing of data, but also the modelling of mental phenomena.

Mathematical psychology by G.V. Sukhodolsky. G.V. Sukhodolsky was one of the most prominent representatives of mathematical psychology in the St. Petersburg (Leningrad) psychological school. Along with V.A. Hansen, he advocated the use of mathematical methods in psychology and, in general, its mathematisation, while not being afraid to call his concept mathematical psychology.

G.V. Sukhodolsky proposed a system of mathematical and psychological interpretations, which should allow introducing mathematics into psychology and at the same time avoiding reductionism. It includes:

- Psychological-psychological interpretations
- Psychological-mathematical interpretations
- Mathematical-psychological interpretations
- Mathematical-mathematical interpretations

According to the author, mathematical means of describing psychological objects should include sets, matrices, graphs, functions and algorithms (Sukhodolsky G.V., 1997).

Set and graph theories, as well as algorithms and matrices, are widely used by G.V. Sukhodolsky in the analysis of such a psychological object as human activity. The author's theory of activity includes the following classes of mathematical models:

- conceptual models;
- models on sets;
- models on matrices;
- models on graphs, the most important of which is the abstract activity graph (AAG);
- algorithmic models (Sukhodolsky G.V., 1994)

The most important element of this concept is structural-algorithmic modelling, which includes such operations as structural analysis, algorithmisation and structural synthesis. They, in turn, also include a number of operations: operations of structural analysis; algorithmisation operations; operations of structural synthesis (Sukhodolsky G.V., 1976).

As mentioned above, the mathematisation of psychology contributes to its formation as an exact science, thereby bringing it closer to the natural sciences. Thus, G.V. Sukhodolsky made a significant contribution to the development of the natural science paradigm in the St. Petersburg (Leningrad) School of Psychology.

The esearch made by L.N. Granovskaya and E.I. Stepanova. Granovskaya-Stepanova formula. This study of the dynamics of intellectual functions in the period of adulthood (18-35 years) is important for this work, as it shows the way to apply the mathematical method to describe mental activity. The following functions were studied: intelligence, memory, thinking and attention.

The results of the study showed the harmony of phase oscillations. These continuous fluctuations in the level of functions can be approximated by the function

$$y = A\sin(\omega t + \varphi_a) \qquad (1)$$

where A and ω are themselves a function of age: $A = \varphi(t)$; $\omega = \psi(t)$.

With increasing age amplitude ($|A|$) decreases, frequency (ω) also decreases, and the oscillation period $T = \frac{2\pi}{\omega}$ increases (Granovskaya L.N., Stepanova E.I., 1971).

1.8 Integration of natural sciences and its role for the St. Petersburg (Leningrad) psychological school

In order to understand the role played by the integration of the natural sciences for psychologists of the St. Petersburg (Leningrad) school, one needs to understand the very essence of the integration of the natural sciences. The fact is that natural science is a unified system of scientific knowledge about nature, and the division into separate disciplines is rather arbitrary. For example, organic chemistry is an example of the integration of chemistry and biology.

Such concepts as, for example, "atom", "molecule", "space", "time", "energy", "information" are used in many natural science disciplines. The following examples can be given:

1. "Information" as a natural science term is used not only in mathematics (computer science and information theory), but also in biology (genetic information encoded in DNA).
2. The concept of "invariant" is used both in physics (E. Noether's theorem establishing the connection between conservation laws and invariants of space and time) and in mathematics (geometric invariants of space).
3. Knowledge of the atomic and molecular structure of matter is used in physics (electrodynamics, quantum and nuclear physics), chemistry (ions, the concept of relative atomic mass) and biology (molecular biology, as well as the study of DNA and RNA).
4. The term "energy" is physical, but it is also used in physical geography and geology (the internal energy of the Earth), as well as in biology (digestion, circadian rhythms, sleep and wakefulness, fatigue, etc.).
5. "Space" is a fundamental physical term that is widely used in other disciplines, such as mathematics (stereometry).
6. Another fundamental term that came from physics is the concept of "time", which is also used, for example, in physiology (reaction time).
7. The term "gravity" ("attraction") is used not only in physics, but also in astronomy.

It should be noted that not only Russian, but also foreign psychologists used natural scientific terminology when creating their concepts. A striking example is the field theory of K. Levin. The author used such terms as "field", "force", "vector", "valence", etc. to mental phenomena. K. Levin also made interesting correspondences between psychological and physical terms: for example, he considered the term “behaviour” to

be a psychological analogue of the physical term “state of the system at the moment” (Levin K., 1980; Levin K., 1980).

Such disciplines as synergetics and cybernetics are the most notable. Although the first of these is a branch of physics, and the second is a branch of mathematics, both of these sciences can be called integrative:

1. Non-equilibrium synergetics studies the so-called non-equilibrium systems, which include living organisms.
2. Cybernetics also has a section devoted to living organisms (bionics and the theory of neural networks).

1.9 Discussion

From the analysis of the works of representatives of the St. Petersburg (Leningrad) psychological school, it was concluded that the founder of the St. Petersburg psychological school is V.M. Bekhterev, who was the first to apply the natural-scientific domain to describe mental phenomena. Reflexology stems from the neuroscience and physiology of HNA, so in fact it was already a natural science. In his reflexological concept, V.M. Bekhterev used physical and biological laws and theories. He is also known for his attempt to create a system of laws in psychology. The famous V.M. Bekhterev’s 23 natural science principles originate either from physics or from biology.
After V.M. Bekhterev’s death, his school broke up into several separate areas. One of them is connected with the study of the structure of the personality and its relationship with the outside world. It can be called "the psychology of relationships". The authors of this direction created models of the mind according to a physical model. This flow includes:

- A.F. Lazursky, the author of the theory of relations, created a model of endo- and exo-mind using the atom model
- M.Y. Basov also used the atom model, but in relation to the behaviour
- V.N. Myasishchev, being a clinical psychologist, resorted to natural-scientific domain less than others and even criticized it as a “biological approach”. However, he argued that psychophysiology is inseparable from psychology.

Starting with B.G. Ananiev, psychologists of the St. Petersburg (Leningrad) school apply a complex or systemic approach to the study of a person, emphasising his biosocial nature. Representatives of "complex human knowledge" (the term of B.G. Ananyev) are:

- B. G. Ananyev, speaking about a person, singled out, among other things, his biological structure (individual) and determined his properties (age, gender, neurodynamics and constitution), he also developed an integrated approach to the

study of a person, created the doctrine of sensory-perceptual organisation and deduced the law of heterochrony in the development of mental functions.

- B.F. Lomov, developing the teachings of B.G. Ananyev, created a systemic approach and the doctrine of anticipation
- L.M. Wecker made an attempt to create a unified classification of mental phenomena, searched for psychological invariants
- V.A. Hansen was one of the first to apply the method of mathematical modelling to mental objects.

Followers of L.M. Wecker and V.A. Hansen understood that for the development of psychology as an exact science, a mathematical apparatus is needed. They began the mathematisation of psychology:

- G.V. Sukhodolsky created a number of original methods of mathematical modelling
- L.N. Granovskaya and E.I. Stepanova used mathematical methods in specific studies

In general, the following characteristic topics developed within the St. Petersburg (Leningrad) psychological school can be distinguished:

- issues of neurodynamics
- the issue of psychogenesis
- the bilateral asymmetry issue
- the issue of psycho-physiological "price"
- the issue of predicting the success of labour activity
- the issue of energy-information relationships
- the issue of the ratio of different forms of activation
- typological researches
- researches of sensory systems
- the search for psychological invariants
- mathematical modelling of mental phenomena
- accumulation of statistical characteristics for different samples and the creation of equipment (Balin V.D., 2012).

In all these topics, the use of the natural science paradigm in its three aspects is clearly visible:

1. Biological aspect:
    - issues of neurodynamics
    - the issue of psychogenesis
    - the bilateral asymmetry issue
    - the issue of psycho-physiological "price"

- the issue of predicting the success of labour activity
- the issue of the ratio of different forms of activation
- typological studies
- researches of sensory systems

2. Physical aspect:
    - search for psychological invariants
    - creation of equipment
3. Mathematical aspect
    - mathematical modelling of mental phenomena
    - accumulation of statistical characteristics for different samples.

Based on the review, we can conclude that the St. Petersburg School of Psychology adheres to this domain from the very beginning. Based on the results of the analysis of the works of the classics of the St. Petersburg School, it was found that different authors applied the natural-scientific domain in different ways:

- Direct application of physical and biological laws to mental phenomena (V.M. Bekhterev, L.M. Wecker, V.A. Hansen, partly B.G. Ananyev and B.F. Lomov)
- Creation of models of the mind according to a physical model (A.F. Lazursky, M.Y. Basov)
- Definition and special studies of the biological aspect of the human mind (B.G. Ananyev, B.F. Lomov, to a lesser extent V.N. Myasishchev)
- Using system theory and systemic approach (B.F. Lomov and V.A. Hansen)
- Mathematisation (V.A. Hansen, G.V. Sukhodolsky, L.N. Granovskaya and E.I. Stepanova)

1.10 Conclusions to chapter 1

So, within the St. Petersburg (Leningrad) psychological school, three lines of development of the natural-scientific domain can be distinguished:

1. The biological (physiological) direction. This direction dates back to I.P. Pavlov and his HNA concept. V.M. Bekhterev applied these laws almost directly, believing, like I.M. Sechenov, that "all acts of conscious and unconscious life are reflexes in terms of their mode of origin". B.G. Ananyev, B.F. Lomov and V.N. Myasishchev recognised the importance of the biological nature of man, but did not reduce absolutely all aspects of mental life to it.
2. The physical diection. Physics is the science of the basic patterns of the structure of the material world. Therefore, the St. Petersburg (Leningrad) school of psychology took the path of creating physical models of mental (psycho-physiological) processes and applying the laws of physics to describe the patterns of the flow of mental (psycho-physiological) phenomena. We see the beginnings

of this in V.M. Bekhterev's theory, he borrows part of his laws from physics. A.F. Lazursky and M.Y. Basov built the concept of the structure of the mind, reminiscent of the model of the atom structure. L.M. Wecker and V.A. Hansen dealt with such issues as the search for invariants. Also, B.F. Lomov and V.A. Hansen used a systemic approach in describing the mental reality.

3. The mathematic direction. As can be seen from the previous sections, the scientists of the St. Petersburg (Leningrad) psychological school did not limit themselves to using the mathematical apparatus exclusively for statistical data processing, but used mathematical principles to describe and explain mental (psycho-physiological) phenomena. V.A. Hansen and G.V. Sukhodolsky were the first to apply mathematical modelling, and L.N. Granovskaya and E.I. Stepanova introduced new methods of mathematical analysis into practice.

Chapter 2. Research organisation

The thesis study of the evolutionary development of the natural-scientific domain at the St. Petersburg psychological school was carried out in several stages:

1. At the first stage, with the help of semantic analysis, the collections of abstracts of the international scientific conference "Ananyev's Readings" were studied in order to study the current stage of evolution
2. Next, a comparative study of the development of the natural-scientific domain in the Moscow and St. Petersburg (Leningrad) psychological schools was carried out (based on the material of the Bulletins of Moscow State University and St. Petersburg State University)
3. Since the results of a comparative study revealed the phase dynamics of scientific activity, it was decided to study this phenomenon in more detail, but at the individual level by studying phase changes in psycho-physiological indicators

2.1 The research of collections of abstracts of the scientific conference "Ananyev's Readings" since 2015 to 2020

2.1.1 Research hypothesis

After a detailed consideration of the history of the development of the natural-scientific domain in the St. Petersburg (Leningrad) psychological school, it is necessary to study the current stage of its evolution. The material of this study was the abstracts of the collections of the international scientific conference "Ananyev's Readings", published since 2015 to 2020. The research topics published in these collections were studied.

Hypothesis: Because of the orientation of the authors of the St. Petersburg (Leningrad) psychological school on the natural-scientific domain, neuro- and psycho-physiological topics prevail, as well as theses on the methodology and history of psychology.

2.1.2 Research methods and methodology

The study used the method of semantic analysis. At the beginning, the topics (titles) of the theses published in the collections of the scientific conference "Ananyev's Readings" were analysed. Then the topics were grouped into thematic groups according to the semantic principle. The following groups were identified:

- Theoretical psychology, history and methodology of psychology

- Cognitive psychology
- Differential Psychology
- Psychology of Personality
- Emotional-volitional sphere
- Mental states
- Social Psychology
- Ethnopsychology and cross-cultural studies
- Psychology of dysontogenesis, child clinical psychology and diagnostics of child mental development
- Psychology of crisis and extreme situations
- Pedagogical psychology
- Clinical psychology, patho- and neuropsychology
- Ergonomics, work psychology and organisational psychology
- Special psychology
- Psychological diagnostics
- Psychophysiology
- Family psychology (including studies of dysfunctional families)
- Psychotherapy, psychological counselling and mental correction
- Psychology of deviant behaviour and prevention of behavioural anomalies
- Behavioural psychology
- Animal psychology
- Group forms of psychological assistance
- Health psychology
- Psycholinguistics
- Forensic psychology
- Political psychology
- Sports Psychology
- Economic psychology
- Experimental psychology
- Existential psychology
- Interdisciplinary researches
- Environmental consciousness
- Professional psychological ethics

The following research topics were chosen as indicators of the application of the natural-scientific domain:

- Psychophysiology

- Theoretical psychology
- Methodology of psychology
- Experimental psychology
- Neuropsychology
- Study of stress and coping mechanisms of personality

The topics of all published studies for the specified period were analysed ($N_{2015} = 386$, $N_{2016} = 674$, $N_{2017} = 371$, $N_{2018} = 392$, $N_{2019} = 324$, $N_{2020} = 506$, $N_{total} = 2653$) and calculated the number of articles on each topic.

2.1.3 Data processing methods

Mathematical processing of the study data was carried out using the Microsoft Excel. As a method of mathematical analysis, the method of bar graph construction was used. All considered research topics were divided into three groups: leading (the number of abstracts is greater than or equal to 10), significant (the number of abstracts from 5 to 9) and rarer (the number of abstracts is less than 5) (see Appendix A) topics. The number 10 was chosen as a benchmark for highlighting the leading topics due to the fact that the average number of topics with occurrences of 10 or more was 7±2. Next, bar graphs were constructed, reflecting the number of abstracts on each topic in a particular collection. For a more detailed analysis, only the group of leading topics was used as the most representative.

2.2 The comparative study of the development of the natural-scientific domain in the Moscow and St. Petersburg (Leningrad) psychological schools (on the material of Moscow State University and St. Petersburg State University Bulletin)

If you look closely at the concepts of various authors of the considered psychological schools, then they can be divided into three groups: fundamental psychological theories that underlie the scientific school (their authors are the "founding fathers" of this direction), psychophysiology and engineering psychology. The conducted analogies are shown in Table 1.

Table 1. Comparison of the concepts of representatives of the Moscow and St. Petersburg (Leningrad) psychological schools

Main Representatives		
Direction of scientific work	Moscow	St. Petersburg
Fundamental psychological theory	S.L. Rubinstein, A.N. Leontyev, L.S. Vygotsky, A.R. Luria	V.M. Bekhterev, A.F. Lazursky, M.Y. Basov, V.N. Myasishchev, B.G.

		Ananyev, L.M. Wecker
Psychophysiology and system approach	V.B. Shvyrkov	V.A. Hansen, I.M. Paley, V.D. Balin
Engineering psychology and ergonomics	E.I. Boyko	B.F. Lomov

The Moscow School of Psychology, like the St. Petersburg School, was studied on the example of the work of psychologists at Moscow State University (MSU). The result of the literature review indicates that the leading representatives of the Moscow School of Psychology worked mainly within the philosophical domain rather than the natural-scientific one. The natural-scientific domain was used in particular researches. In turn, the leading representatives of the St. Petersburg (Leningrad) school really worked within the natural-scientific domain (Balin V.D., 2017; Zhdan A.N., 2015). However, to create a complete picture, a detailed qualitative and quantitative analysis of smaller-scale publications by various authors is required.

2.2.1 The research hypothesis

It follows from the first chapter of the thesis that there are three aspects of the natural-scientific domain: biological, physical and mathematical. Since physics is, firstly, an exact science, and secondly, it is the science of the most general patterns of the structure of the world, it was assumed that it is the physical aspect that is most developed in the Moscow psychological school (in the philosophy of science, it is customary to focus on physics as to the "ideal" scientific discipline). The St. Petersburg school is considered to be focused on the natural-scientific domain, and, based on this, it can be assumed that all components are developed in the same way and are integrated with each other (the systemic approach).

Hypothesis: Throughout its development, the St. Petersburg (Leningrad) psychological school is more focused on the natural-scientific domain than the Moscow one; the leading aspect in the Moscow school is the physical one (along with the philosophical domain), and in the St. Petersburg school the most important is the systemic approach (the integration of the three aspects).

2.2.2 Research methods

The study used the original *inciampata* model: the principle of quantitative analysis of scientific publications, based on taking into account natural-scientific terms and their subsequent sorting into three groups (see Table 2). A similar method was used by M. Clemente Linuesa (Clemente Linuesa M., 1983) in the study of school history textbooks: the author sorted historical terms into categories and then analysed their ideological features.

Table 2. Natural-scientific terms sorted into semantic groups (inciampata model)

Biological terms	Physical terms	Mathematical terms
-zoology -anatomy - anatomy of the central nervous system -physiology -HNA physiology and psychophysiology -evolution theory -ecology -genetics	-invariants -conservation laws -mechanics -electrodynamics -quantum physics -relativistic mechanics (relativity theory) - synergetics	- statistical methods - mathematical models -set theory -graph theory -geometry -geometric space invariants -trigonometry -functions and graphs -algebra -mathematical analysis -probability theory -Informatics -artificial intelligence -cybernetics

The material for studying the problem of using the natural-scientific domain in the Moscow and St. Petersburg (Leningrad) psychological schools was publications in the scientific journals "Moscow University Bulletin" since 1977 to 2019 and "St. Petersburg University Bulletin" (titled "Bulletin of the Leningrad University" until 1991) since 1949 to 2019. Series 14 “Psychology” of the Moscow State University Bulletin and series 6 “Philosophy, Political Science, Sociology, Psychology, Law, International Relations” of the St. Petersburg State University Bulletin were analysed.

2.2.3 Data processing methods

The following statistical processing methods were used for data processing:

1. Building of an autocorrelation function;
2. Correlation analysis (Pearson);
3. The method of displaying links between experimental features using graphs (P.V. Terentyev’s method);
4. Maximum correlation path method (L.K. Vyhandu method).

At the beginning of the study, a glossary of terms found in the publications of these journals was compiled. The terms were classified according to the semantic principle into the three categories mentioned above: biological, physical and mathematical terms. Thus, three lists of words found in articles published in this period were compiled.

Then, graphs of change over the years of the following five indicators were built:

1. The number of issues of a scientific journals in which there were articles written within the natural-scientific domain
2. The number of articles written within the natural-scientific domain (percentage of selected articles see Appendix B)

3. The number of biological terms
4. The number of physical terms
5. The number of mathematical terms

The graphs of changes in the frequency of occurrence of terms contained artefacts, so graphs of the autocorrelation function (ACF) were constructed to remove them. This method is often used as a mathematical filter that allows you to filter out random processes and highlight the main ones.

Next, a correlation analysis was carried out. Relationships between all indicators were studied (the number of journal issues, the number of articles, and three groups of terms: biological, physical, and mathematical) (Stepanova J.V., 2019[a]; Stepanova J.V., 2019[b]; Stepanova J.V., 2020; Stepanova J.V., Balin V.D., 2020).

2.3 The study of the phase dynamics of psycho-physiological functions as an example of the operation of the law of phases at the individual level

2.3.1 Research hypotheses

Taking into account the B.G. Ananyev's law of heterochrony in the development of mental functions, as well as the above-described study by L.N. Granovskaya and E.I. Stepanova, it makes sense to check these patterns on the example of the psycho-physiological parameters of temperament (psychological type). On the other hand, there is also a statement by V.V. Belous about the invariance of temperament, which also cannot be excluded from consideration. All this allows us to put forward the following hypotheses:

- Hypothesis 1. Psycho-physiological parameters of the three parts of the nervous system (central, autonomic and somatic ones) change periodically (they are harmonic oscillations)
- Hypothesis 2. The total scores for the three blocks of the nervous system are invariant to a greater or lesser extent

2.3.2 Research methods

As mentioned earlier, the parameters studied were related to three parts of the nervous system:

1. Indicators of the central nervous system (CNS), measured using EEG:
   1) Alpha index of the right and left hemisphere
   2) Average frequency for the right and left hemisphere
   3) Dominant frequency for the right and left hemisphere
2. Indicators of the autonomic nervous system (ANS):
   1) Heart rate (pulse), or HR

2) Blood pressure (systolic and diastolic)
3) Respiratory rate (RR) measured by pneumography
4) Breathing volume (BV) measured with a spirometer
5) Vital capacity (VC) measured with a spirometer

3. Indicators of the somatic nervous system (SNS):
   1) Static tremor of the right and left hand
   2) Dynamic tremor of the right and left hand
   3) Dynamometry of the right and left hand

Thus, the research methods were:

1. Electroencephalography
2. Blood pressure measurement
3. Heart rate measurement
4. Pneumography
5. Spirometry
6. Tremorometry
7. Dynamometry

2.3.3 Sample characteristics

The data for the study were obtained from the database of the educational laboratory of psychophysiology of the Faculty of Psychology of St. Petersburg State University. The study itself was carried out in the practical classes of the Psychophysiology course. Data for 2011-2017 were taken from the database, according to several indicators of three parts of the nervous system: CNS (alpha index, average and dominant frequency), ANS (heart rate, systolic and diastolic pressure, respiratory rate and volume, VCL) and SNS (dynamometry, static and dynamic tremor). Data were obtained on 566 subjects who were 2nd year students of the Faculty of Psychology at the time of the study. The age of students varies from 17 years 8 months old to 44 years 1 month old (see Appendix C). $M_x = 23{,}78$, $\sigma = 6{,}63$, $M_d = 22$.

2.3.4 Research methodology

The study used *the cross-sectional method (comparative age method)*. This is the most common method in developmental and developmental psychology. It consists in the fact that different age groups are simultaneously examined. At the same time, it is important that the samples are representative (taking into account the specific objectives of the study), and the compared groups are homogeneous. The advantage of the method lies in the fact that the study is carried out in a short time period, it is better manageable than longitudinal. Disadvantages: the problem of comparability of samples; explores age-related variability to a greater extent than age-related dynamics; as in the longitudinal, cohort effects can affect, that is, it is difficult to separate the effects of chronological age from the effects of the historical period (Ananyev B.G., 2001;

Ananyev B.G., 2010; Savenysheva S.S., Vasilenko V.E., Strizhitskaya O.Y., 2011). This method allows us to compare the age of the subjects and the date of the study.

2.3.5 Data processing methods

The following methods of statistical data processing were used for data processing:

- Scaling procedure
- Building an autocorrelation function

At the beginning of the study, the entire sample was divided into 93 age groups. An attempt was made to equalize the intervals between the groups so that the age difference between the groups of subjects was 1 month (dividing into groups with a step of 1 month is necessary for a more accurate accounting of significant changes). Unfortunately, this could not be done completely, which significantly reduces the accuracy of the study. Also, the problem was the presence of a large number of small groups, including 1-3 subjects, and it was decided to introduce an additional array of data to neutralise it. However, this led to an increase in the number of small groups, but in this way it was possible to achieve an almost normal distribution of data.

Then graphs of changes in the average indicators of the psycho-physiological functions of the central, autonomic and somatic nervous system were plotted, but the graphs built according to the "raw" estimates contained some artefacts, so it was decided to convert the "raw" indicators to scale ones. But the charts based on the scaled scores also contained some artefacts, although they were less than in the charts built on the raw scores. To smooth the artefacts, autocorrelation functions (ACF) were constructed.

Next, the scale scores were added up for three blocks of the nervous system (CNS, ANS and SNS), and graphs of the age dynamics of the scale scores for each of the blocks were plotted. To establish the degree of variability of the total scale scores, the mean scale score, standard deviation, and coefficient of variation within each block were calculated. A graph of the change in the total amount of scale scores was also plotted and the same indicators (mean score, standard deviation, and coefficient of variance) were calculated to assess the variability in the total amount of scale scores.

2.4 Conclusions to chapter 2

Based on the literature review conducted in the first chapter, it was proposed to conduct the following studies:

1) Firstly, to study the current state of the natural-scientific domain by semantic analysis of the collections of abstracts of the scientific conference "Ananyev's Readings" in the period from 2015 to 2020. This will allow us to assess the direction of development of the scientific thought of the authors of the St. Petersburg School at the present time.

2) Secondly, to trace the evolution of the domain using the semantic analysis of publications in the scientific journal “St. Petersburg University Bulletin” (titled “Leningrad University Bulletin” until 1991) since 1949 to 2019. In parallel with this, it is necessary to make a comparison with the development of the natural-scientific domain in the Moscow school psychology. For this purpose, publications in the scientific journal “Moscow University Bulletin” since 1977 to 2019 were also analysed.
3) Thirdly, it was necessary to explain the phase fluctuations that occurred in the ACF plots of the results of the previous study. For this purpose, an analogy was drawn with the results of the study of phase changes in psycho-physiological functions. This will allow us to trace the patterns of development of the natural-scientific domain in the St. Petersburg School of Psychology.

Chapter 3. The experimental part of the study

This chapter presents the results of three studies, as well as their discussion and conclusions.

3.1 The research of collections of abstracts of the scientific conference "Ananyev's Readings" in the period from 2015 to 2020

The results of the semantic analysis of the abstracts of the international scientific conference "Ananyev's Readings" are described below.

3.1.1 Research results

1) *2015.* Leading research topics are cross-cultural researches (11 theses), methodology of psychology (18 theses), psychology of dysontogenesis (11 theses), coping with stress (17 theses), history of psychology (21 theses), psychology of art (10 theses), educational psychology (18 theses), organisational psychology (13 theses) (Fig. 1).

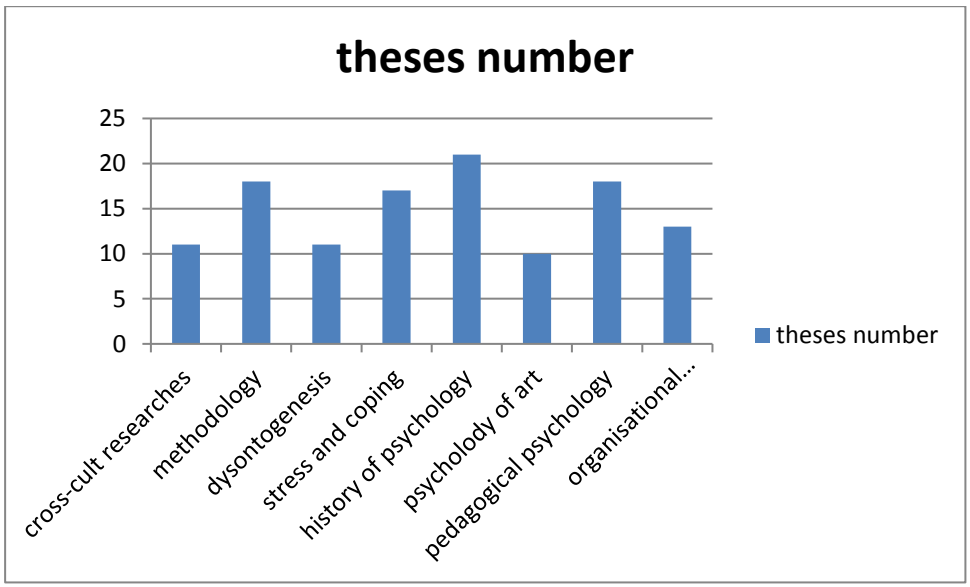

Figure 1. Leading research topics (2015). The abscissa axis refers to the topic, and the ordinate axis refers to the number of theses.

2) *2016.* Leading research topics are history of psychology (37 theses), methodology of psychology (29 theses), psychology of emotions (22 theses), psychology of dysontogenesis (18 theses), addictive behaviour (16 theses), pathopsychological studies of persons with mental disorders (10 theses), gender studies (11 theses), coping with stress (30 theses), educational psychology (22 theses), psychophysiology (20 theses), professionally important qualities (24 theses), youth (16 theses), adolescence (16 theses), personality psychology (12 theses),

cross-cultural studies (20 theses), theoretical psychology (13 theses), ethnopsychology (16 theses), motivational-need sphere (12 theses), psychology of thinking (13 theses), mental health (14 theses) (Fig. 2).

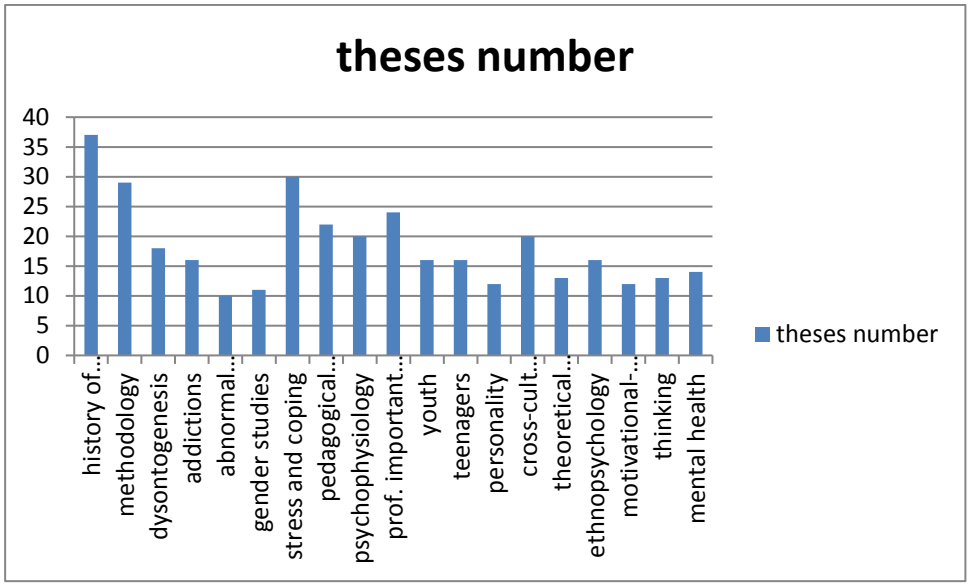

Figure 2. Leading research topics (2016). The abscissa axis refers to the topic, and the ordinate axis refers to the number of theses.

3) *2017.* Leading research topics are methodology of psychology (12 theses), history of psychology (27 theses), coping with stress (24 theses), adolescence (12 theses), cross-cultural studies (12 theses), organisational psychology (11 theses), pedagogical psychology (12 theses) (Fig. 3).

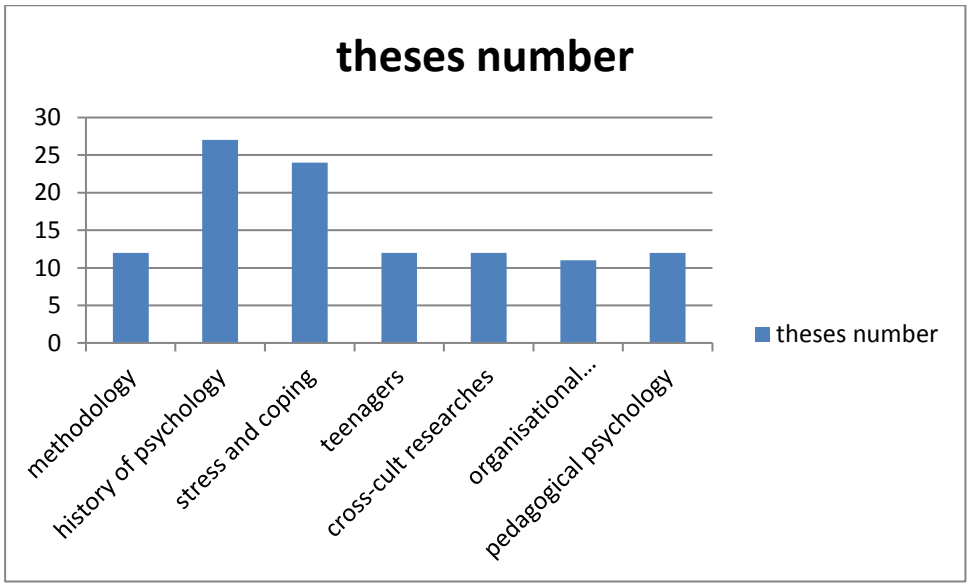

Figure 3. Leading research topics (2017). The abscissa axis refers to the topic, and the ordinate axis refers to the number of theses.

4) *2018*. Leading research topics are history of psychology (25 theses), methodology of psychology (34 theses), educational psychology (14 theses), adolescence (21 theses), youth (14 theses), coping with stress (21 theses), child psychology (16 theses), psychophysiology (10 theses), psychology of dysontogenesis (10 theses), motivational-need sphere (10 theses) (Fig. 4).

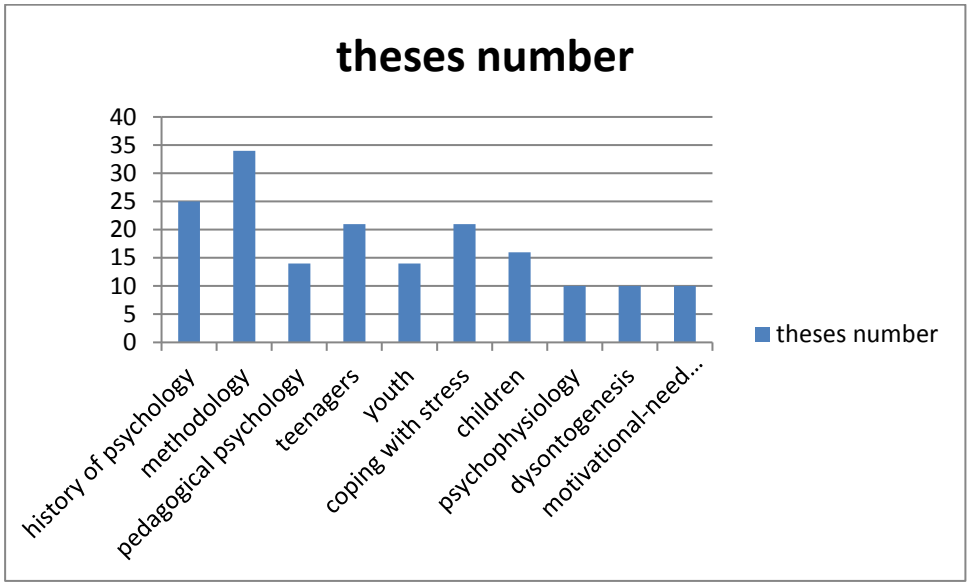

Figure 4. Leading research topics (2018). The abscissa axis refers to the topic, and the ordinate axis refers to the number of theses.

5) *2019*. Leading research topics are history of psychology (18 theses), methodology of psychology (13 theses), political psychology (21 theses), coping with stress (17 theses), psychology of dysontogenesis (13 theses) (Fig. 5).

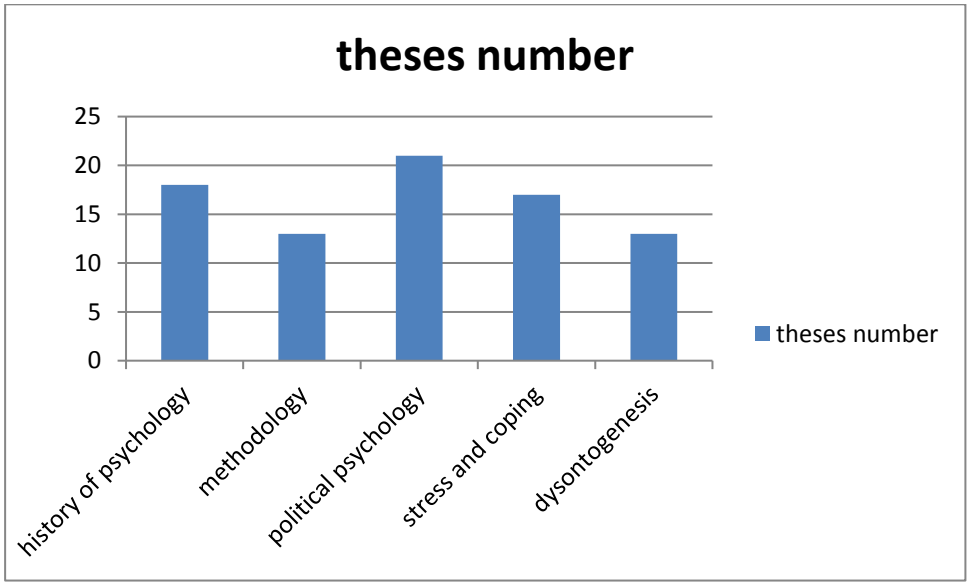

Figure 5. Leading research topics (2019). The abscissa axis refers to the topic, and the ordinate axis refers to the number of theses.

1) *2020.* Leading research topics are youth (15 theses), methodology of psychology (28 theses), coping with stress (33 theses), educational psychology (19 theses), social psychology of personality (12 theses), history of psychology (24 theses), psychology of performance (16 theses), professionally important qualities (11 theses), organisational psychology (12 theses), motivational-need sphere (12 theses), psychophysiology (13 theses), psychology of emotions (10 theses), study of the phenomenon of occupational burnout (10 theses) (Fig. 6).

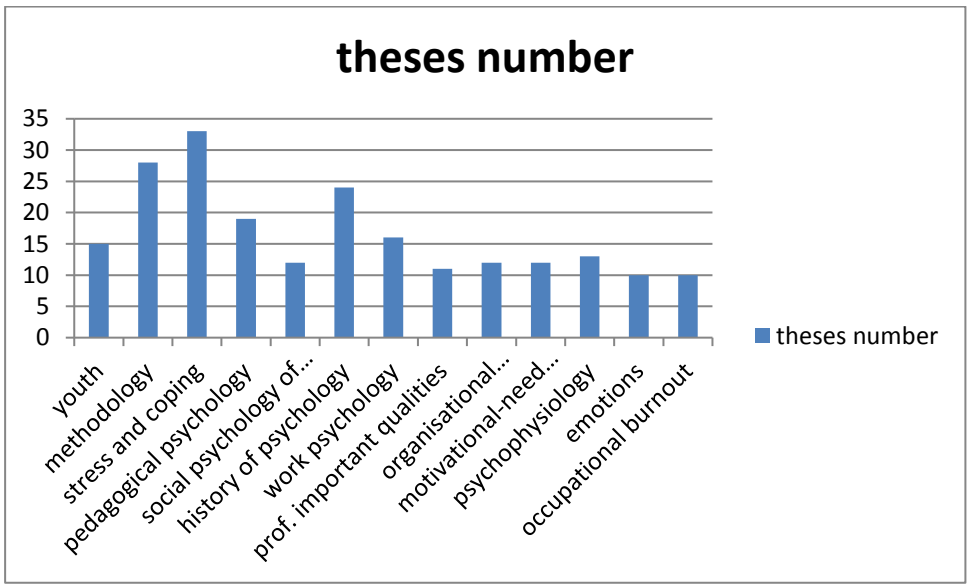

Figure 6. Leading research topics (2020). The abscissa axis refers to the topic, and the ordinate axis refers to the number of theses.

3.1.2 The discussion of the results

The results of the study show that during the investigated period, the theses devoted to the history of psychology and the methodology of psychological research predominate. This allows us to conclude that the representatives of the St. Petersburg school of psychology have a stability orientation, preferring to use time-tested methods of research and data interpretation. Applied research is dominated by studies of stress and coping mechanisms of personality, as well as psycho-physiological studies. On the contrary, studies within the humanistic domain (the study of value orientations, the semantic sphere, etc.) are few in number. This fact proves the orientation of modern authors of the St. Petersburg School of Psychology towards the natural-scientific domain (Leningrad psychologists continue the traditions of their predecessors). Also traditional are studies in the field of educational psychology (the pedagogy and educational psychology department is the oldest at the faculty).

It should be noted that a large number of theses devoted to theory and methodology of psychology testifies to the currently observed trend towards the integration of psychological and, more broadly, scientific knowledge. Similar tendencies are also observed now in other scietists. For example, there is I.M. Garskova's study, dedicated to the analysis of theses of the conferences of the Association "History and Computer". It analysed the dynamics of computer simulation in history. The results of the study showed that since 2000 to 2010, the systemic approach and the principles of synergetics have already been applied in historical research (Garskova I.M., 2012), which also means a trend towards integration. Thus, this trend can be considered as general-scientific.

3.1.3 Conclusion

1) At the present stage, the St. Petersburg (Leningrad) psychological school is largely focused on the natural-scientific domain;
2) Modern representatives of the St. Petersburg (Leningrad) psychological school have an attitude towards stability;
3) The only area of research being developed at the St. Petersburg school of psychology outside of the natural-scientific domain is educational psychology, which may be related to the faculty's traditions.

3.2 The comparative study of the development of the natural-scientific domain in the Moscow and St. Petersburg (Leningrad) psychological schools (based on Moscow State University Bulletin and St. Petersburg State University Bulletin)

This part presents an analysis of the results of a comparative study of the development of the natural-scientific domain in the Moscow and St. Petersburg (Leningrad) psychological schools.

3.2.1 Research results

The quantitative and qualitative analysis of the results of the study is described below.

Frequency graphs

1) *Number of journals.* The graphs have approximately the same height, but during the period when they coincide (1977-2019), the number of peaks in the graph according to the of SPSU Bulletin (Fig. 8) is greater than in the graph according to the MSU Bulletin (Fig. 7), but there are more periods when issues with articles containing natural-scientific terms were not published at all. Thus, the graph shows that, although the average number of journals on the relevant topics is

approximately the same, interest in the natural-scientific domain arose more often in the St. Petersburg psychological school.

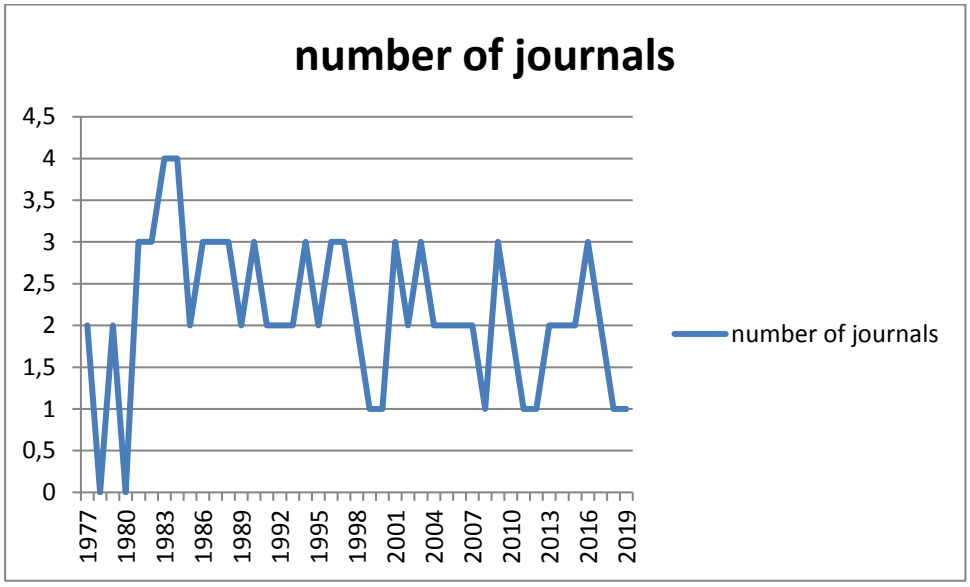

Figure 7. The number of journals published in the Moscow State University Bulletin and containing articles using natural-scientific terminology (the abscissa axis refers to time, and the ordinate axis refers to the number of journals).

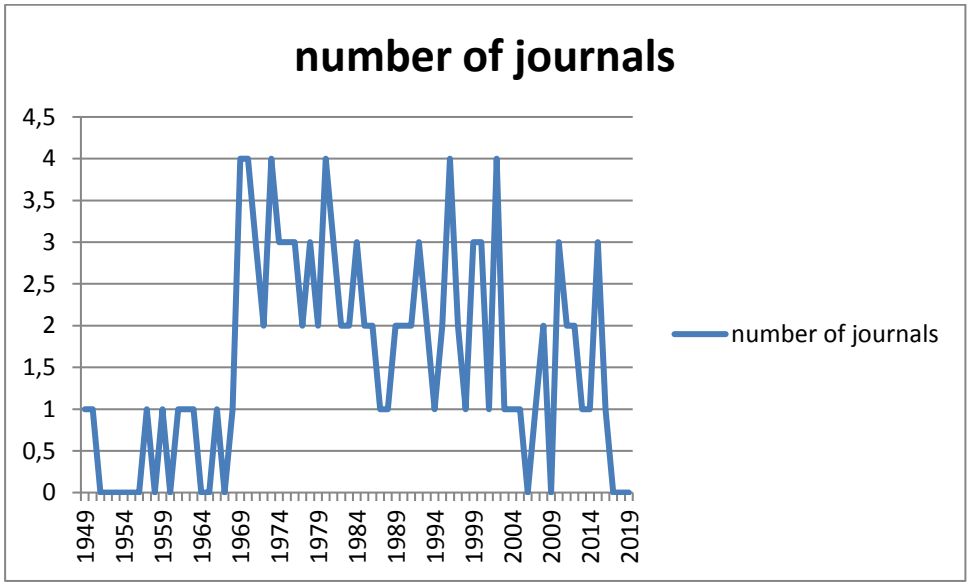

Figure 8. The number of journals published in the St. Petersburg State University Bulletin and containing articles using natural-scientific terminology (the abscissa axis refers to time, and the ordinate axis refers to the number of journals).

2) *Number of articles.* The average height of the graph for the MSU Bulletin (Fig. 9) is higher than for the SPSU Bulletin (Fig. 10). This means that more articles containing natural science terms were published during the specified period. During the studied period, the maximum number of articles (11) was published at

Moscow State University once (in 2001), at St. Petersburg State University the same number of articles was published twice (1969 and 1996).

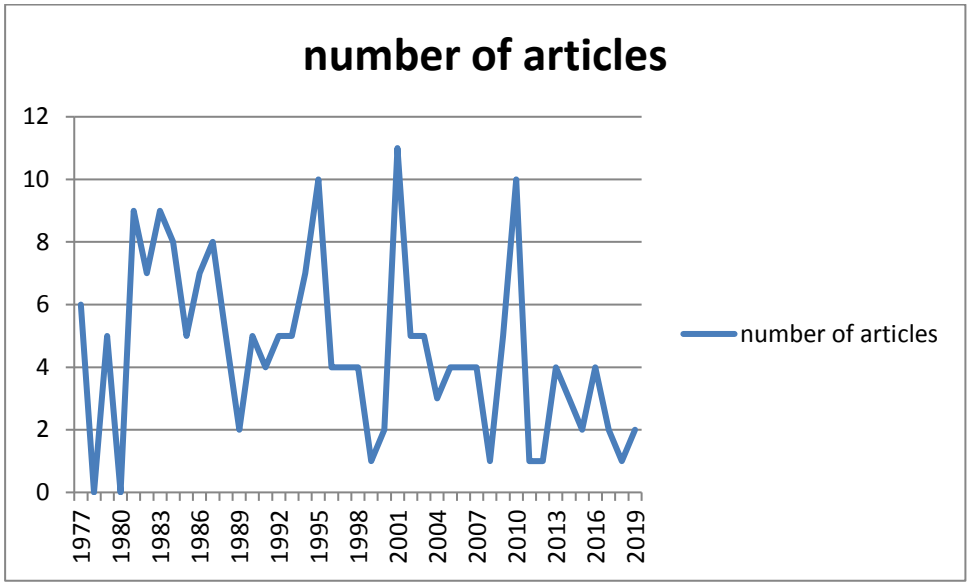

Figure 9. Number of articles using natural-scientific terminology published in the Moscow State University Bulletin (the abscissa axis refers to time, and the ordinate axis refers to the number of articles).

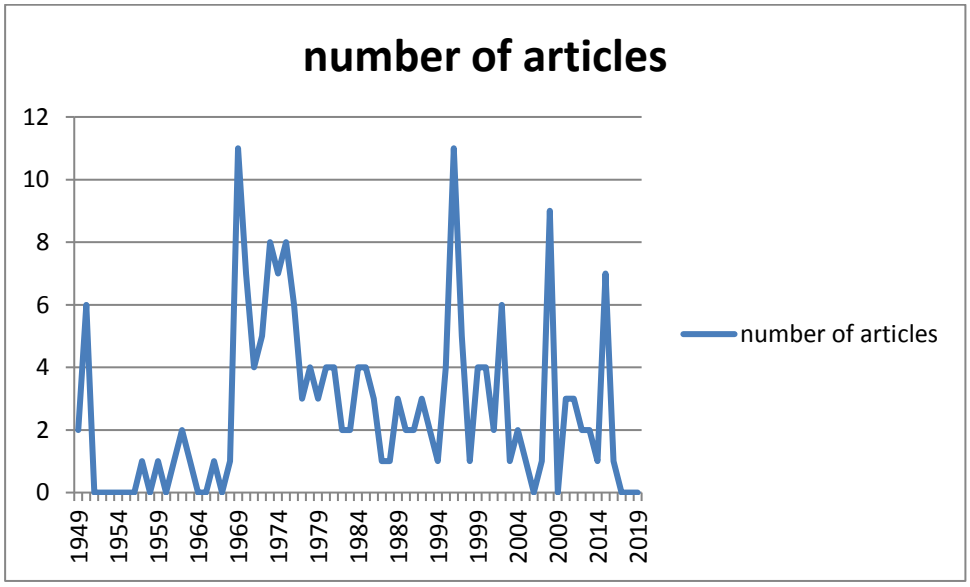

Figure 10. Number of articles using natural-scientific terminology published in the St. Petersburg State University Bulletin (the abscissa axis refers to time, and the ordinate axis refers to the number of articles).

3) *Biological terms.* The graph for the Moscow State University Bulletin (Fig. 11) is on average higher than the graph for the St. Petersburg State University Bulletin (Fig. 12), from which we can conclude that the psychologists of the Moscow School used more biological terms than the authors of the St. Petersburg School.

The maximum number of biological terms in the Moscow State University Bulletin was used in 2010 (317 words), and in the St. Petersburg State University Bulletin the maximum number was used in 1950 (243 words).

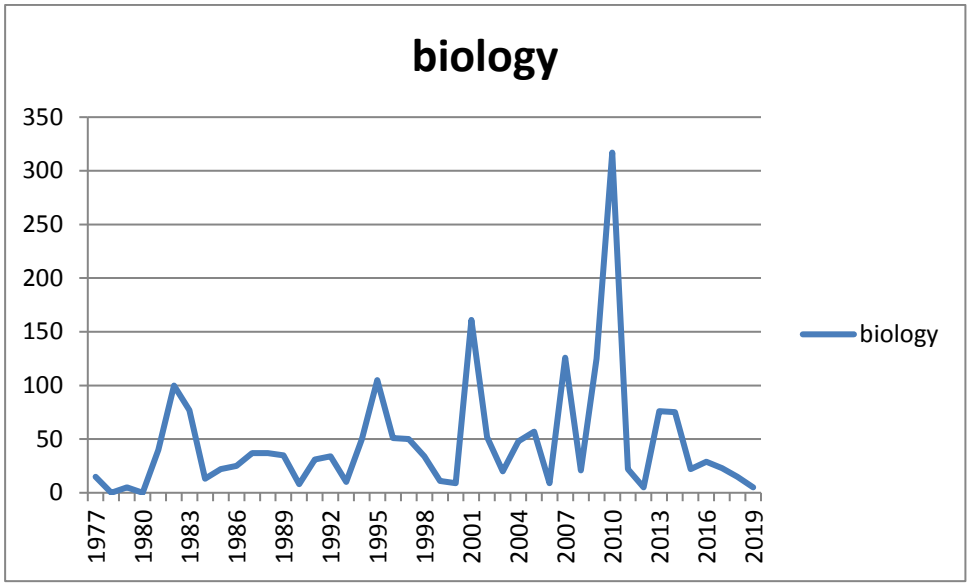

Figure 11. The number of biological terms in the Moscow State University Bulletin (the abscissa axis refers to time, and the ordinate axis refers to the number of terms).

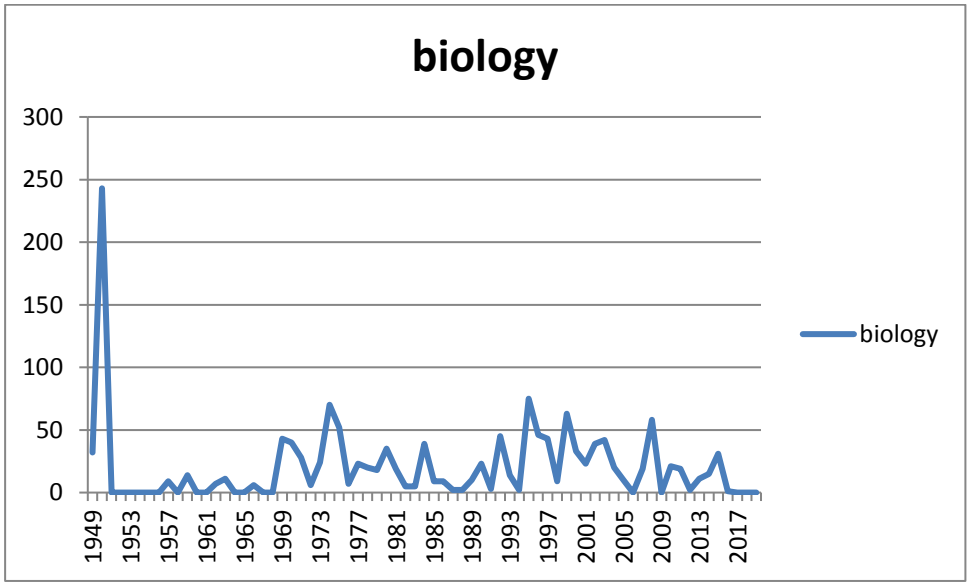

Figure 12. The number of biological terms in the St. Petersburg State University Bulletin (the x-axis refers to time, and the y-axis refers to the number of terms).

4) *Physical terms.* The graphs are about the same height. The largest number of physical terms in the Moscow State University Bulletin (Fig. 13) was used in 2010 (99 words), and in the St. Petersburg State University Bulletin (Fig. 14) the largest number was used in 1996 (96 words).

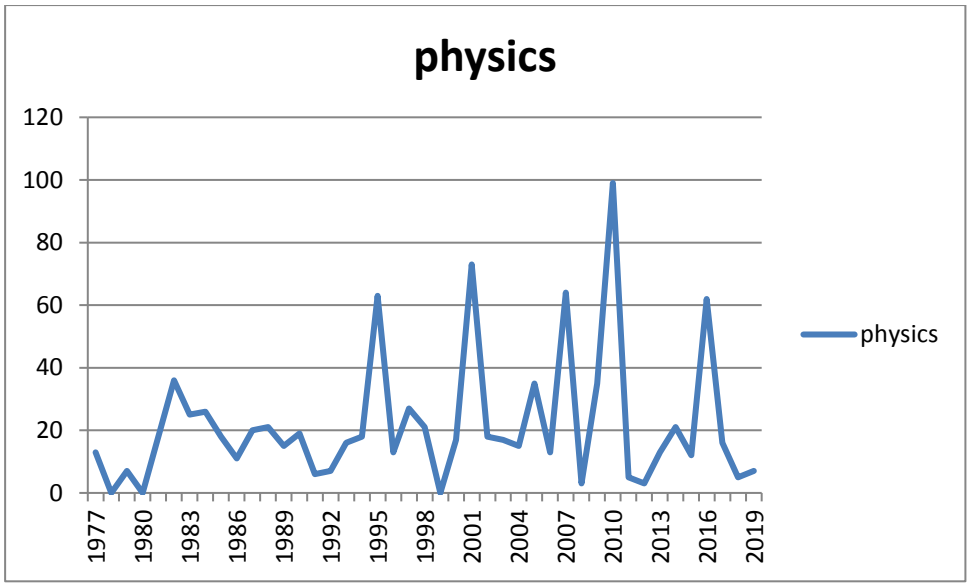

Figure 13. The number of physical terms in the Bulletin of Moscow State University (the x-axis refers to time, and the y-axis refers to the number of terms).

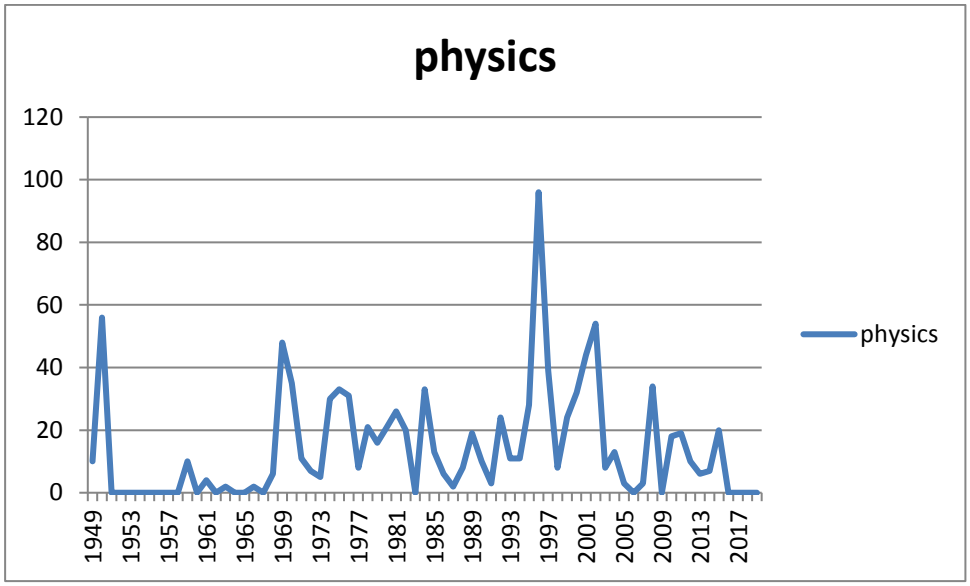

Figure 14. The number of physical terms in the Bulletin of St. Petersburg State University (the abscissa axis refers to time, and the ordinate axis refers to the number of terms).

5) *Mathematical terms.* The average height of the graph for the MSU Bulletin (Fig. 15) is slightly higher than the graph for the St. Petersburg State University Bulletin (Fig. 16). Most of the mathematical terms were used in the Moscow State University Bulletin in 2001 (112 words), and in the St. Petersburg State University Bulletin most of the mathematical terms were used in 1970 (68 words).

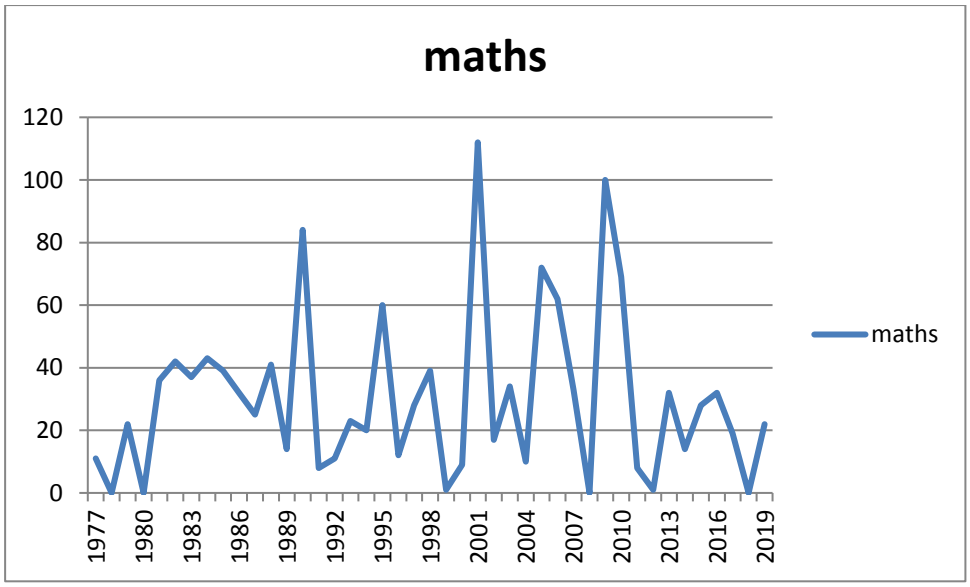

Figure 15. The number of mathematical terms in the Bulletin of Moscow State University (the abscissa axis refers to time, and the ordinate axis refers to number of terms).

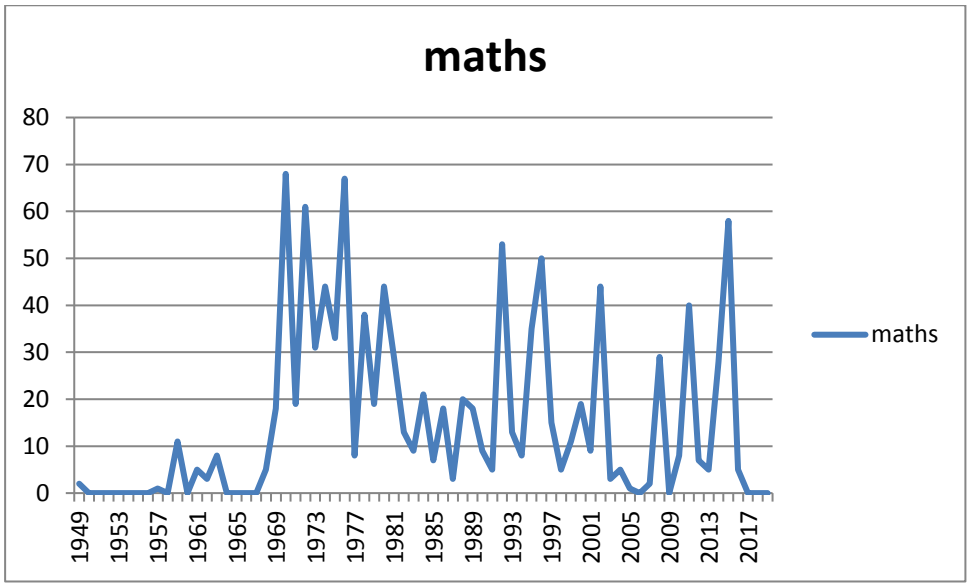

Figure 16. The number of mathematical terms in the Bulletin of St. Petersburg State University (the abscissa axis refers to time, and the ordinate axis refers to number of terms).

ACF charts

This method, as already it was mentioned, makes it possible to determine the main frequency of a periodic process for the examined time interval.

1) *Number of journals*. The oscillation period of the ACF chart of the Moscow State University Bulletin (Fig. 17) is 5 years, the oscillation period of the ACF chart of the St. Petersburg State University Bulletin is 20 years (Fig. 17).

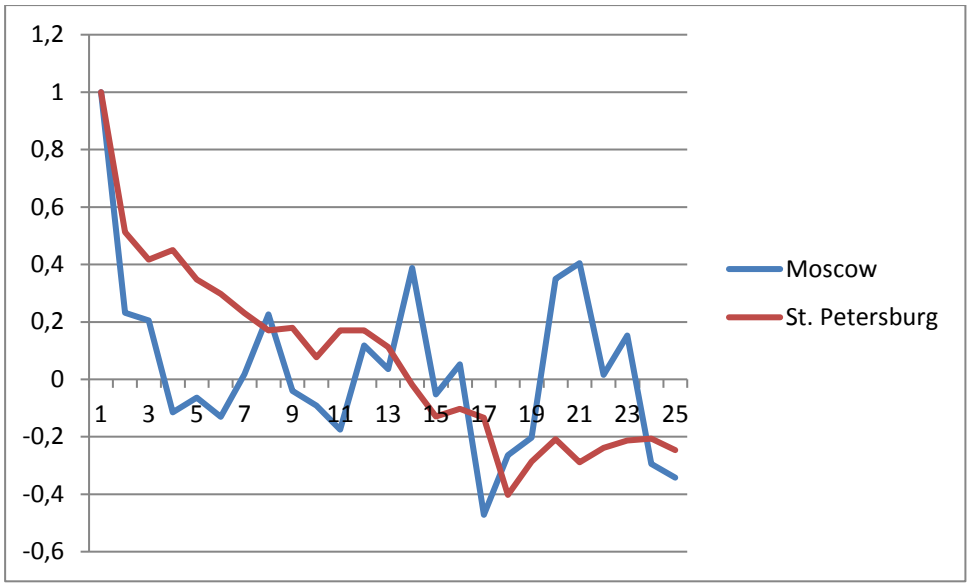

Figure 17. The number of journals containing articles using natural-scientific terminology (ACF). The ordinate axis refers to the correlation, the abscissa axis refers to time.

2) *Number of articles.* The oscillation period of the ACF chart of the Moscow State University Bulletin is 4 years, the oscillation period of the ACF chart of the St. Petersburg State University Bulletin is 20 years (Fig. 18).

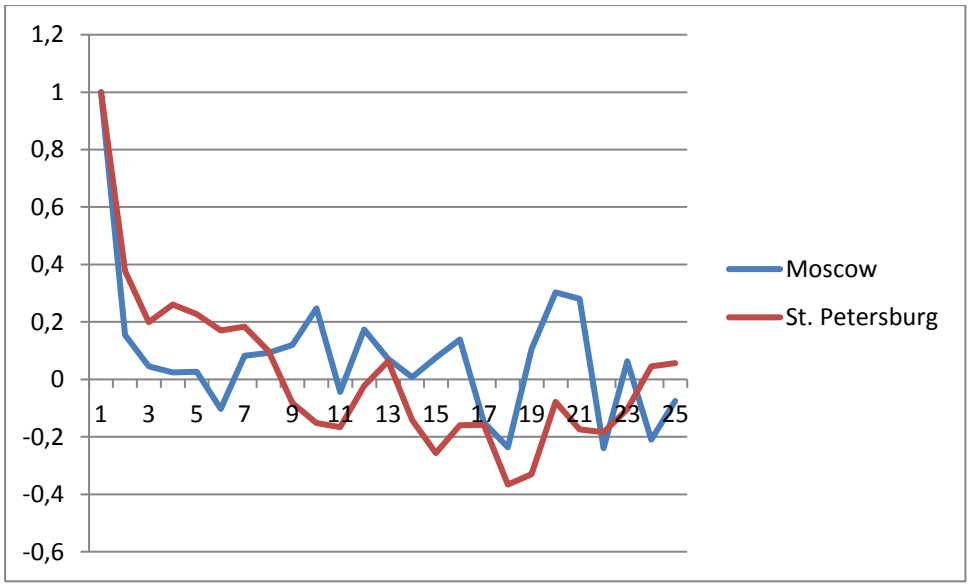

Figure 18. The number of articles using natural-scientific terminology (ACF). The ordinate axis refers to the correlation, the abscissa axis refers to time.

3) *Biological terms.* The oscillation period of the ACF chart of the Moscow State University Bulletin is 3 years, the oscillation period of the ACF chart of the St. Petersburg State University Bulletin is 15 years (Fig. 19).

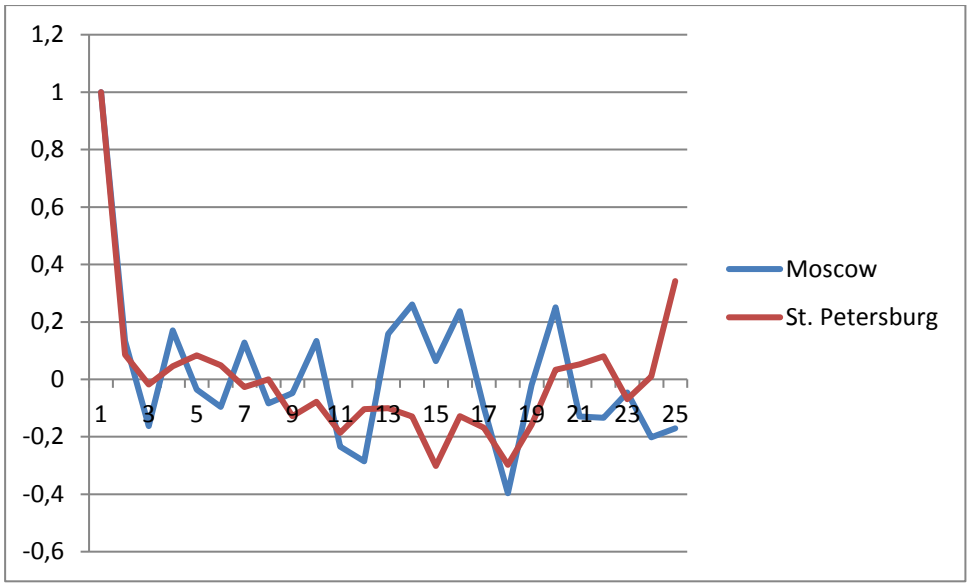

Figure 19. The number of biological terms (ACF). The ordinate axis refers to the correlation, the abscissa axis refers to time.

4) *Physical terms.* The oscillation period of the ACF chart of the Moscow State University Bulletin is 4 years, the oscillation period of the ACF chart of the St. Petersburg State University Bulletin is 8 years (Fig. 20).

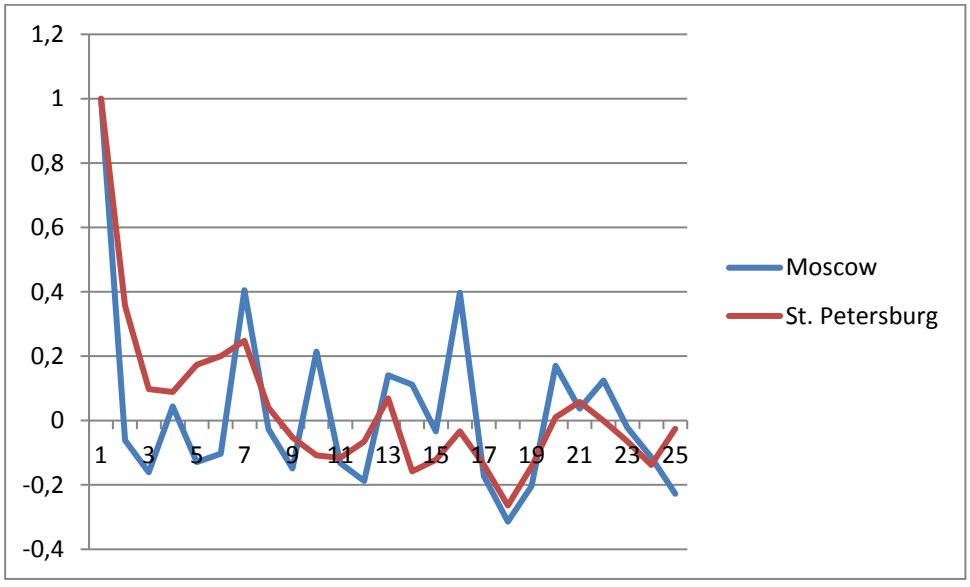

Figure 20. The number of physical terms (ACF). The ordinate axis refers to the correlation, the abscissa axis refers to time.

5) *Mathematical terms.* The oscillation period of the ACF chart of the Moscow State University Bulletin is 4 years, the oscillation period of the ACF chart of the St. Petersburg State University Bulletin is 5 years (Fig. 21).

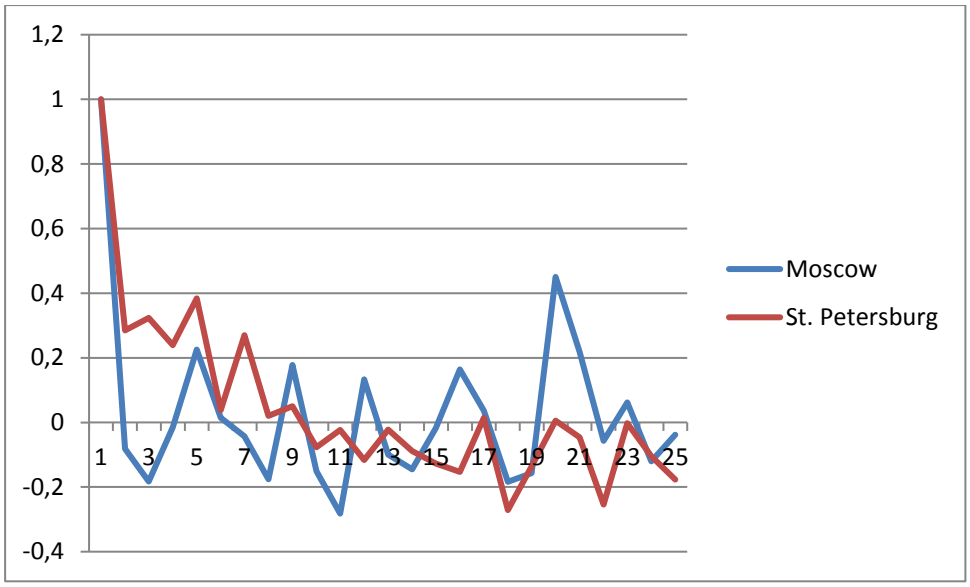

Figure 21. The number of mathematical terms (ACF). The ordinate axis refers to the correlation, the abscissa axis refers to time.

As can be seen, the change in signs over time is different for the Moscow and St. Petersburg schools. At the same time, the change in the features of the Moscow school has a shorter period (4-8 years), and the same change in the same features for the St. Petersburg school has a longer period, as a rule, 15-20 years. It can be assumed in this regard that the employees of the Moscow School have an orientation towards novelty in their research, while their colleagues representing the St. Petersburg School have an orientation towards stability.

However, it is noticeable that most of the ACF charts indicators of the St. Petersburg School contain additional rhythms. All cycles of the ACF charts indicators of the St. Petersburg school are shown in Table 3.

Table 3.ACF graph cycles

	Slow component	Fast component
1. Number of journals	20 years	5 years
2. Number of articles	20 years	5 years
3. Biology	15 years	5 years
4. Physics	-	8 years
5. Maths	-	5 years

Correlation analysis

Table 4 is a correlation matrix that reflects the relationship between the five considered characteristics of publications in the journals of the Moscow and St. Petersburg (Leningrad) psychological schools.

Table 4. Correlations between indicators of the occurrence of natural-scientific terminology in publications of the Moscow and St. Petersburg schools

Index (number of cases considered n = 43)	Correlation between indicators in the publications of the Moscow and St. Petersburg schools
Number of published journals using natural-scientific terminology	-0.14
Number of articles with natural-scientific terminology	-0.09
Number of biological terms	0.01
Number of physical terms	0.02
Number of mathematical terms	-0.32*

Note: * means the significance of the statistic link at the 5% significance level

It can be assumed, judging by the obtained correlations, that the Moscow and St. Petersburg scientific psychological schools exist independently of one another, since the change in time of the studied indicators occurs in each case in its own way.

The correlation matrix, which shows the relationship between the five considered features for the Moscow School, is presented in Table 5.

Table 5. Correlations between indicators of occurrence of natural-scientific terminology in publications of the Moscow School (number of cases considered n = 43)

No. p / p	Index	one	2	3	four	5
1	Number of journals	1.0				
2	Number of articles	0.73***	1.0			
3	Biology	0.25	0.57***	1.0		
4	Physics	0.37*	0.63***	0.85***	1.0	
5	Mathematics	0.52***	0.63***	0.55***	0.66***	1.0

Note: * -5%; ** - one% ; *** - 0.1% correlation confidence level

The correlation matrix, which presents the relationships between the five considered features for the St. Petersburg School, is shown in Table 6.

Table 6. Correlations between indicators of the occurrence of natural-scientific terminology in the publications of the St. Petersburg School (number of cases considered n = 71)

No. p / p	Index	one	2	3	four	5
1	Number of journals	1.0				
2	Number of articles	0.84***	1.0			
3	Biology	0.35**	0.53***	1.0		
4	Physics	0.67***	0.80***	0.62***	1.0	
5	Mathematics	0.76***	0.71***	0.24*	0.57***	1.0

Note : * -5%; ** - one% ; *** - 0.1% correlation confidence level

More clearly, the relationship between the indicators under consideration is seen in the graphical representation of features, using an arsenal of graph theory methods. In

this case, we use the methods of P.V. Terentiev and L.K. Vyhandu (Balin V.D., 2015). The essence of the Terentiev's method is that each experimental indicator is considered as the top of the graph, and the correlation between such indicators is the edge of the graph (line). The Vyhandu's method allows you to select in the correlation matrix only the most significant relationships between features, that's why this method is called the method of the maximum correlation path.

Figure 22 shows the links between the features that characterise the publications of the Moscow School, displayed using a graph (the Terentyev's method) (see Figure 22).

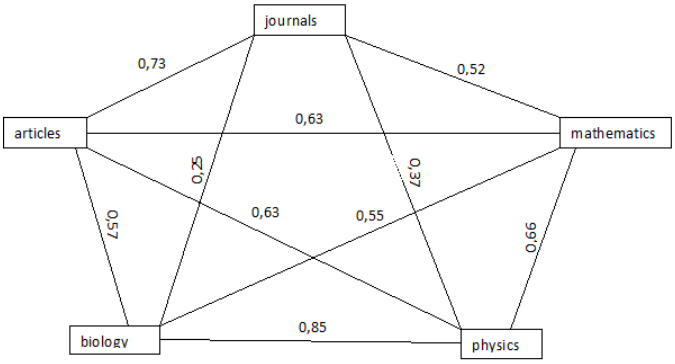

Figure 22. Indexes and correlation coefficients between them for the Moscow School sample (the Terentyev's method).

Figure 23 shows the relationships between the five considered features for the St. Petersburg School, displayed using graphs (the Terentyev's method) (see Figure 23).

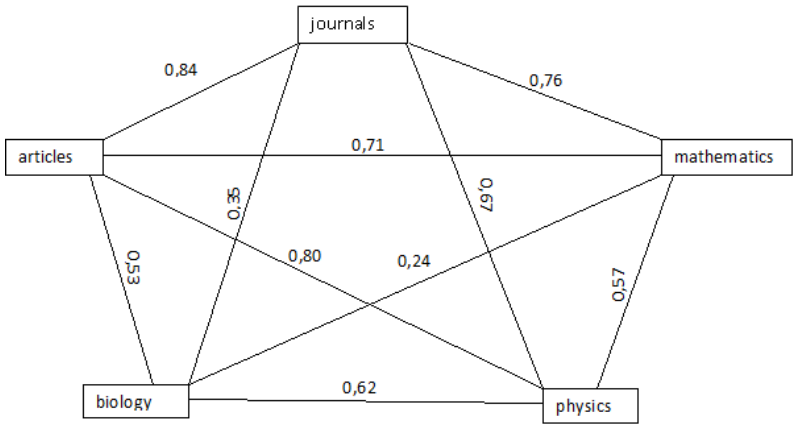

Figure 23. Indexes and correlation coefficients between them for the St. Petersburg School sample (the Terentyev's method).

Figure 24 shows the links between the features that characterise the publications of the Moscow School, displayed using the Vyhandu's method (see Figure 24).

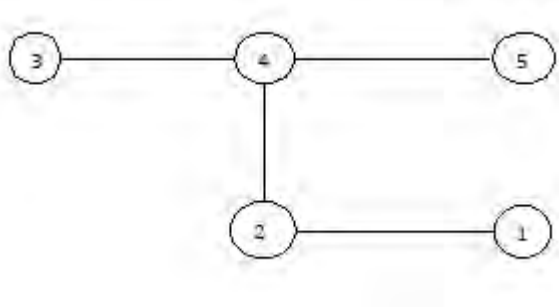

Figure 24. The graph built using the L.K. Vyhandu's method (the Moscow school). The names of the signs correspond to the table 4.

Figure 25 shows the links between the features that characterise the publications of the St. Petersburg School, displayed using the Vyhandu's method (see Figure 25).

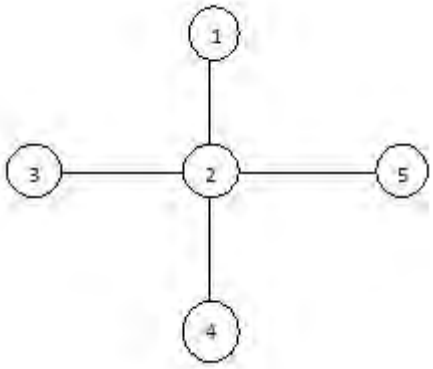

Figure 25. A graph built according to the L.K. Vyhandu's method (the St. Petersburg School). The names of the signs correspond to the table 5.

Qualitative analysis

The results of the Moscow school publications research have permitted to sign the most important topics:

1. Animal psychology (based on K.E. Fabry's studies)
2. Artificial intelligence (based on O.K. Tikhomirov's studies)
3. Eye movement study (researches of T.M. Buyakas and Y.B. Dormashyov)
4. Researching of lateralisation of brain functions (E.D. Khomskaya's publications)
5. Development of K. Levin's field theory (B.V. Zeigarnik's articles)

In 1990s the natural-scientific domain of the Moscow psychological school was deformed: scientists tried to explore supernatural phenomena. As a result, many weird studies appeared. They were done on small subjects, and this fact does not let consider them seriously.

We have also signed the main topics of publications of the St. Petersburg (Leningrad) psychological school:

1. The holistic approach (B.G. Ananyev's articles)
2. Study of ontogenetic development of psycho-physiological functions (E.F. Rybalko's researches)
3. Mathematical psychology (publications of G.V. Sukhodolsky and V.A. Ganzen)
4. The systemic approach (V.A. Ganzen's publications)
5. Psychophysiology
6. Engineering psychology
7. Sports psychology

The qualitative analysis permit us conclude the following facts:

1. The natural-scientific domain is represented in the Moscow psychological school by particular studies illustrating its certain aspects (eye movements, lateralisation of brain functions, artificial intelligence).
2. The St. Petersburg (Leningrad) psychological school uses the natural-scientific domain in other way:
   2.1 The holistic and systemic approaches (especially the second one) have natural-scientific origin.
   2.2 The natural-scientific domain covers whole fields of psychology in the St. Petersburg (Leningrad) psychological school, such as engineering psychology, sports psychology and especially psychophysiology and mathematical psychology.

3.2.2 The discussion of the results

Frequency graphs for the Moscow psychological school show that the most variable parameter is "biological terms". The parameters of the frequency of occurrence of terms change relatively evenly, but there is a peak in the indicator "biological terms" in 2010 (317 words). It may be related to research in psychophysiology and the study of eye movements. ACF charts usually have a small period of fluctuations (from 3 to 5 years). This may be due to the fact that the change in the direction of development of the Moscow psychological school in general and the natural-scientific domain in particular is associated with a change in the direction of research within planned economy (five-year plans), or with a period of study at a university, also equal to five years. Data processing according to the method of L.K. Vyhandu showed that the parameter "physical terms" is the central feature (which allows us to confirm the hypothesis about the importance of the physical aspect for the Moscow school), and this connection is not very obvious. Probably, the fact is that the authors of the Moscow psychological school, like most modern scientists, consider physics to be an "ideal" science that has all the basic attributes of science.

It is known that the leaders of the Moscow psychological school worked mostly within the philosophical domain. A connection between the physical aspect of the natural-scientific domain and the philosophy of science, based on works of such famous philosophers as K. Popper, T. Kuhn and P. Feierabend, seems the most obvious. These authors used physics, considered as an ideal science, as an example in their books on history of science (Popper K., 1983; Popper K., 2008; Kuhn T., 1975; Feierabend P., 1986). Kuhn's theory is particular: being a physicist, the author created his concept of five stages of science development using this discipline as an example. This is the reason why the physics is so idealised in the philosophy of science, and why the leaders of the Moscow psychological school are orientated to the physical aspect of the natural-scientific domain.

It should be mentioned that several authors of the Moscow psychological school notice the importance of the physical aspect of the natural-scientific domain. For example, B.V. Zeigarnik is famous not only for her works on clinical psychology, but also for development of K. Levin's field theory (she was taught by K. Levin). It should be noticed that K. Levin, like the psychologists of the Moscow school thought that physics is the most fundamental natural science; his theory of psychological field is an adaptation of physicists' statements about electromagnetic fields (Zeigarnik B.V., 1981; Levin K., 1980; Levin K., 1980).

Frequency graphs of the St. Petersburg (Leningrad) psychological school show that the most variable parameter is the "number of articles". The terms frequency rates change relatively evenly, but there are two peaks that need to be highlighted: the peak of the "biological terms" in 1950 (243 words) and the peak of the "physical terms" in 1996 (96 words). The first one may be associated with an increased interest in HNA physiology in connection with the famous Pavlovian session, the second one with the active introduction of systems theory and synergetics into psychology. ACF charts usually have a long period of fluctuations (up to 20 years). This may be due to the fact that the change in the direction of development of the St. Petersburg (Leningrad) psychological school as a whole and the natural-scientific domain is associated with a change in the generation of researchers and the leader of the school. Data processing according to the L.K. Vykhandu's method showed that the "number of articles" parameter is the central feature, and if the relationship with the "number of journals" parameter is not in doubt, then other links are not so obvious. Probably, the point is the systemic approach and the orientation of the authors of the St. Petersburg (Leningrad) school to integrative disciplines, such as cybernetics and synergetics (Ananiev B.G., 1968; Ananiev B.G., 1977; Vekker L.M., 1964 ; Vekker L.M., 2000; Ganzen V.A., 1974; Ganzen V.A., 1983; Ganzen V.A., 1984; Lomov B.F., 1984). This allows us to

confirm the hypothesis about the significance of integrative processes for representatives of the St. Petersburg Psychological school.

The leaders of the St. Petersburg (Leningrad) psychological school (B.G. Ananyev, B.F. Lomov, L.M. Vekker. V.A. Ganzen) used holistic and systemic approaches in their researches. They paid attention on the union of the biological and social aspects of the human being and also on the union of the human being and his or her environment. The authors confirmed the importance of the natural sciences in holistic study of the human being; they also highlighted the union of all the natural sciences (Ananiev B.G., 1968; Ananiev B.G., 1977; Vekker L.M., 1964; Vekker L.M., 2000; Ganzen V .A., 1974; Ganzen V.A., 1983; Ganzen V.A., 1984; Lomov B.F., 1984).

The data of both psychological schools since 1977 to 2019 were chosen for correlation analysis (see the table 4). We have discovered that there is only one significant correlation, and this is the correlation of “mathematical terms” parameter. It can happen for various reasons. Firstly, mathematics is universal “language” of the natural sciences, and if we discuss the natural-scientific domain, we must pay attention on mathematics. Secondly, the authors of both main Russian psychological schools are equally interested in cybernetics and artificial intelligence, and this interest is only increasing in the late XX – early XXI century (Stepanova J.V., 2019[a]; Stepanova J.V., 2019[b]; Stepanova J.V., 2020; Stepanova J.V., Balin V.D., 2020).

Already mentioned above M. Clemente Linuesa (Clemente Linuesa M., 1983) used a method similar to semantic analysis: the author analysed the ideological features of school history textbooks. In Russian psychology, there is A.A. Fedorov’s article, devoted to the bibliometric analysis of publications on post-non-classical psychology in Scopus since 2002 to 2017. In the course of the study, 30 publications containing terms related to the concept of "post-non-classical" and represented in the field of knowledge "Psychology" were analysed. And although the hypothesis that modern psychology can be considered a post-non-classical science could not be confirmed by quantitative data, the author notes an important pattern: the vast majority of articles on post-non-classical psychology were published in Russian scientific journals or by Russian researchers (Fedorov A.A., 2018). An important conclusion follows from this study: in Russian psychology (including the St. Petersburg psychology school) the integrative processes of scientific knowledge are proceeding faster than in foreign ones.

3.2.3 Conclusion

1) The authors of the Moscow psychological school, who mainly adhered to the humanistic domain, were guided by physics as an ideal science and, as a result,

the physical aspect of the natural-scientific domain turned out to be the most important;

2) The authors of the St. Petersburg (Leningrad) psychological worked in the context of the the natural-scientific domain as a whole, and did not use elements of separate disciplines;
3) The only parameter connecting the two directions was the frequency of using mathematical terms, which is associated with the same interest in the main mathematical theories (mathematical models, artificial intelligence, graph and set theories, cybernetics).
4) The nature of the distribution of periods of change in features studied using the construction of an autocorrelation function (ACF) suggests that the authors of the Moscow school have an attitude towards novelty in their research. Representatives of the St. Petersburg school have a stability orientation, preferring to use time-tested methods of research and interpretation of data, giving primacy in the use of new methods to colleagues from Moscow.
5) In their research, representatives of the two schools are largely independent of each other.

3.3 The study of the phase dynamics of psycho-physiological functions as an example of the operation of the law of phases at the individual level

Let us repeat that the study used a number of parameters of the activity of the nervous system:

- Indicators of the central nervous system:
  1) Right hemisphere alpha index
  2) Left hemisphere alpha index
  3) Right hemisphere average frequency
  4) Left hemisphere average frequency
  5) Right hemisphere dominant frequency
  6) Left hemisphere dominant frequency
- Indicators of the autonomic nervous system:
  1) Heart rate
  2) Breathing rate
  3) Systolic pressure
  4) Diastolic pressure
  5) Breathing volume
  6) Vital capacity of the lungs
- Indicators of the somatic nervous system:
  1) Right hand dynamometry
  2) Left hand dynamometry
  3) Right hand static tremor

4) Left hand static tremor
5) Right hand dynamic tremor
6) Left hand dynamic tremor

The following procedures were used for statistical processing of the study data:

1. Scaling
2. Autocorrelation function
3. Descriptive statistics
4. The coefficient of variation

3.3.1 Research results

This paragraph describes the analysis of the results of the study, carried out in several stages:

- The analysis of graphs of changes in average scores ("raw" and scaled ones)
- The analysis of ACF charts (of "raw" and scaled scores)
- The analysis of graphs of total scaled grades

Description of graphs of changes in average scores

Firstly, the graphs of "raw" average scores of psychophysiological functions are described, and then scaled ones are.

Graphs of "raw" average scores

1. *Right hemisphere alpha index.* The graph as a whole is in the range of 0-100%, however there is a very high peak of unclear origin (possibly an artefact) between 19 years 1 month and 19 years 5 months. This peak reaches 440%. Otherwise, the graph does not allow any pattern to be distinguished (Fig. 26).
2. *Left hemisphere alpha index.* The graph is very similar to the right hemisphere alpha graph in its location and the presence of a high peak (possibly also an artefact) from 19 years 1 month to 19 years 5 months. However, here this peak is lower than in the case of the right hemisphere and reaches only 400%. The graph is also extremely heterogeneous and does not allow a clear conclusion about the age dynamics of the alpha index (Fig. 26).

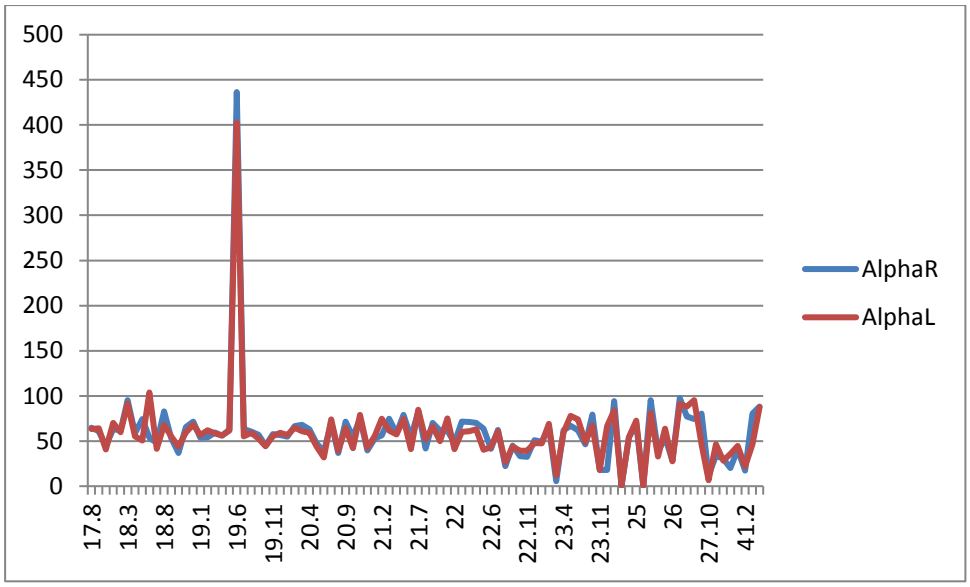

Figure 26. Alpha index ("raw" scores). The abscissa axis refers to age (years, months), and the ordinate axis refers to the alpha index values (percent).

3. *Right hemisphere average frequency.* Up to 18 years, there is a slight rise from 8 to 11 Hz, but then the graph levels off, and its main part fluctuates relatively evenly in the range from 8 to 14 Hz. There is a strong decline at 25 years (4 Hz), as well as a high peak at 27 years (18 Hz), which are probably artefacts (Fig. 27).
4. *Left hemisphere average frequency.* The graph has a similar dynamics with the similar graph for the right hemisphere, except for the decline in 25 years. The existing peak at 27 years (18 Hz) is most likely an artefact (Fig. 27).

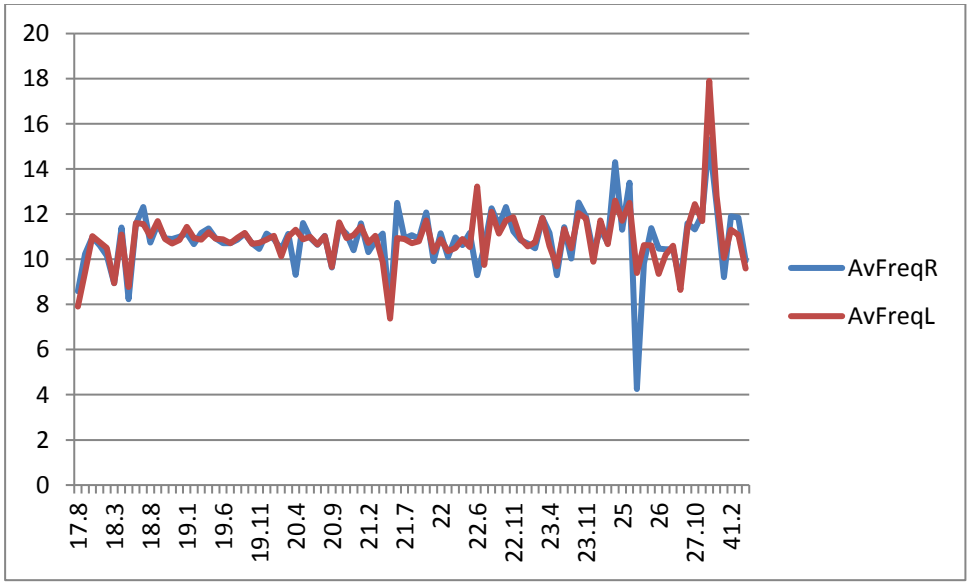

Figure 27. Average frequency ("raw" scores). The abscissa axis refers to age (years, months), and the ordinate axis refers to the average frequency values (Hz).

5. *Right hemisphere dominant frequency.* An extremely heterogeneous graph is located in the range of 8-14 Hz, which does not allow us to draw conclusions about the age dynamics of the dominant frequency. There is a high peak of unclear nature at 27 years 10 months, reaching 22 Hz, it is probably an artefact (Fig. 28).

6. *Left hemisphere dominant frequency*. The graph is very similar to the graph of the dominant frequency for the right hemisphere, however, the peak at 27 years 10 months is somewhat lower and reaches only 20 Hz (Fig. 28).

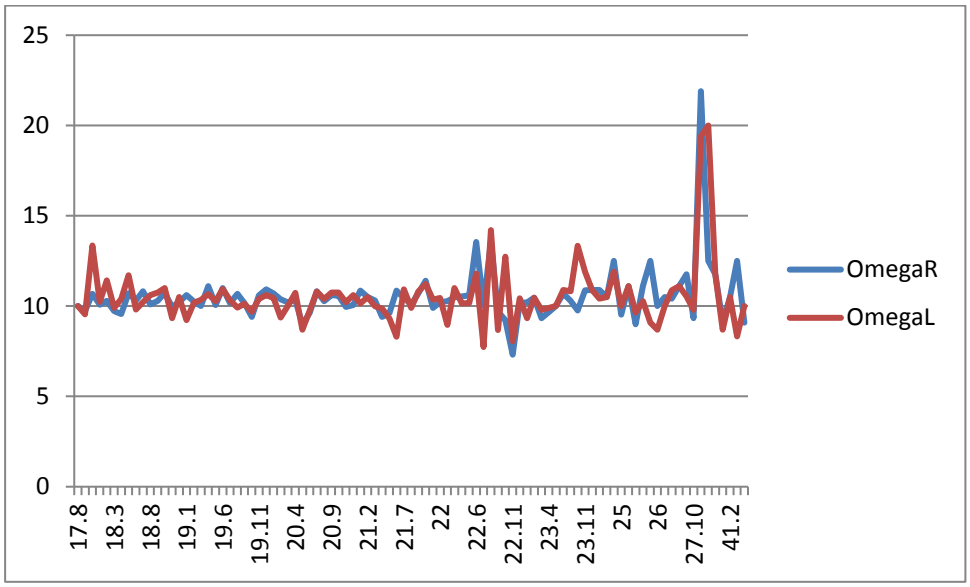

Figure 28. Dominant frequency ("raw" scores). The abscissa axis refers to age (years, months), and the ordinate axis refers to the dominant frequency values (Hz).

7. *Heart rate.* According to the graph, it is impossible to draw a conclusion about the age dynamics of the heart rate, because it is extremely heterogeneous and ranges from 50 to 95 (Fig. 29).
8. *Breathing rate.* Age dynamics is weakly expressed, the graph is additionally complicated by artefacts (Fig. 29).

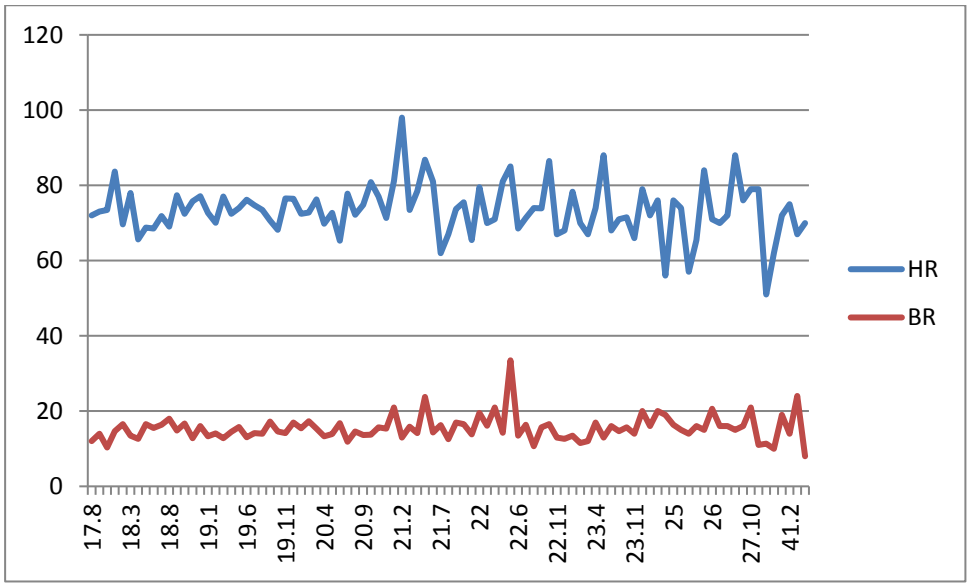

Figure 29. HR and BR ("raw" scores). The abscissa axis refers to age (years, months), and the ordinate axis refers to the values of heart and respiration rate (1/min).

9. *Systolic pressure*. The graph extremely complicated by artefacts, age dynamics is not expressed (Fig. 30).

10. *Diastolic pressure.* A similar situation is observed with the systolic pressure graph: a complex structure and the presence of artefacts that complicate the identification of age-related dynamics (Fig. 30).

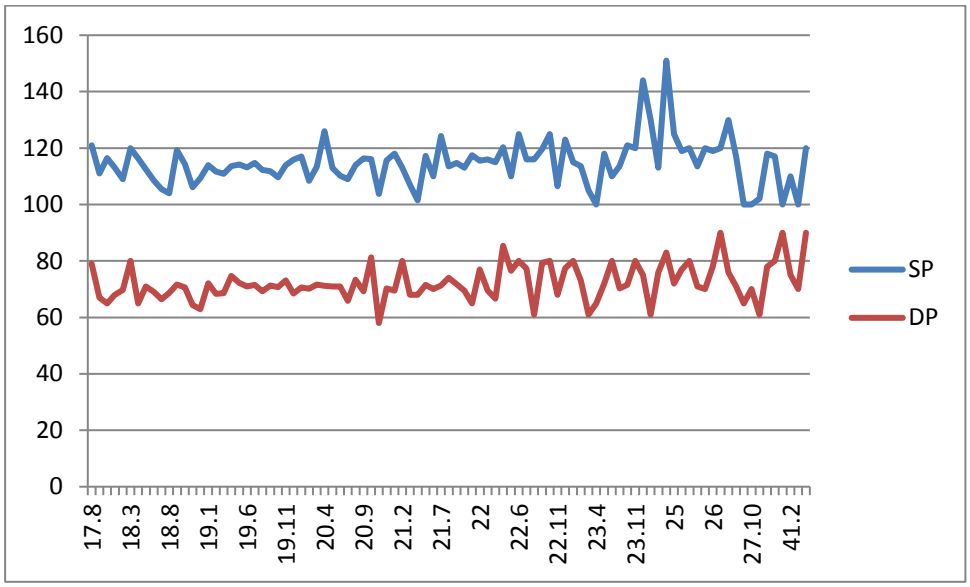

Figure 30. Blood pressure ("raw" scores). The abscissa axis refers to age (years, months), and the ordinate axis refers to the values of systolic and diastolic pressure (mmHg).

11. *Breathing volume.* A fairly even graph, without noticeable dynamics, but having 4 sharp peaks of unclear origin: at 20 years old 4 months (3 ml), at 21 years old 3 months (5 ml), at 23 years old 4 months (9.5 ml) and at 41 year 1 month (3.5 ml). Perhaps these peaks are artefacts (Fig. 31).
12. *Vital capacity of lungs.* Age dynamics is present, but weakly expressed. Towards the end of the graph, the fluctuations become sharper (which is most likely an artefact) (Fig. 31).

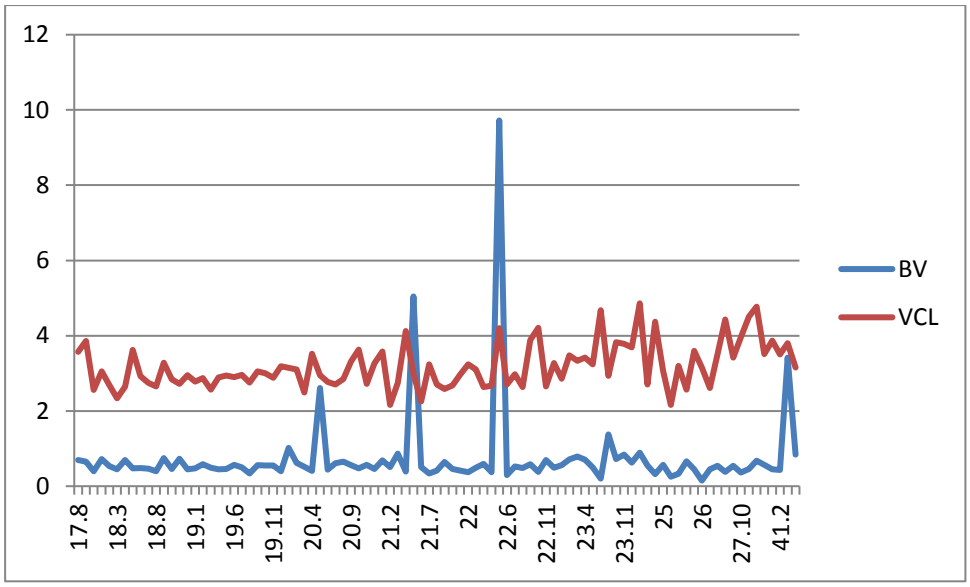

Figure 31. BV and VCL ("raw" scores). The abscissa axis refers to age (years, months), and the ordinate axis refers to the values of respiratory volume and vital capacity (ml).

13. *Right hand dynamometry.* The graph has sharp fluctuations in height, but there is a pronounced increase. Sharp fluctuations are probably artefacts (Fig. 32).
14. *Left hand dynamometry.* The graph is similar to the previous one, there are also sharp peaks and declines (possibly artefacts) and a general upward trend (Fig. 32).

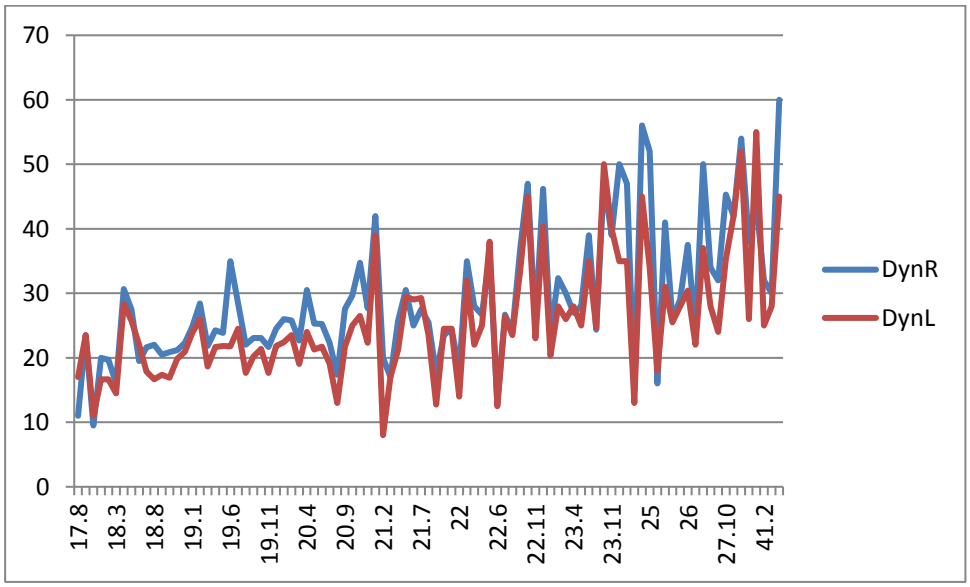

Figure 32. Dynamometry ("raw" scores). The abscissa axis refers to age (years, months), and the ordinate axis refers to the dynamometry values (kg).

15. *Right hand static tremor.* Some age-related dynamics is visible, which is uncertain due to additional sharp fluctuations, which are probably artefacts (Fig. 33).
16. *Left hand static tremor.* As in the previous graph, there is an age-related dynamics that cannot be clearly distinguished due to noise (Fig. 33).

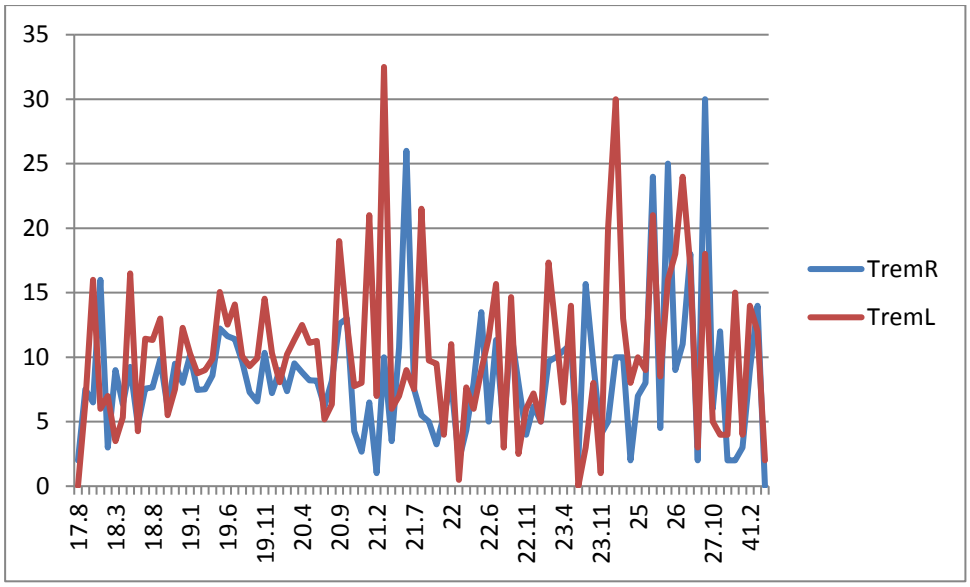

Figure 33. Static tremor ("raw" scores). The abscissa axis refers to age (years, months), and the ordinate axis refers to the values of static tremor.

17. *Right hand dynamic tremor.* Age dynamics can hardly be traced due to the existing interference or additional rhythm (Fig. 34).
18. *Left hand dynamic tremor.* As in the case of the right hand dynamic tremor graph, the existing additional rhythm interferes with the recognition of the main age dynamics of this parameter (Fig. 34).

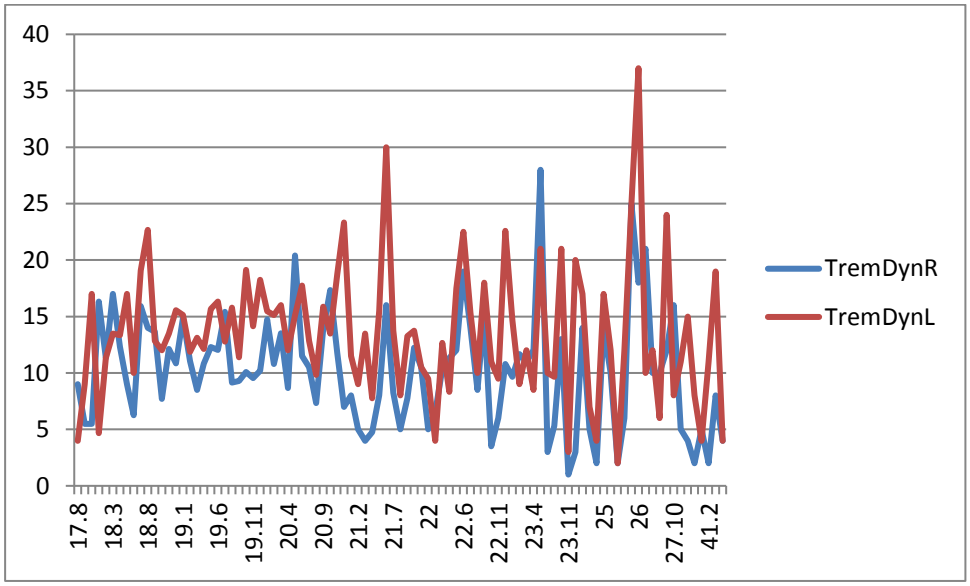

Figure 34. Dynamic tremor ("raw" scores). The abscissa axis refers to age (years, months), and the ordinate axis refers to the values of dynamic tremor.

Graphs of scaled scores

1. *Right hemisphere alpha index.* Age dynamics is poorly represented, the graph contains additional sharp fluctuations (apparently, artefacts) or an additional rhythm, which is difficult to distinguish (Fig. 35).

2. *Left hemisphere alpha index.* As in the previous case, the graph contains additional fluctuations that are difficult to distinguish, which, nevertheless, do not interfere with highlighting the main dynamics (Fig. 35).

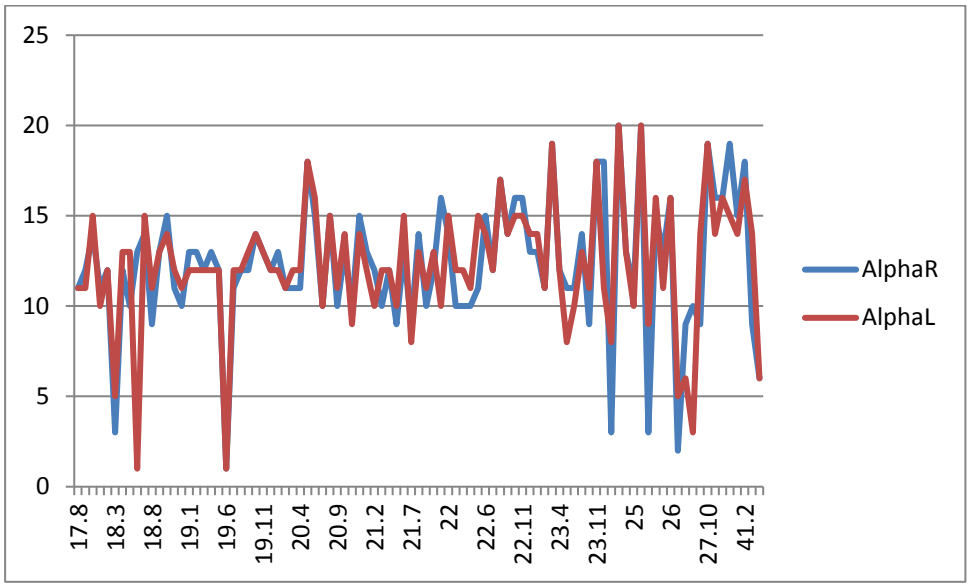

Figure 35. Alpha index (scaled scores). The abscissa axis refers to age (years, months), and the ordinate axis refers to the alpha index values (in points).

3. *Right hemisphere average frequency.* The graph is high, but there are some recessions of unclear origin, which can be considered as outliers. Nevertheless, weak dynamics can be traced, for the description of which more accurate processing methods are needed (Fig. 36).
4. *Left hemisphere average frequency.* The situation is similar to the previous one: a highly located graph with weak harmonic oscillations and separate sharp recessions-outliers (Fig. 36).

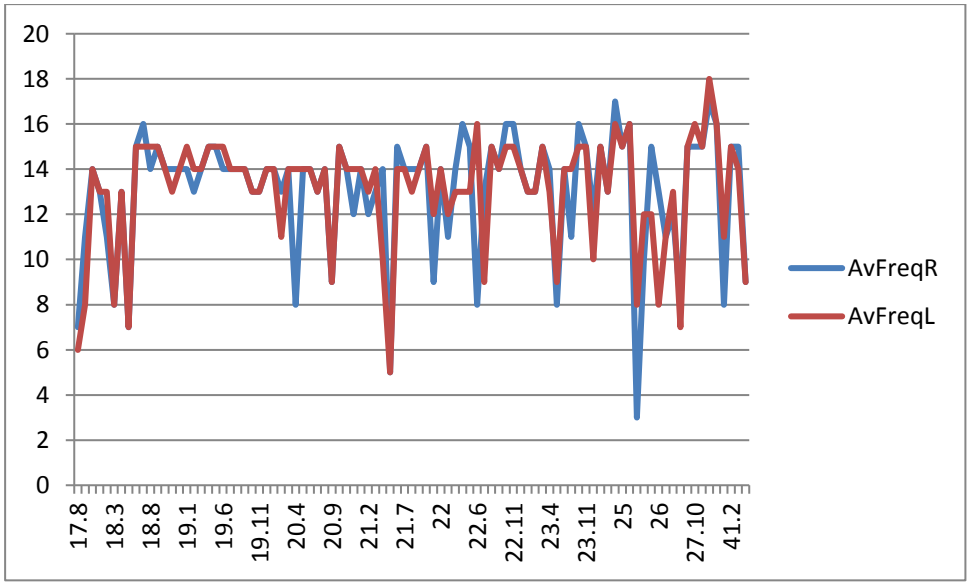

Figure 36. Average frequency (scaled scores). The abscissa axis refers to age (years, months), and the ordinate axis refers to the mean frequency values (in points).

5. *Right hemisphere dominant frequency*. Scaled scores range from 8 to 15 points, which may indicate little variability. Towards the end, the graph becomes uneven (apparently due to the uneven distribution in this part of the sample) (Fig. 37).
6. *Left hemisphere dominant frequency*. As in the case of the right hemisphere, an artefact appears in the graph towards the end. Scaled scores vary in the range of 7-15 points (Fig. 37).

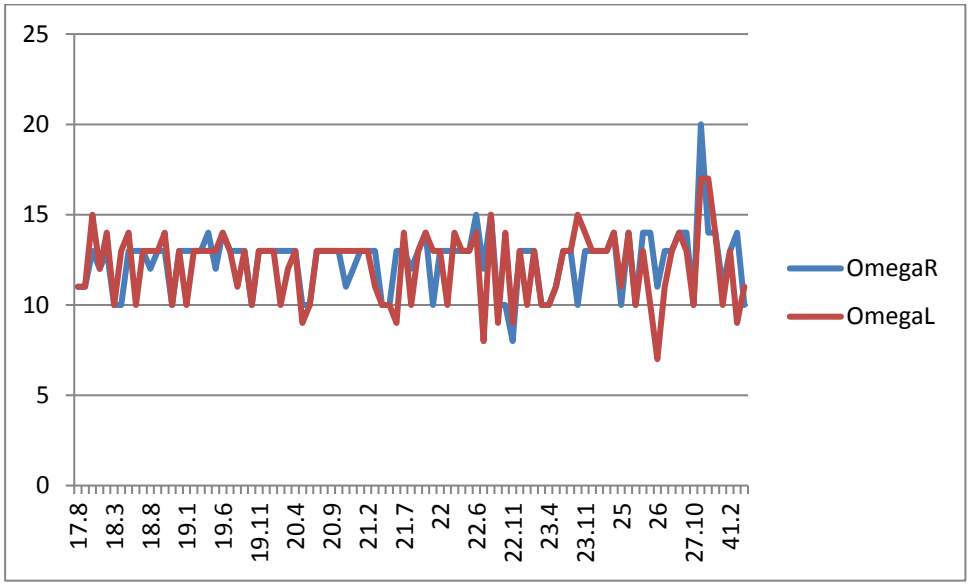

Figure 37. Dominant frequency (scaled scores). The abscissa axis refers to age (years, months), and the ordinate axis refers to the values of the dominant frequency (in points).

7. *Heart rate*. By converting raw scores into scaled ones, we managed to level the graph, but as the age increases, the fluctuations in the graph increase, which do not allow us to draw an accurate conclusion about the age dynamics (Fig. 38).
8. *Breathing rate*. The graph was also aligned, but artefacts remained that did not allow us to draw an accurate conclusion about the age-related dynamics of the respiratory rate (Fig. 38).

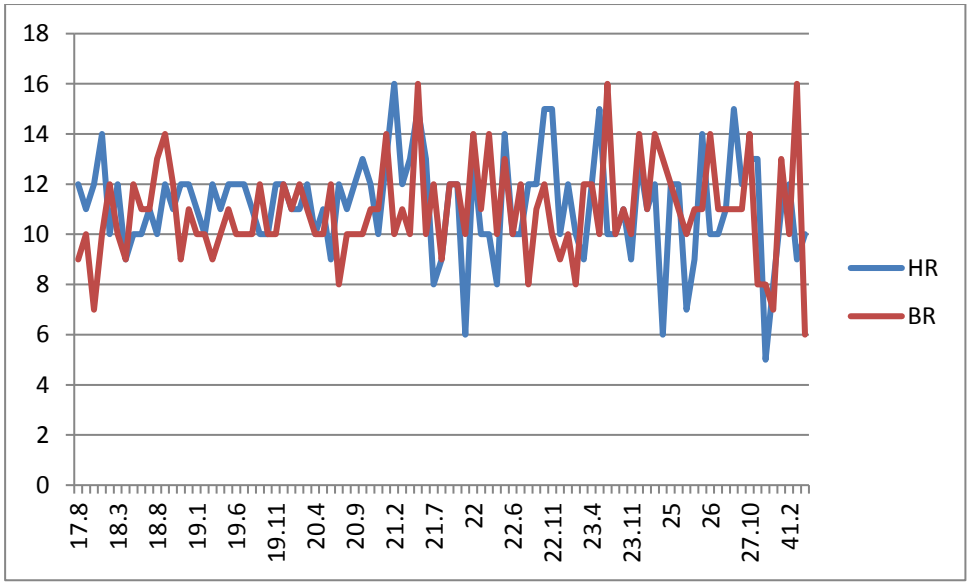

Figure 38. HR and RR (scaled scores). The abscissa axis refers to age (years, months), and the ordinate axis refers to the values of heart and respiration rate (in points).

9. *Systolic pressure*. After transferring to scaled scores, a certain decrease in systolic pressure with age was revealed (Fig. 39).
10. *Diastolic pressure.* The scaled results of measuring diastolic pressure showed a tendency to increase (Fig. 39).

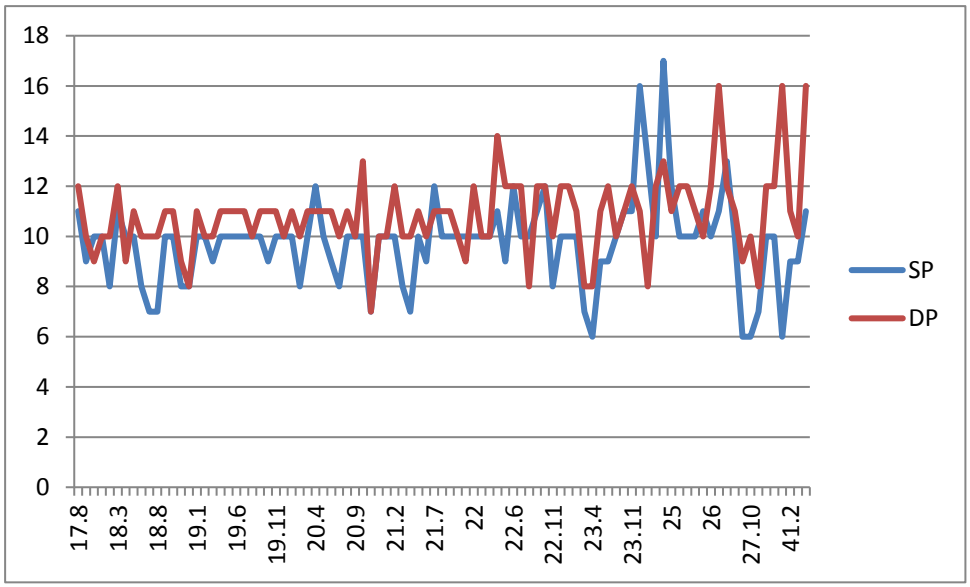

Figure 39. Blood pressure (scaled scores). The abscissa axis refers to age (years, months), and the ordinate axis refers to the values of systolic and diastolic pressure (in points).

11. *Breathing volume.* According to the graph, due to artefacts (high peaks reaching a maximum value of 20 points), it is impossible to draw a clear conclusion about the age dynamics. Estimates are mainly in the range from 4 to 15 points (Fig. 40).
12. *Vital capacity of the lungs.* There are some mild fluctuations of the parameter, the range of estimates is from 4 to 14 points (Fig. 40).

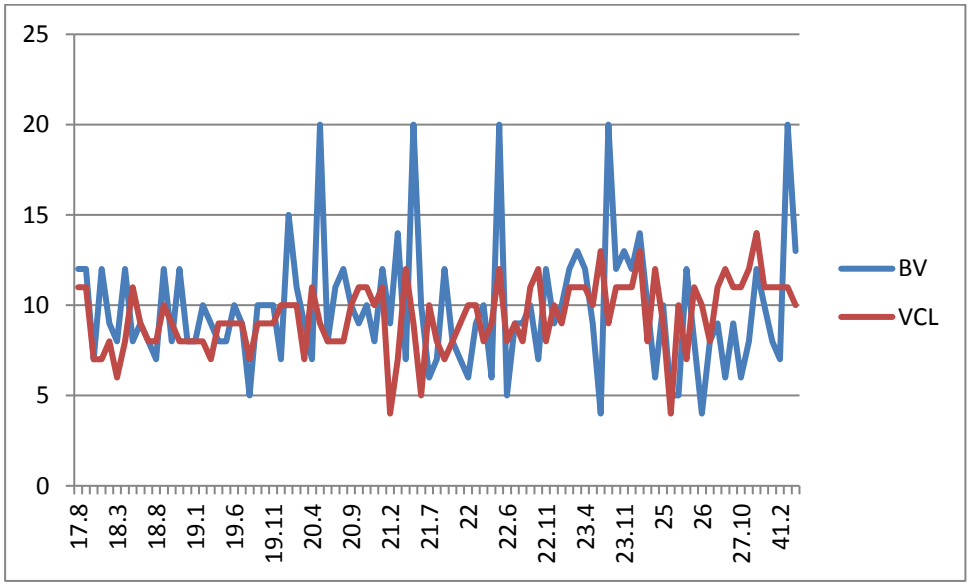

Figure 40. BV and VCL (scaled scores). The abscissa axis refers age (years, months), and the ordinate axis refers to the values of respiratory volume and vital capacity of the lungs (in points).

13. *Right hand dynamometry.* With the help of scaling, it was possible to see a clearer upward trend, despite the remaining noise. This can indicate an increase in muscle strength with age (Fig. 41).
14. *Left hand dynamometry.* The graph also showed a more pronounced upward trend, which also suggests an increase in muscle strength with age (Fig. 41).

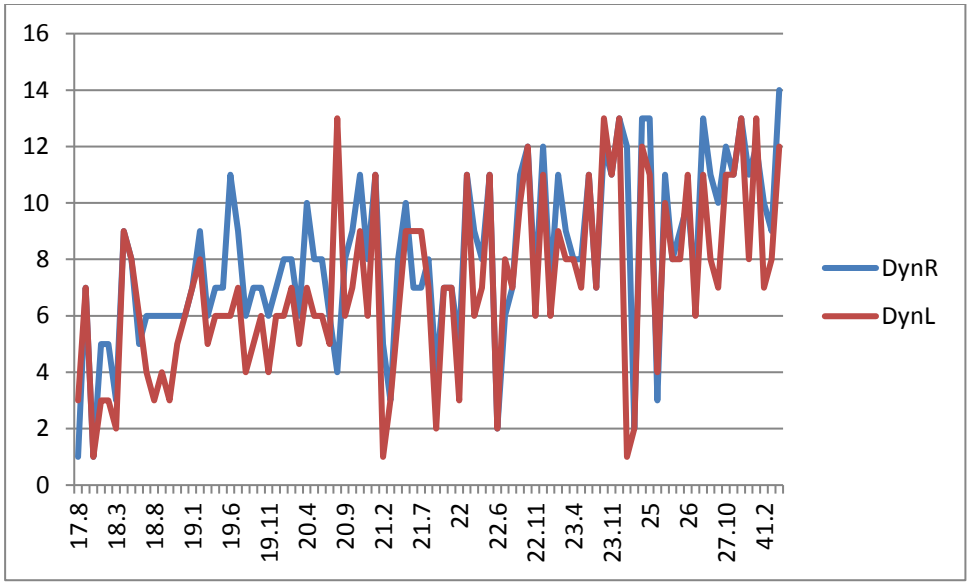

Figure 41. Dynamometry (scaled scores). The abscissa axis refers to age (years, months), and the ordinate axis refers to dynamometry values (in points).

15. *Right hand static tremor.* As a result of the conversion of raw scores into scaled ones, the following was obtained: despite the presence of some artefacts (sharp ups and downs), we can say that static tremor changes little, within 6-10 points (Fig. 42).
16. *Left hand static tremor.* As in the case of the static tremor of the right hand, changes are observed in the range of 6-10 points, despite some outliers (peaks and declines) (Fig. 42).

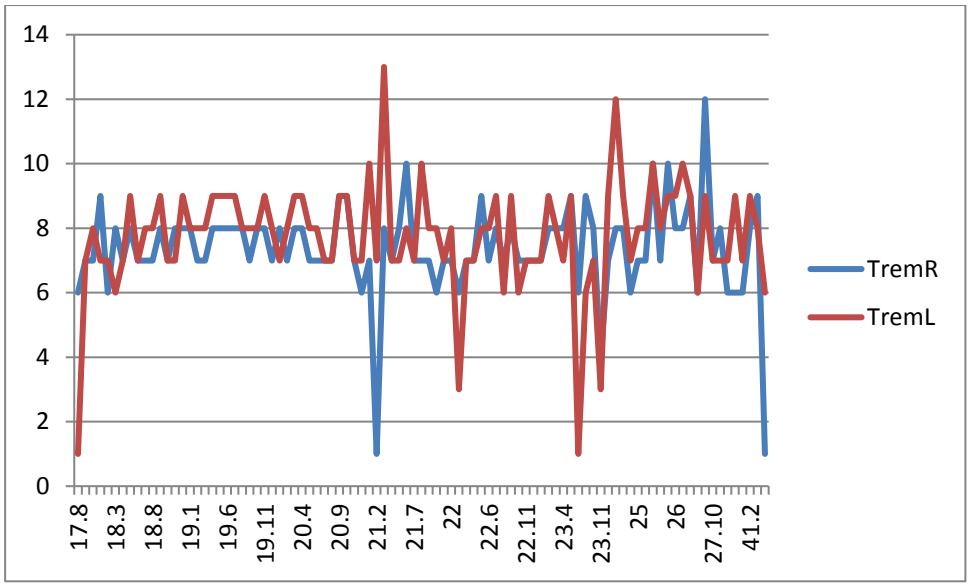

Figure 42. Static tremor (scaled scores). The abscissa axis refers to age (years, months), and the ordinate axis refers to the values of static tremor (in points).

17. *Right hand dynamic tremor.* Up to 19 years 5 months, there is a tendency for the indicator to increase to 13 points, then there is a general decrease, but with irregularities-artefacts (apparently, a consequence of the unevenness of this part of the sample) (Fig. 43).
18. *Left hand dynamic tremor.* A picture reminiscent of the previous chart: first, an increase (up to 15 points at 21 years 2 months), then a general downward trend, also containing obvious artefacts (Fig. 43).

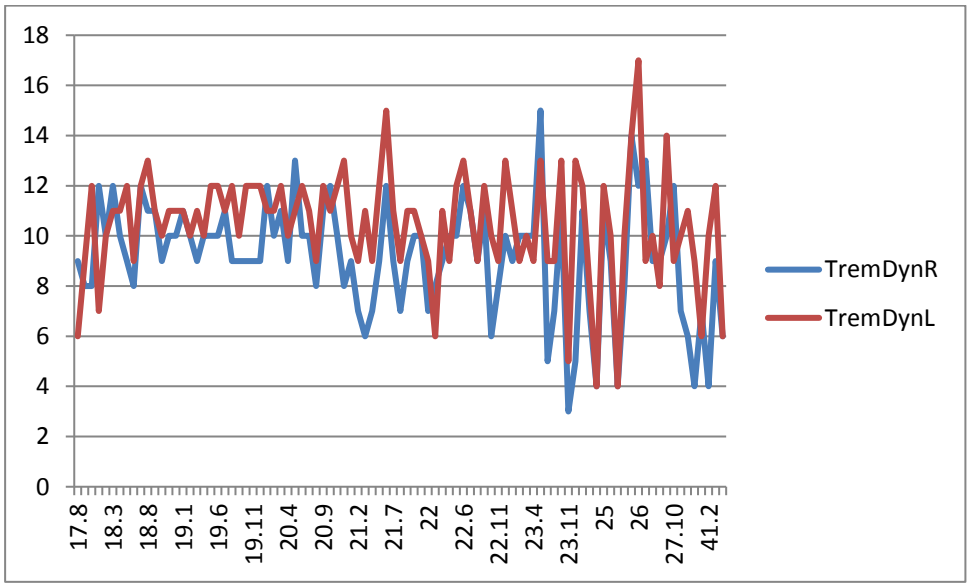

Figure 43. Dynamic tremor (scaled scores). The abscissa axis refers to age (years, months), and the ordinate axis refers to the values of dynamic tremor (in points).

Description of autocorrelation function charts

As in the case with the description of the graphs of changes in the average scores, the description of ACF charts is given in two stages: analysis of the graphs according to "raw" and scaled scores.

ACF charts of "raw" scores

1. *Right hemisphere alpha index.* The chart shows relatively smooth harmonic oscillations with a period of 4 months. To increase accuracy, it is recommended to convert the parameters into scaled scores (Fig. 44).

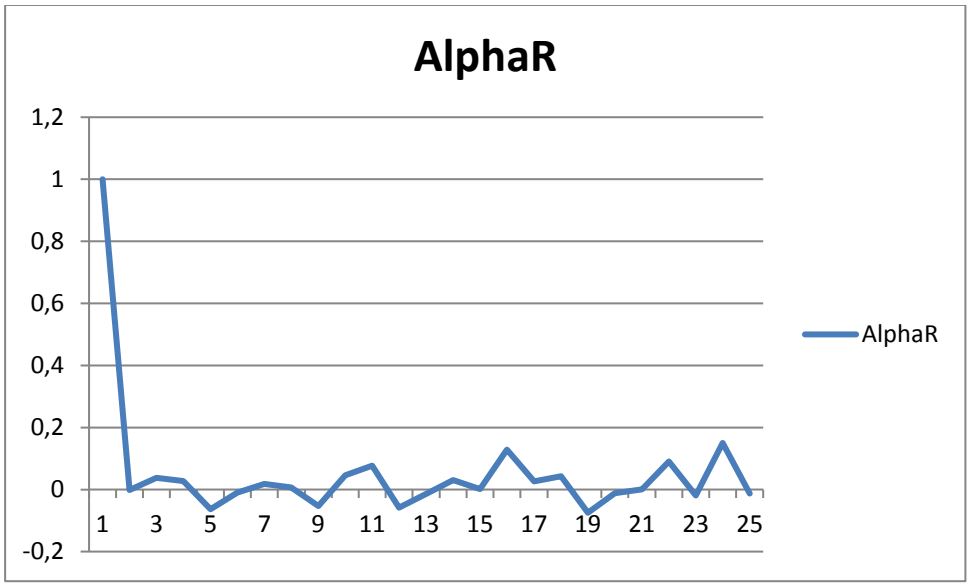

Figure 44. Right hemisphere alpha index (ACF, "raw" scores). The ordinate axis refers to the correlation, the abscissa axis refers to time.

2. *Left hemisphere alpha index.* The oscillation period, as in the previous case, is 4 months. As in the previous case, the fluctuations are harmonious, but the conversion to scaled scores can help increase the accuracy of the results (Fig. 45).

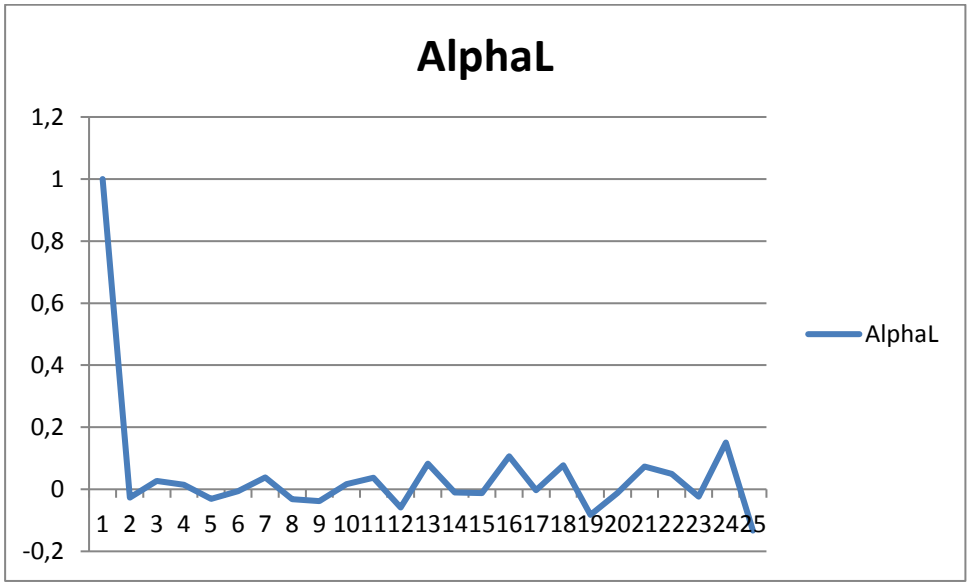

Figure 45. Left hemisphere alpha index (ACF, "raw" scores). The ordinate axis refers to the correlation, the abscissa axis refers to time.

3. *Right hemisphere average frequency.* The parameter needs to be scaled, because the chart is heavily complicated by an additional rhythm. The oscillation period is 3.5 months (Fig. 46).

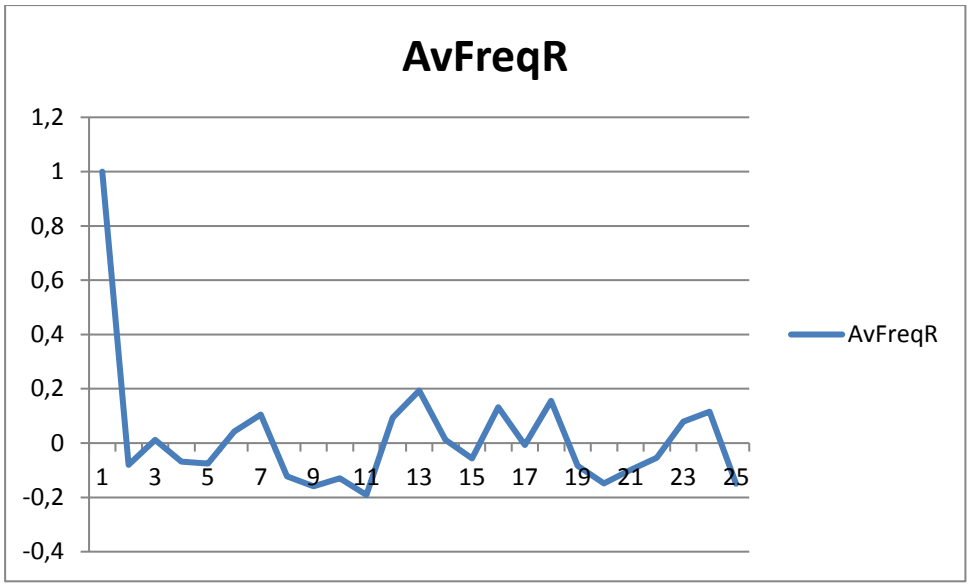

Figure 46. Right hemisphere average frequency (ACF, "raw" scores). The ordinate axis refers to the correlation, the abscissa axis refers to time.

4. *Left hemisphere average frequency.* The chart is very uneven, so the parameter also needs to be scaled. The approximate oscillation period is 4 months (Fig. 47).

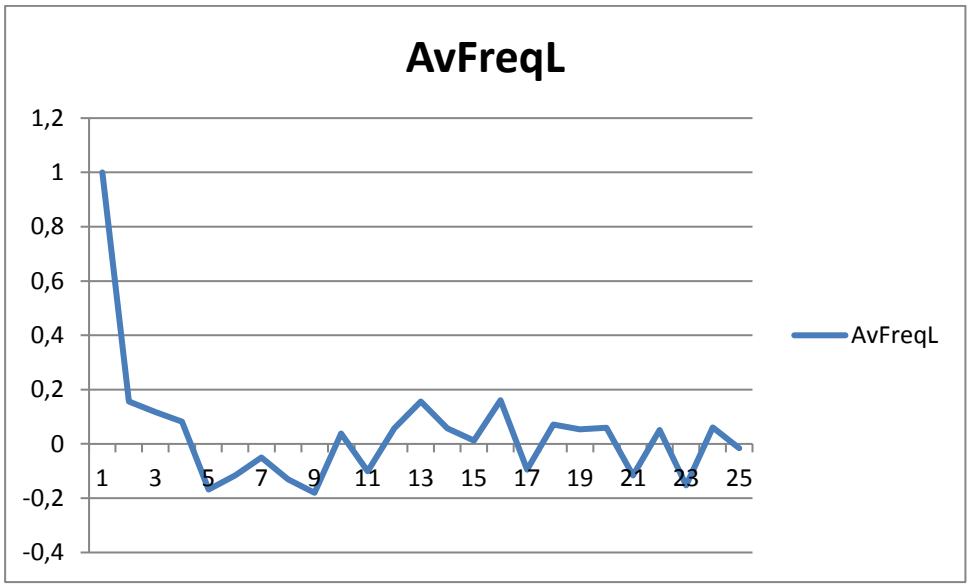

Figure 47. Left hemisphere average frequency (ACF, "raw" scores). The ordinate axis refers to the correlation, the abscissa axis refers to time.

5. *Right hemisphere dominant frequency.* The oscillation period is 3 months, the chart reflects the presence of harmonic oscillations (Fig. 48).

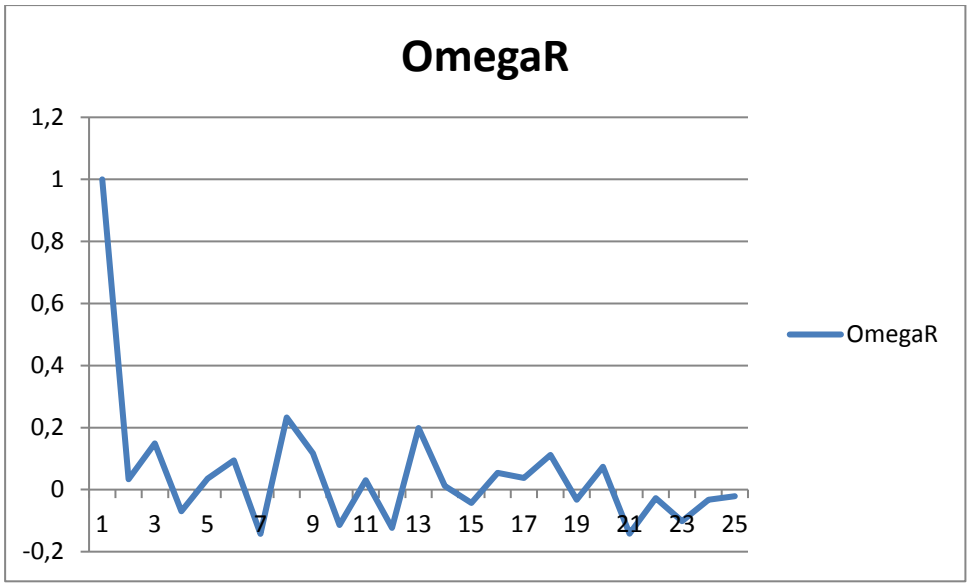

Figure 48. Right hemisphere dominant frequency (ACF, "raw" scores). The ordinate axis refers to the correlation, the abscissa axis refers to time.

6. *Left hemisphere dominant frequency*. The period is 4 months, there is an additional rhythm on the chart that reduces the quality of work with it (Fig. 49).

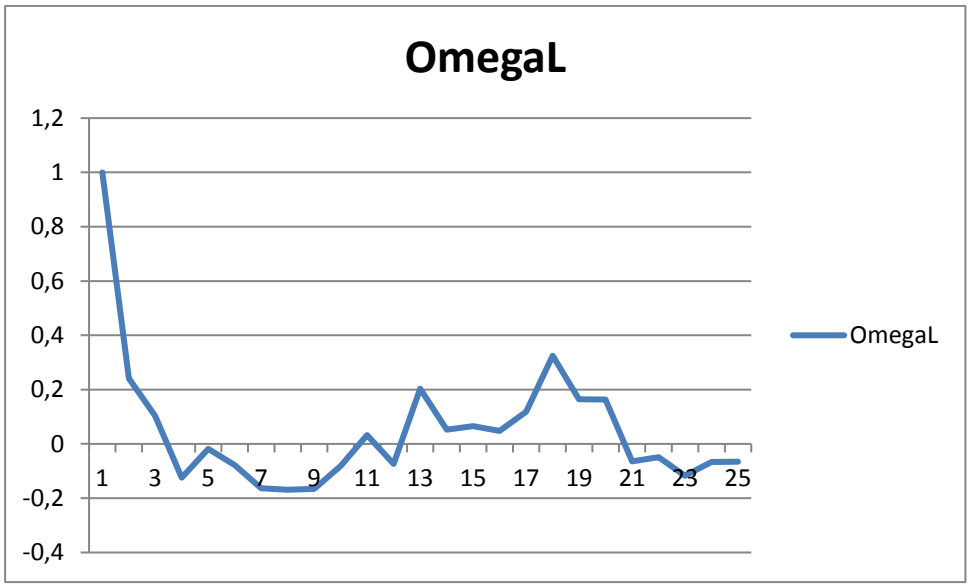

Figure 49. Left hemisphere dominant frequency (ACF, "raw" scores). The ordinate axis refers to the correlation, the abscissa axis refers to time.

7. *Heart rate.* The chart shows almost perfect harmonic oscillations with a period of 3 months. To increase the accuracy, it is necessary to convert the parameters into scaled scores (Fig. 50).

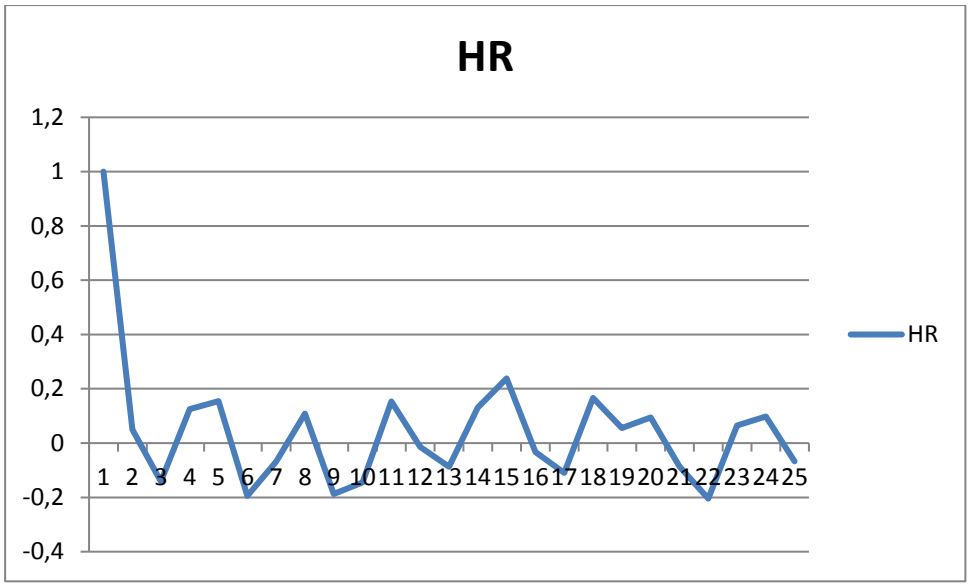

Figure 50. Heart rate (ACF, "raw" scores). The ordinate axis refers to the correlation, the abscissa axis refers to time.

8. *Breathing rate.* The oscillation period is 3.5 months, but there is an additional rhythm that does not allow us to call these oscillations completely harmonic. A more accurate picture can be given by scaled scores (Fig. 51).

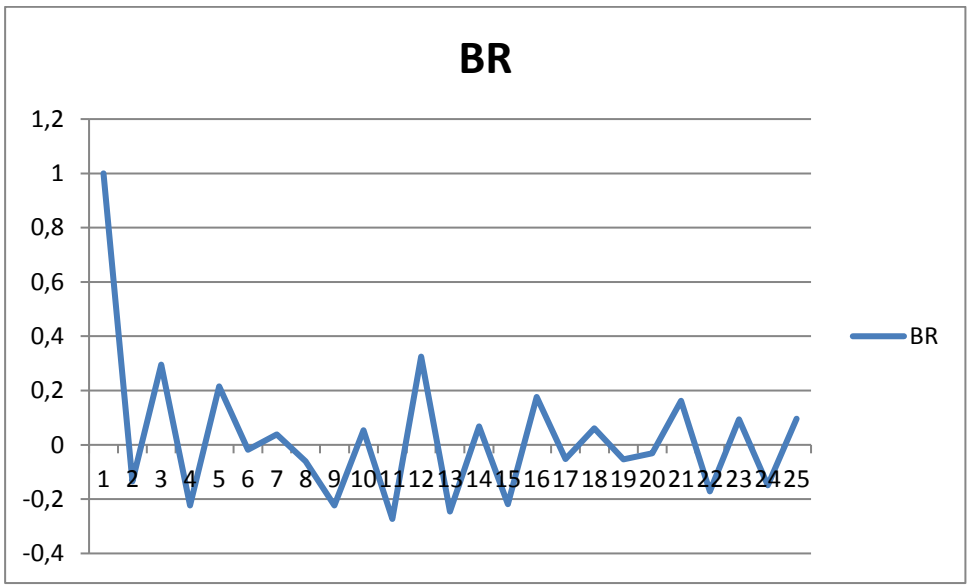

Figure 51. Breathing rate (ACF, "raw" scores). The ordinate axis refers to the correlation, the abscissa axis refers to time.

9. *Systolic pressure*. The oscillation period is 3 months, but the chart itself is very uneven, additional conversion of parameters into scaled scores is required (Fig. 52).

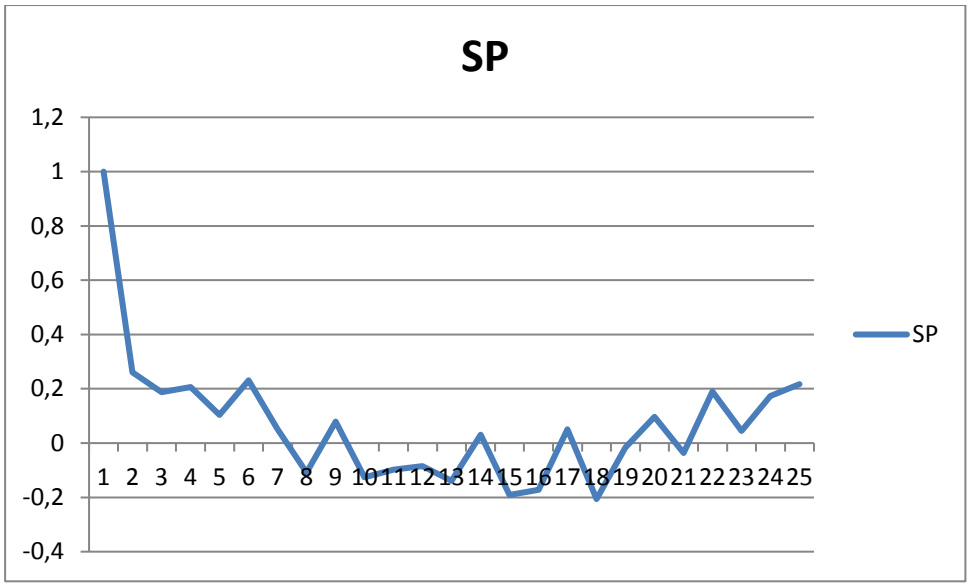

Figure 52. Systolic pressure (ACF, “raw” scores). The ordinate axis refers to the correlation, the abscissa axis refers to time.

10.Diastolic pressure. The oscillation period is 4 months, but there is an additional rhythm that complicates the work with the chart (Fig. 53).

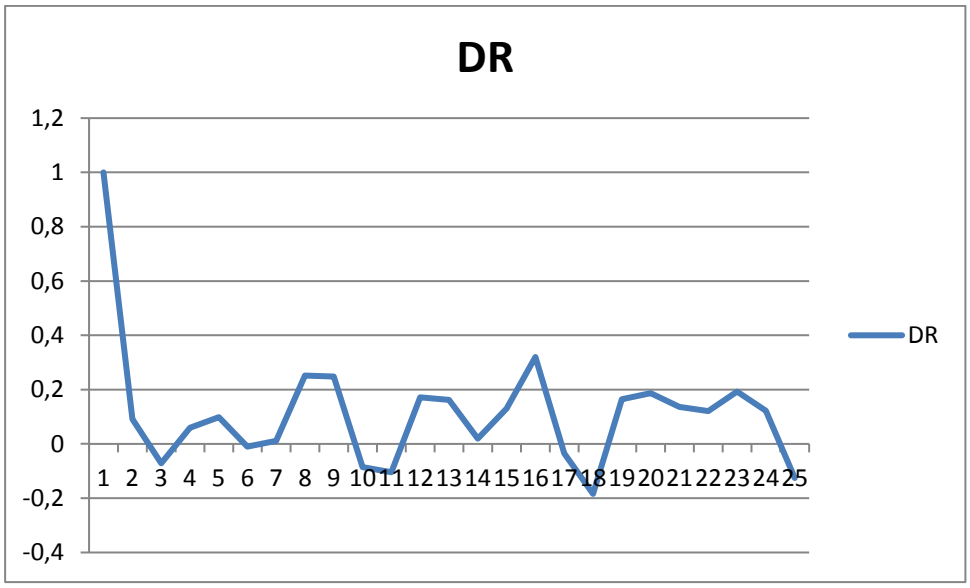

Figure 53. Diastolic pressure (ACF, "raw" estimates). The ordinate axis refers to the correlation, the abscissa axis refers to time.

11.Breathing volume. The oscillation period is 3.5 months. The graph has two sharp peaks of unclear origin, which are probably artefacts (Fig. 54).

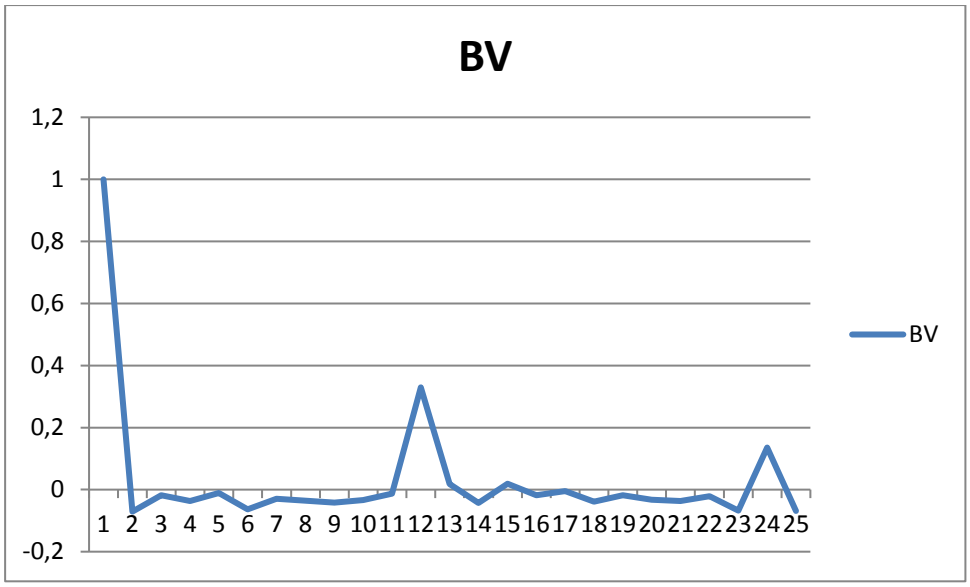

Figure 54. Breathing volume (ACF, "raw" scores). The ordinate axis refers to the correlation, the abscissa axis refers to time.

12. *Vital capacity of the lungs.* The oscillation period is 5 months, but the schedule includes an additional rhythm that makes it difficult to work with it (Fig. 55).

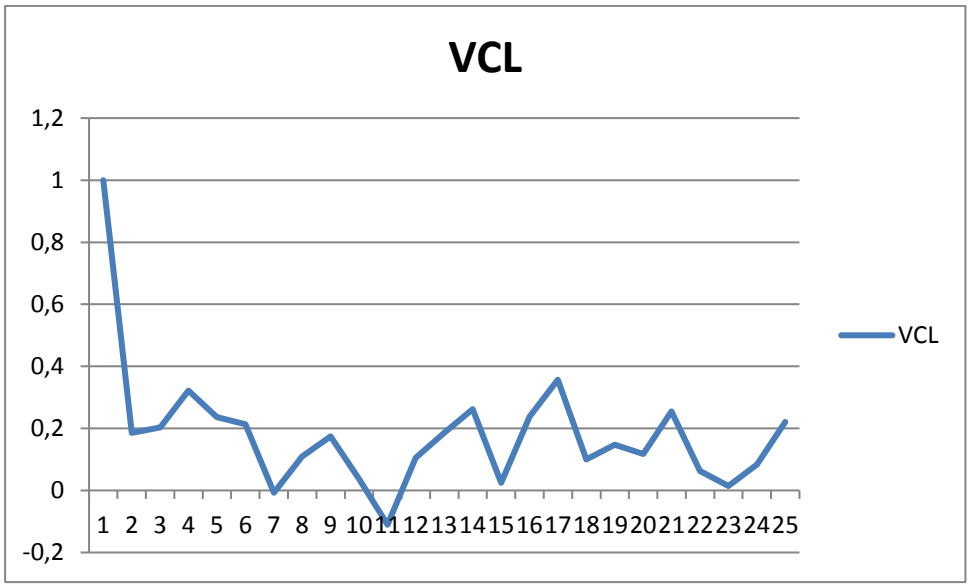

Figure 55. Vital capacity of the lungs (ACF, "raw" scores). The ordinate axis refers to the correlation, the abscissa axis refers to time.

13. *Right hand dynamometry.* The chart is located above the x-axis, which makes it difficult to analyse. The oscillation period is approximately 3 months. Additional complexity of the analysis is given by an additional rhythm (Fig. 56).

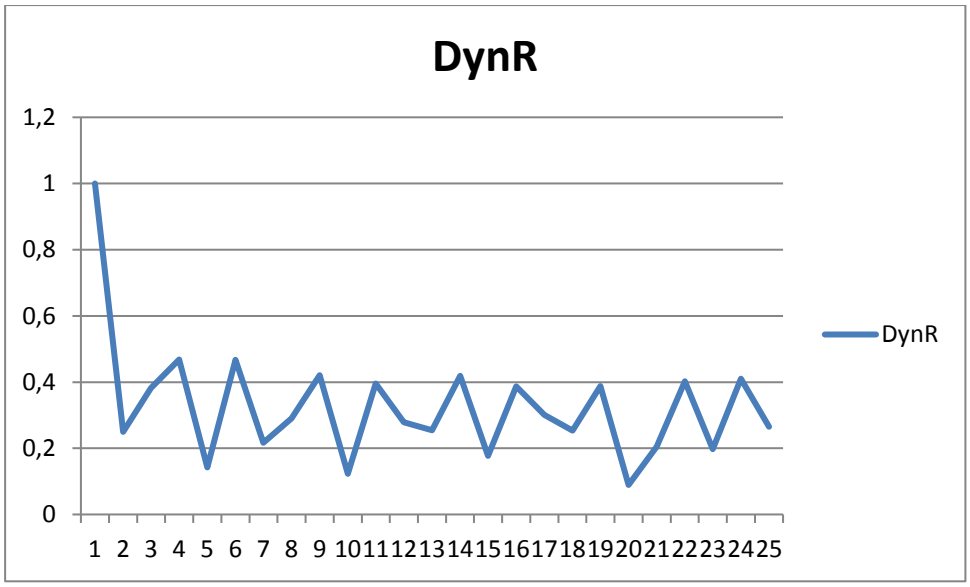

Figure 56. Right hand dynamometry of the (ACF, "raw" scores). The ordinate axis refers to the correlation, the abscissa axis refers to time.

14. *Left hand dynamometry.* As in the previous case, the chart is located above the x-axis and is complicated by an additional rhythm. The oscillation period is 4 months (Fig. 57).

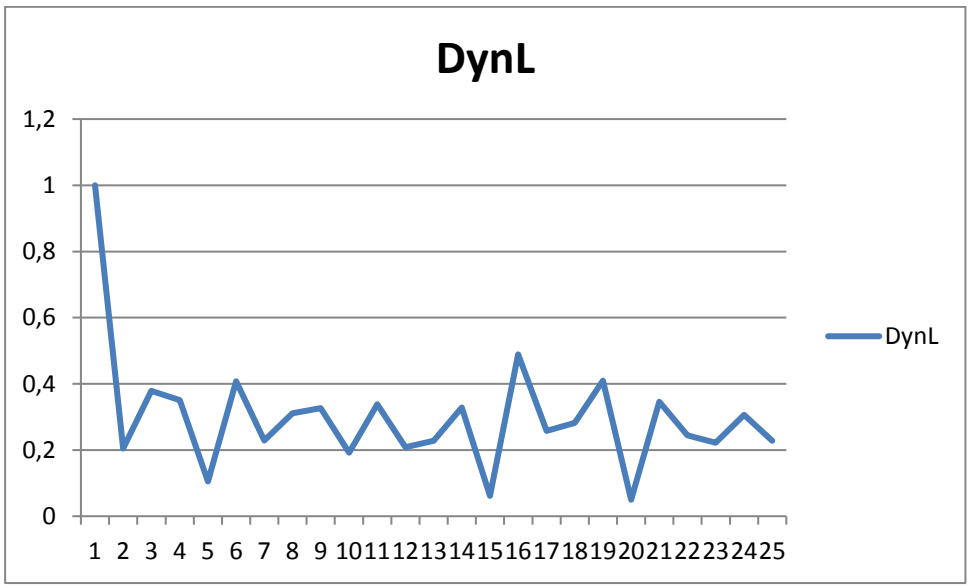

Figure 57. Left hand dynamometry (ACF, "raw" scores). The ordinate axis refers to the correlation, the abscissa axis refers to time.

15. *Right hand static tremor.* The oscillation period is 3 months. Despite the presence of some artefacts in the form of an additional rhythm, the chart as a whole reflects the presence of harmonic oscillations (Fig. 57).

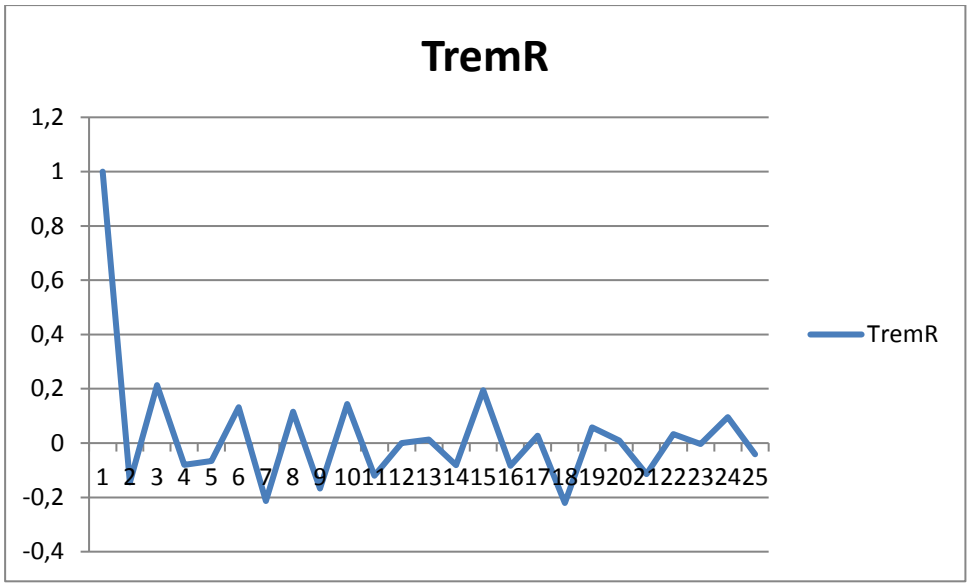

Figure 57. Right hand static tremor (ACF, "raw" scores). The ordinate axis refers to the correlation, the abscissa axis refers to time.

16. *Left hand static tremor.* The oscillation period is 4 months. Periodicity can be traced worse than in the previous case, the conversion to scaled scores can help smooth out the irregularities in the chart (Fig. 58).

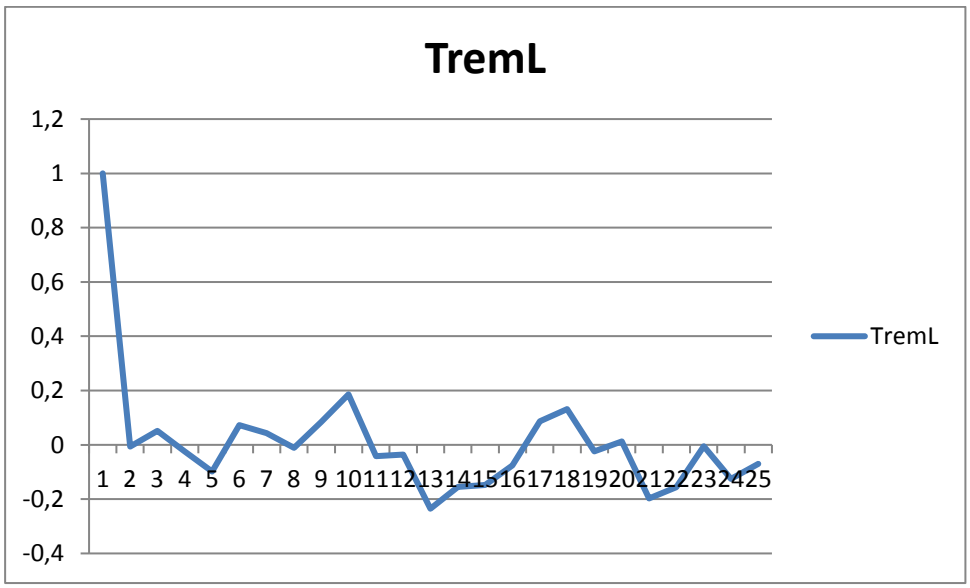

Figure 58. Left hand static tremor (ACF, "raw" scores). The ordinate axis refers to the correlation, the abscissa axis refers to time.

17. *Right hand dynamic tremor.* The oscillation period is 3 months. The chart shows an almost imperceptible additional rhythm (Fig. 58).

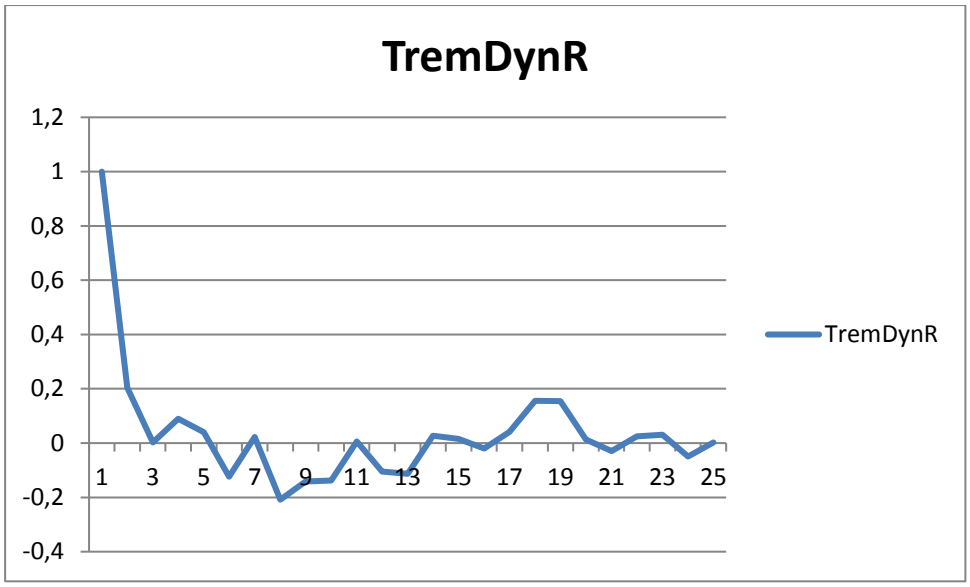

Figure 58. Right hand dynamic tremor (ACF, "raw" scores). The ordinate axis refers to the correlation, the abscissa axis refers to time.

18. *Left hand dynamic tremor.* The additional rhythm on the chart is more noticeable than in the case of the right hand, but it is still very weak. The oscillation period is 4 months (Fig. 59).

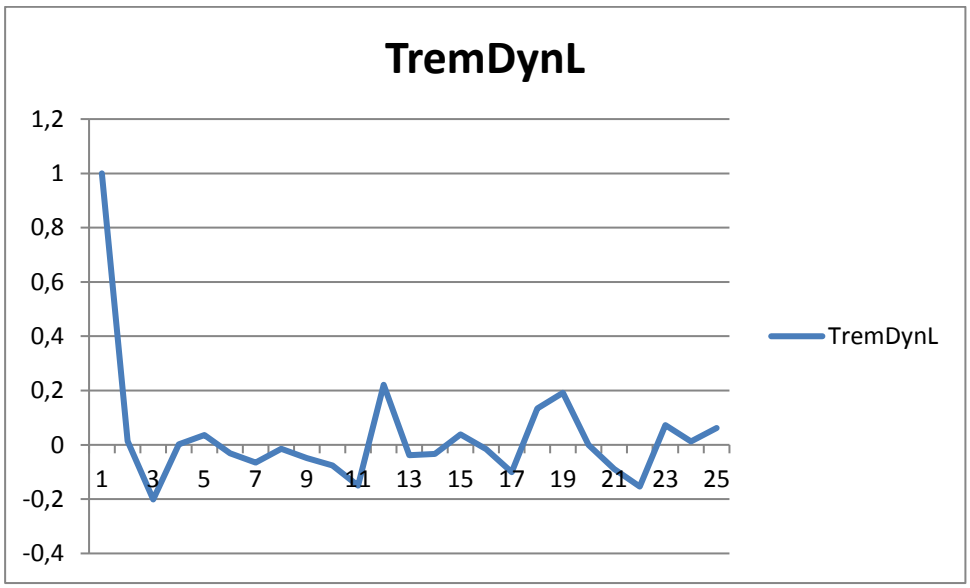

Figure 59. Left hand dynamic tremor of the (ACF, "raw" scores). The ordinate axis refers to the correlation, the abscissa axis refers to time.

ACF charts on scaled scores

1. *Right hemisphere alpha index.* The oscillation period is 4 months. An additional rhythm is still visible on the chart, but it is much weaker (Fig. 60).

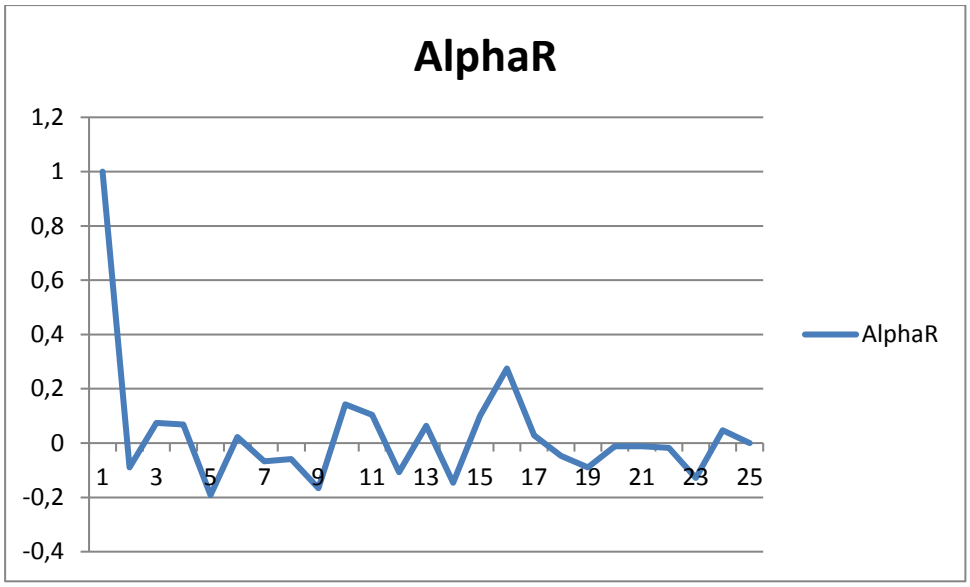

Figure 60. Right hemisphere alpha index (ACF, scaled scores). The ordinate axis refers to the correlation, the abscissa axis refers to time.

2. *Left hemisphere alpha index.* There are almost no artefacts on the chart, the oscillation period is 4 months. The oscillations can be considered as harmonic (Fig. 61).

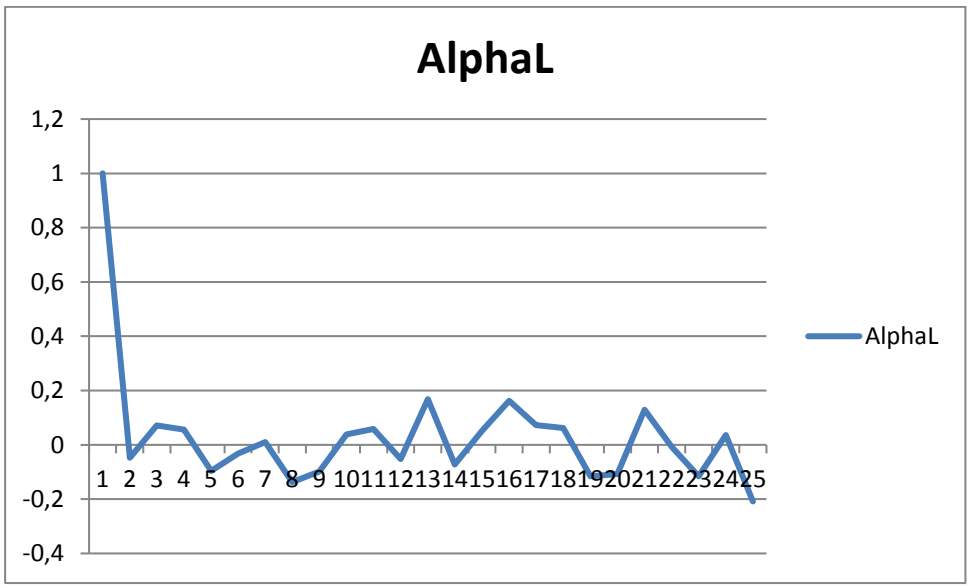

Figure 61. Left hemisphere alpha index (ACF, scaled scores). The ordinate axis refers to the correlation, the abscissa axis refers to time.

3. *Right hemisphere average frequency.* The chart shows an artefact in the form of peaks of relatively small amplitude. In general, the frequency and amplitude of the chart oscillations are low, their period is 3 months (Fig. 62).

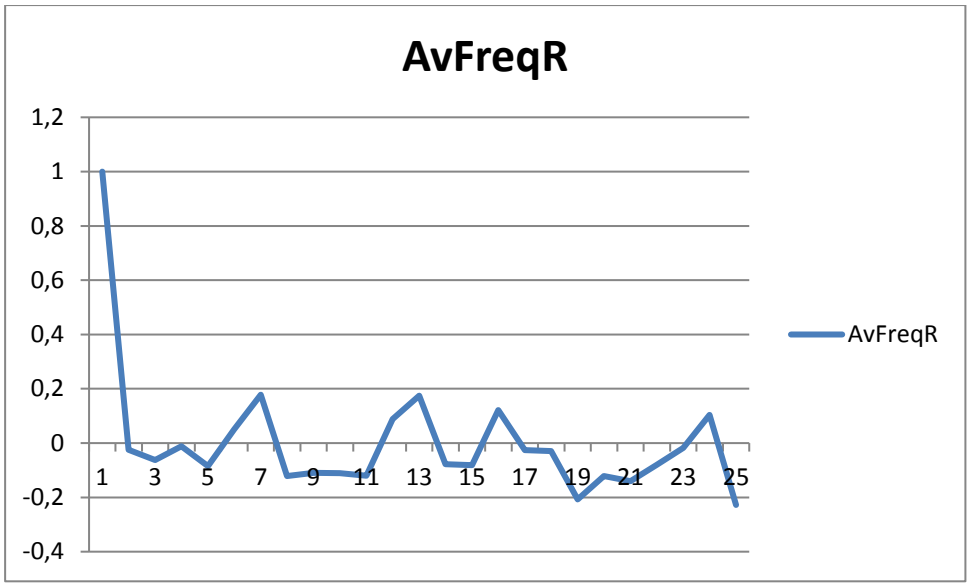

Figure 62. Right hemisphere average frequency (ACF, scaled scores). The ordinate axis refers to the correlation, the abscissa axis refers to time.

4. *Left hemisphere average frequency.* The oscillations of small amplitude and frequency, their period is 3 months (Fig. 63).

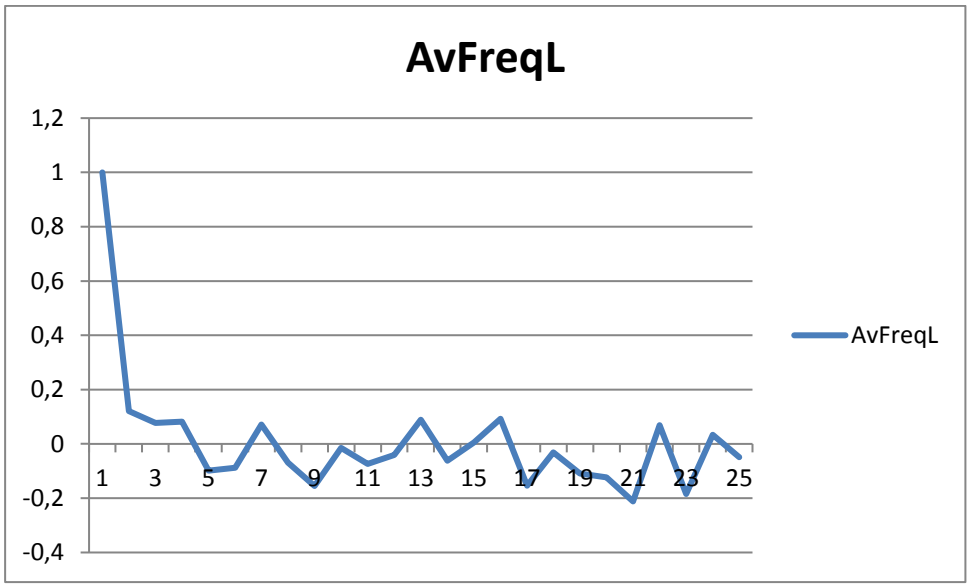

Figure 63. Left hemisphere average frequency (ACF, scaled scores). The ordinate axis refers to the correlation, the abscissa axis refers to time.

5. *Right hemisphere dominant frequency.* The oscillation period is 3 months, the amplitude and frequency of oscillations are small. Toward the end of the chart, a plateau of unclear origin was noted (Fig. 64).

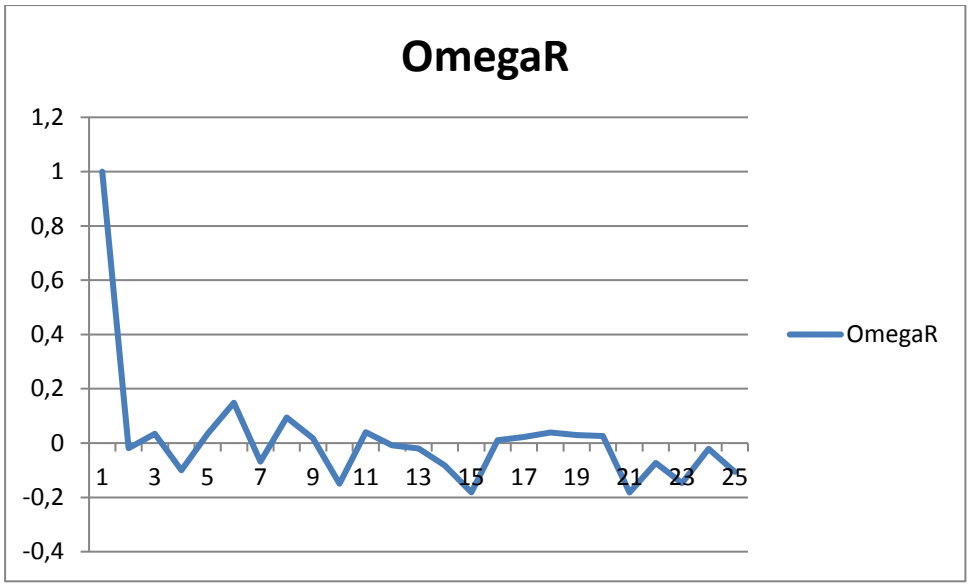

Figure 64. Right hemisphere dominant frequency (ACF, scaled scores). The ordinate axis refers to the correlation, the abscissa axis refers to time.

6. *Left hemisphere dominant frequency*. The oscillation period is 3 months, with a low amplitude, the frequency is relatively large. There is also an extraneous rhythm of unclear nature (Fig. 65).

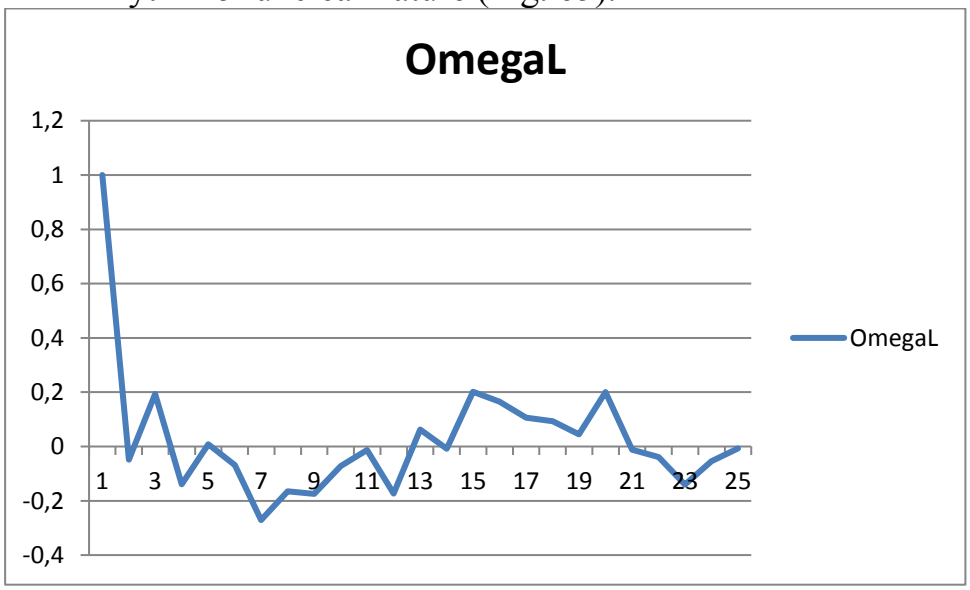

Figure 65. Left hemisphere dominant frequency (ACF, scaled scores). The ordinate axis refers to the correlation, the abscissa axis refers to time.

7. *Heart rate.* The oscillations are harmonic, with a sufficiently large amplitude and frequency, their period is 4 months (Fig. 66).

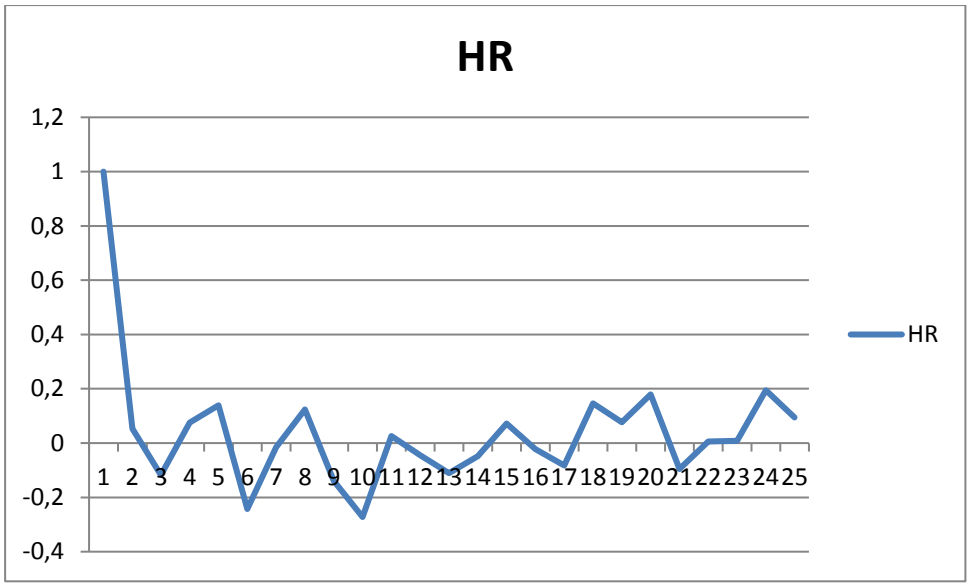

Figure 66 Heart rate (ACF, scaled scores). The ordinate axis refers to the correlation, the abscissa axis refers to time.

8. *Breathing rate.* The oscillations of high frequency with a sufficiently high amplitude, the oscillation period is 2 months (Fig. 67).

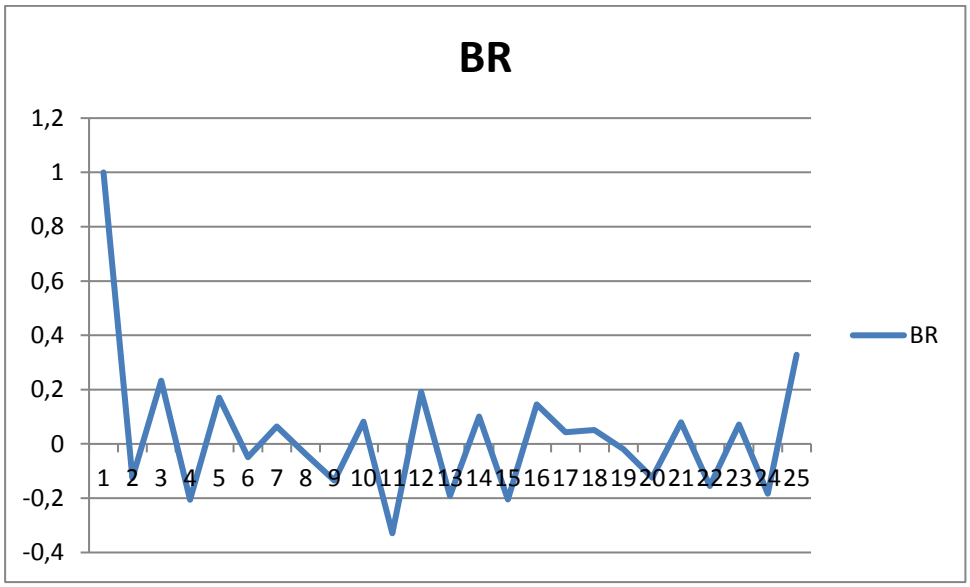

Figure 67. Breathing rate (ACF, scaled scores). The ordinate axis refers to the correlation, the abscissa axis refers to time.

9. *Systolic pressure*. The oscillations in the chart of small amplitude and frequency, their period is 3 months. However, there is an additional rhythm on the chart, which makes it difficult to work with it (Fig. 68).

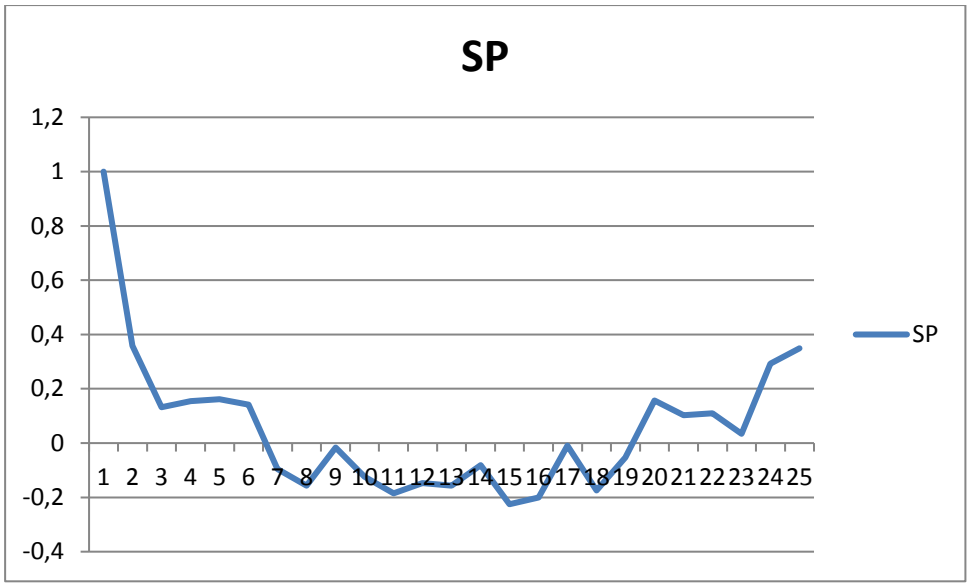

Figure 68. Systolic pressure (ACF, scaled scores). The ordinate axis refers to the correlation, the abscissa axis refers to time.

10. *Diastolic pressure.* The oscillation period is 3 months, their amplitude increases by the end of the chart, but the frequency remains constant (Fig. 69).

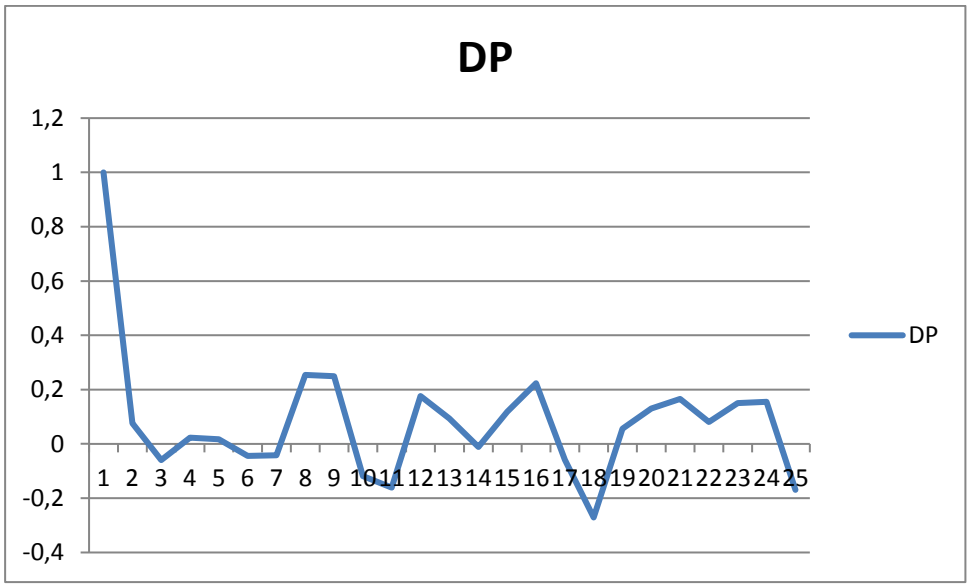

Figure 69. Diastolic pressure (ACF, scaled scores). The ordinate axis refers to the correlation, the abscissa axis refers to time.

11. *Breathing volume.* The oscillation period is 4 months, the amplitude varies depending on the area, while the frequency is approximately the same everywhere. There are sections with different oscillation amplitudes (Fig. 70).

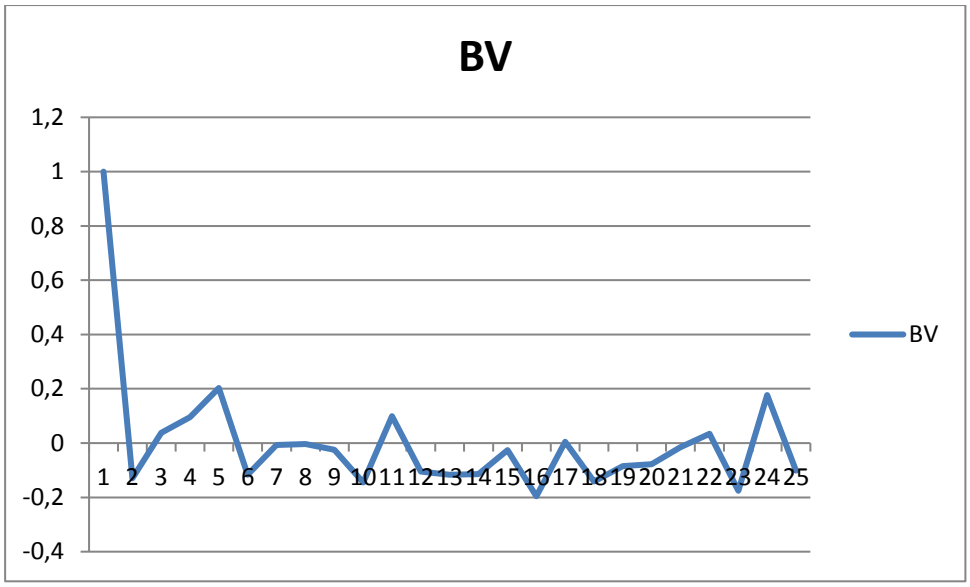

Figure 70. Breathing volume (ACF, scaled scores). The ordinate axis refers to the correlation, the abscissa axis refers to time.

12. *Vital capacity of the lungs.* The oscillation period is 3 months, the amplitude is relatively low, the frequency is average. The chart is located above the x-axis (Fig. 71).

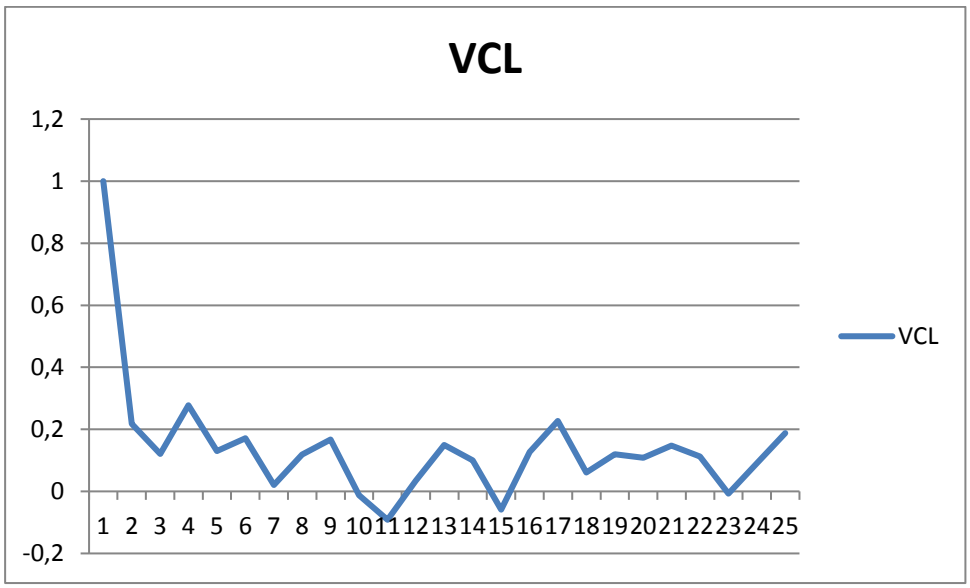

Figure 71. Vital capacity of the lungs (ACF, scaled scores). The ordinate axis refers to the correlation, the abscissa axis refers to time.

13. *Right hand dynamometry.* The oscillations in the average frequency with a low amplitude, the oscillation period is 3 months (Fig. 72).

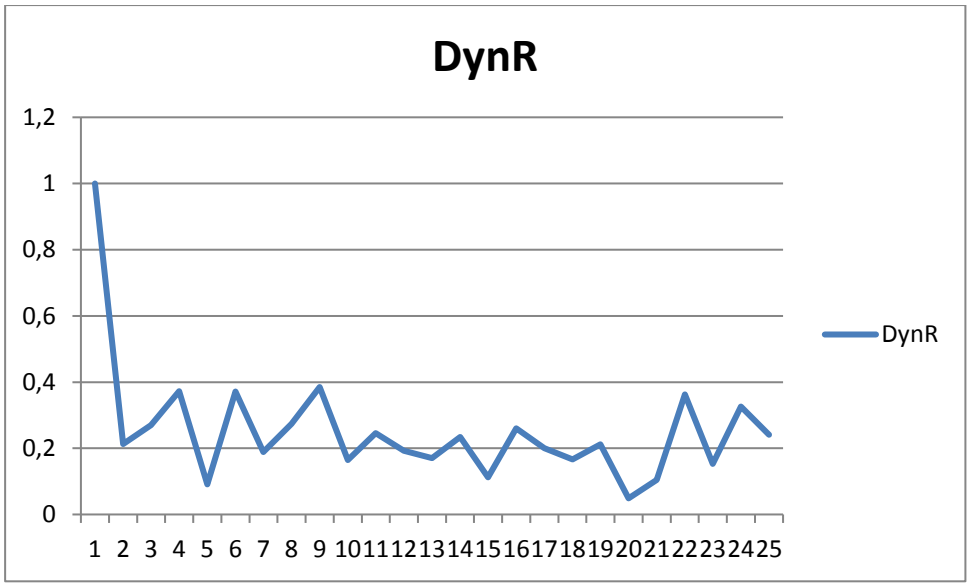

Figure 72. Right hand dynamometry (ACF, scaled scores). The ordinate axis refers to the correlation, the abscissa axis refers to time.

14. *Left hand dynamometry.* The oscillations of small amplitude and low frequency, their period is 5 months (Fig. 73).

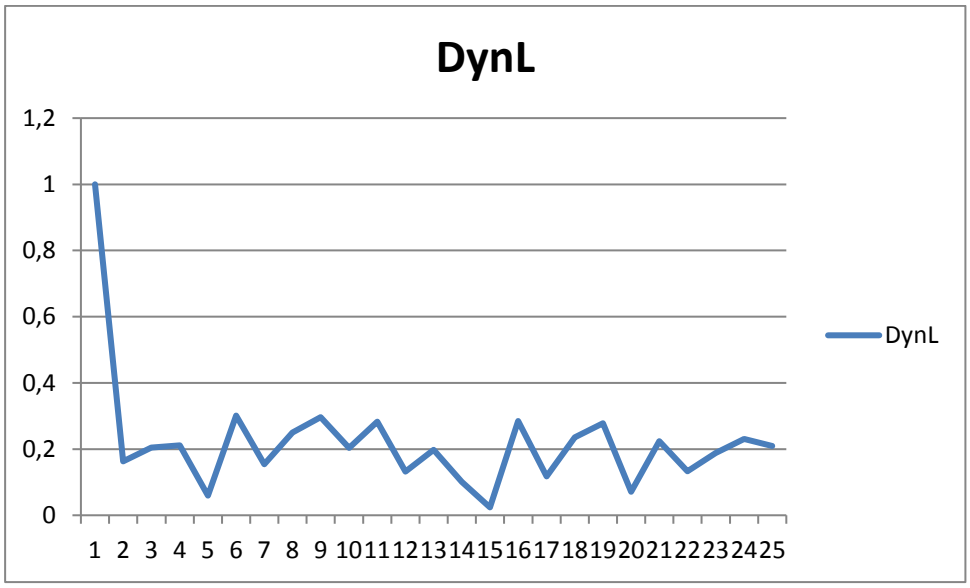

Figure 73. Left hand dynamometry (ACF, scaled scores). The ordinate axis refers to the correlation, the abscissa axis refers to time.

15. *Right hand static tremor.* The oscillation period is 3 months, their frequency and amplitude are relatively small (Fig. 74).

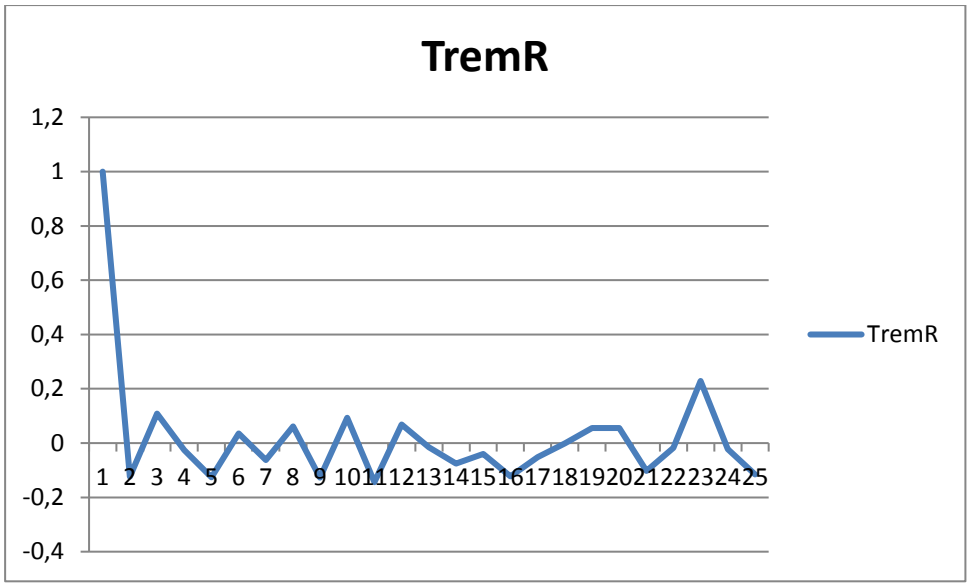

Figure 74. Right hand static tremor (ACF, scaled scores). The ordinate axis refers to the correlation, the abscissa axis refers to time.

16. *Left hand static tremor.* The oscillations of low amplitude and frequency, their period is 4 months. The chart is complicated by an extraneous rhythm of unclear origin (Fig. 75).

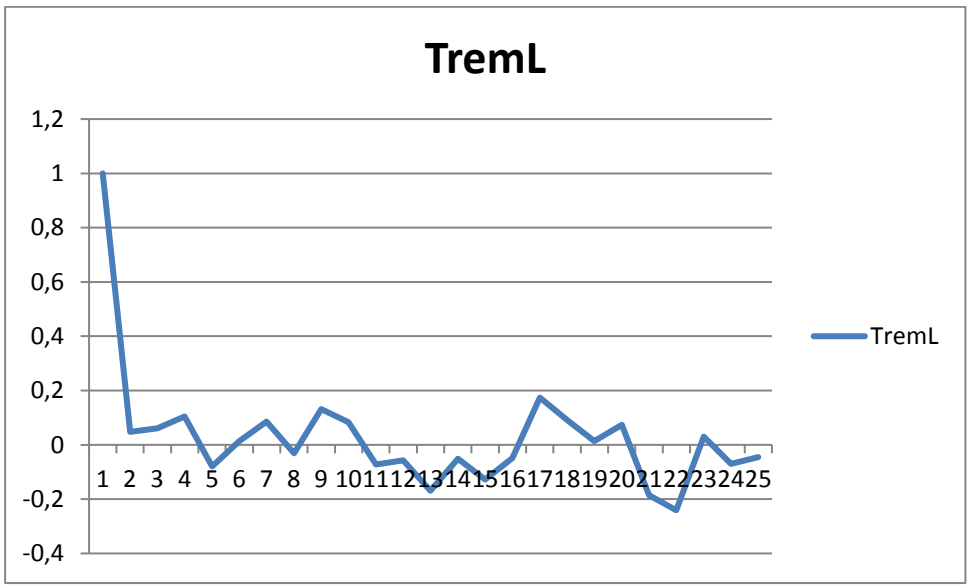

Figure 75. Left hand static tremor (ACF, scaled scores). The ordinate axis refers to the correlation, the abscissa axis refers to time.

17. *Right hand dynamic tremor.* The oscillation period is 3.5 months; in the second half of the chart, the amplitude and frequency of oscillations decrease, i.e. the oscillations can be characterised as damped (Fig. 76).

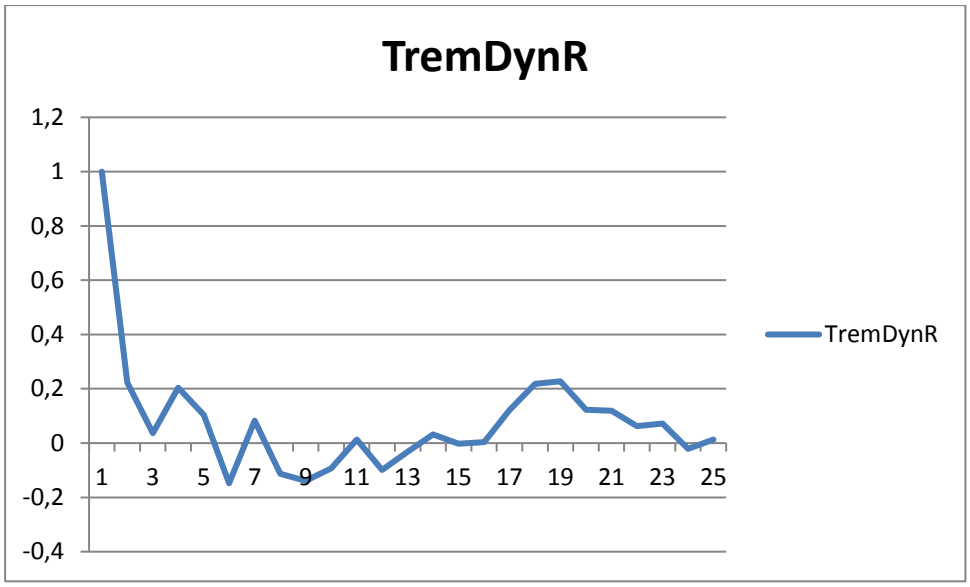

Figure 76. Right hand dynamic tremor (ACF, scaled scores). The ordinate axis refers to the correlation, the abscissa axis refers to time.

18. *Left hand dynamic tremor.* The oscillation period is 3 months, the amplitude is relatively low, however, due to extraneous rhythms, oscillations of different frequencies (Fig. 77).

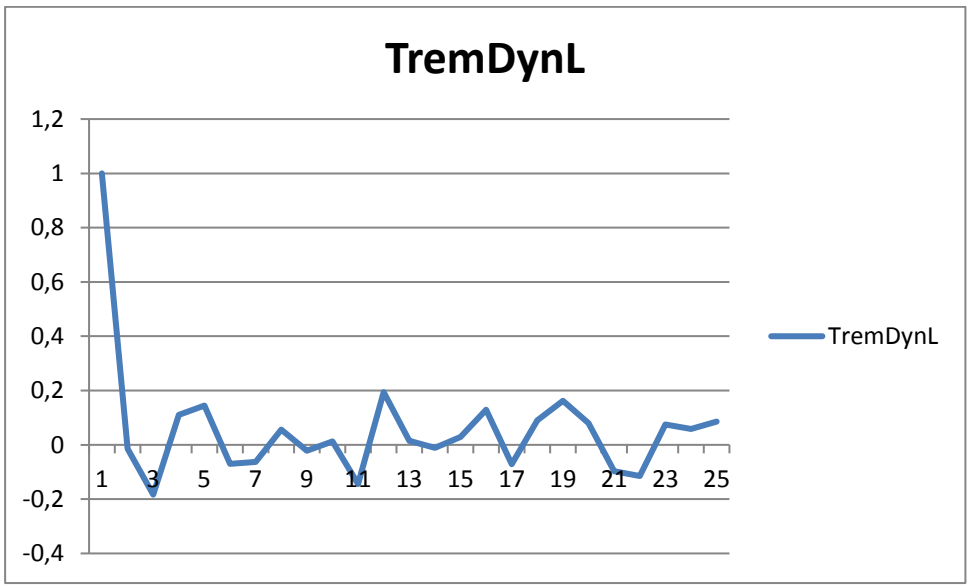

Figure 77. Left hand dynamic tremor (ACF, scaled scores). The ordinate axis refers to the correlation, the abscissa axis refers to time.

Description of scaled score sum graphs

1. *The sum of CNS parameters.* Features of the graph: located very high, in the range from 40 to 100 points, a fairly large oscillation amplitude at a relatively low frequency. M_x = 75.41935484; σ = 10.86610464; CV = 6.940790406, (Fig. 78).

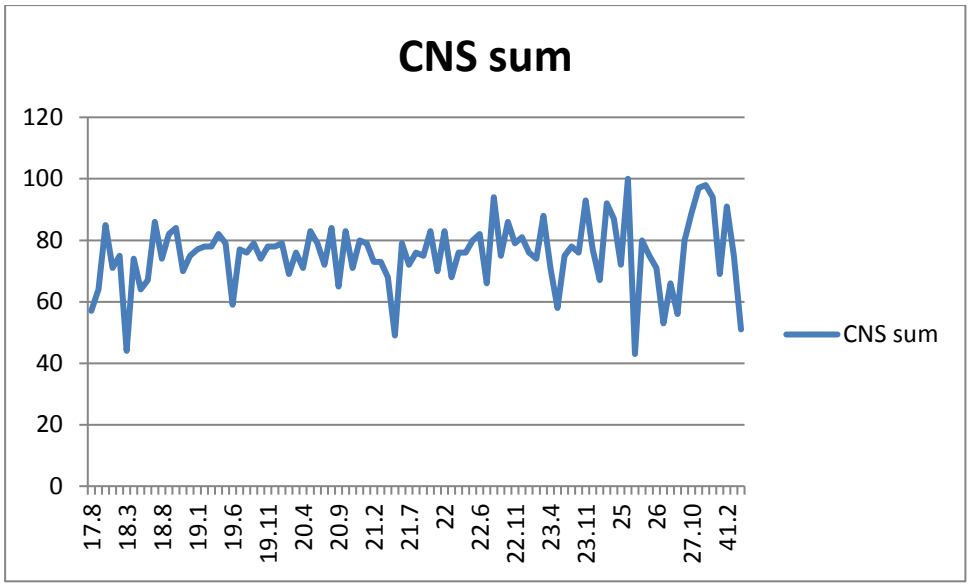

Figure 78. Scaled score sum (CNS). The abscissa axis refers to age (years, months), the ordinate axis refers to the sum of scaled scores (in points).

2. *The sum of ANS parameters.* Features of the graph: the range of values is from 50 to 82 points, the oscillation amplitude is small, the frequency is also small. M_x = 62.30107527; σ = 6.0948748; CV = 10.22187942 (Fig. 79).

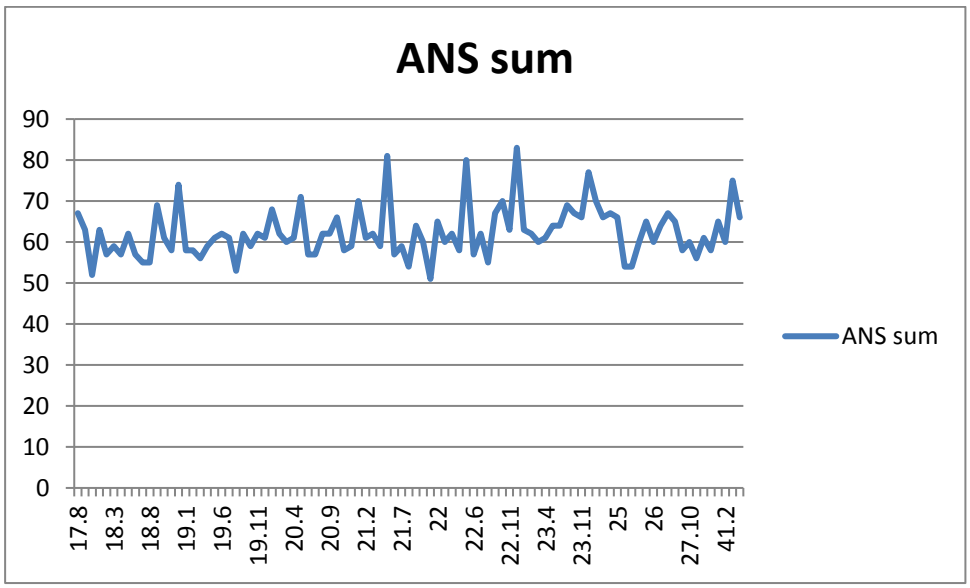

Figure 79. Scaled score sum (ANS). The abscissa axis refers to age (years, months), the ordinate axis refers to the sum of scaled scores (in points).

3. *The sum of SNS parameters.* Features of the graph: the oscillation amplitude is quite large, the range of scaled scores is from 30 to 68 points. M_x = 49.95698925; σ = 7.314241585; CV = 6.830098332 (Fig. 80).

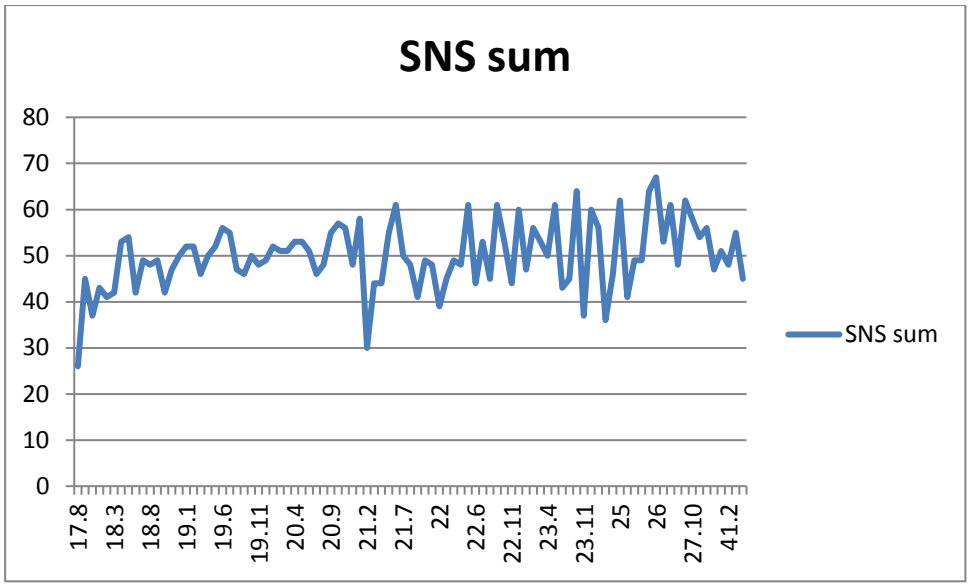

Figure 80. Scaled score sum (SNS). The abscissa axis refers to age (years, months), the ordinate axis refers to the sum of scaled scores (in points).

4. *The total score sum.* Features of the graph: the oscillation frequency of is lower compared to the graphs of individual parameter, but the amplitude is quite high. The range of total score sum is from 150 to 230 points. M_x = 187.6774194; σ = 14.59017037; CV = 12.86327813 (Fig. 81).

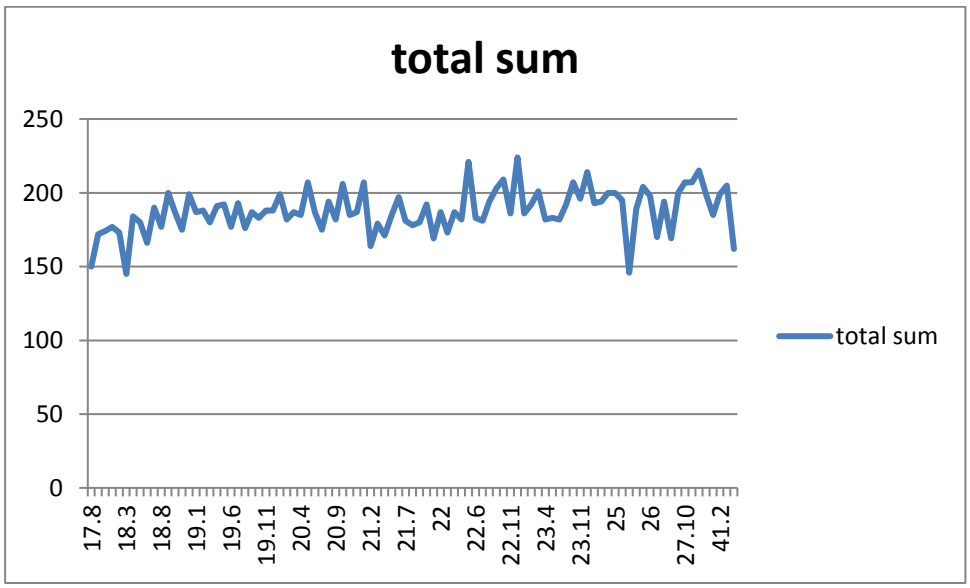

Figure 81. Total scaled score sum. The abscissa axis refers to age (years, months), the ordinate axis refers to the sum of scaled scores (in points).

5. *The Granovskaya-Stepanova formula and its application to the results of the study.* To consider the degree of applicability of the Granovskaya-Stepanova formula to psycho-physiological parameters, let us consider the dynamics of their sums:
   1) CNS: the level of development of the indicator rises to 18 years 3 months, after which it drops sharply. Then there is a rise again, but at the age of 19 years 5 months the parameter sharply decreases again. After that, the level of

development increases again, but at the age of 21 years 4 months, a sharp decline in the parameter is again observed. Further, until the age of 25, the level of development rises again, after which it falls sharply again. A slow rise is observed until the age of 29 years 3 months, then the level of development decreases again.

2) ANS: up to 18 years 4 months, the level of development falls, then begins to rise until 21 years 4 months, after which it decreases again, and at about 21 years 10 months it rises again. The next decline is observed at the age of 25 years 5 months, after which an increase is again observed.
3) SNS: up to 20 years 10 months, the level of development of the indicator rises, then a sharp decline follows. It falls on 22 years, after which there is a rise, reaching its peak at 25 years 5 months, after which the level begins to decline.
4) Total sum: The total amount rises to 18 years 10 months, then starts to decrease until 19 years 10 months. This is followed by a decline that lasts until 21 years 10 months, after which the parameter decreases until 25 years 5 months, then rise again.

Having studied the dynamics of the development of psycho-physiological parameters, we have come to the conclusion that intra-annual cycles take place here, which means that the Granovskaya-Stepanova formula should look like this (2):

$$y = \frac{A\,sin\,(\omega t + \varphi o)}{12} \quad (2)$$

3.3.2 The discussion of the results

Hypothesis 1. Graphs of autocorrelation functions showed that the fluctuations of indicators are phase. Thus, the first hypothesis is proved. But it is interesting that the period of fluctuations is 3-5 months (on average 4 months), which is approximately equal to one academic semester (let's not forget that all the participants were students). At the same time, the graphs show that approximately by the middle of the semester, the activity of the nervous system (all its departments) reaches its peak, and then (closer to the exam session) begins to decline. That is, it turns out that students take exams in a state of reduced activity of all parts of the nervous system, which may adversely affect the results, but this assumption needs additional verification on samples of students from other faculties and representatives of other types of activity. It can also be assumed that there are seasonal cycles of regulatory systems (nervous and endocrine ones), which also needs additional verification. However, based on the results of the study, it is already possible to draw up the following recommendation: it will be more comfortable for students to take exams immediately after graduation (a similar system is practiced in Europe, as well as in the USA and Canada). Otherwise, by the end of the semester, the activity of the nervous system drops (students “relax”), which can lead to adverse consequences on the exam.

Hypothesis 2. An analysis of the total scale indicators showed that, firstly, the coefficient of variance in all four cases is small, which allows us to conclude that the sum of indicators has a certain degree of invariance. Of course, the presence of a non-zero coefficient of variance does not allow us to call the resulting invariant metric (having the highest degree of accuracy), so it would be most reasonable to consider it a similarity invariant. At the same time, it is important that the overall total indicator has a higher coefficient of variability than the total indicators for various parts of the nervous system: CNS, ANS and SNS. This means that the summation of indicators increases the variability. It is possible that the data of individual parts of the nervous system are more accurate than their total score. With the help of the Granovskaya-Stepanova formula, it was possible to prove the harmony of fluctuations in indicators, so we can talk about the invariance of the total indicator. The next step may be to test the hypothesis of V.V. Belous about the invariance of the type of temperament, for this you need to compare psychological types for different age groups.

Examples of other studies of phase changes in psycho-physiological phenomena are L.V. Volkova's PhD thesis and an article by E.V. Lee. Both publications use the terms "phase transition", "phase fluctuations" to describe and explain the periodic changes in the observed phenomena. So, E.V. Lee uses this concept to describe the psycho-physiological state of the human body that occurs when external conditions (both biological and social) change (Lee E.V., 2019). In fact, we are talking about a condition known as a general adaptation syndrome ("a stress" according to H. Selye). As for the study of L.V. Volkova, it explores the annual cycles of the psycho-physiological properties of individuality. And although some of the conclusions presented in the thesis abstract seem somewhat doubtful (for example, data on the dependence of personal characteristics on the date of birth), the author proves the presence of phase fluctuations and describes their spectral characteristics (Volkova L.V., 1998). These and many other examples show the possibility of speaking about the general phase change law.

The results of a comparative analysis of the work of representatives of the two leading psychological schools make it possible to extend the regularity obtained in this study to the mental activity of scientists, including representatives of the St. Petersburg psychological school. If we return to the description of the results of the semantic analysis of publications, we can see that the ACF graphs of the publications of the St. Petersburg school have an additional rhythm (the oscillation period is 5-8 years), presumably associated with five-year academic cycles.

From the point of view of psychophysiology, it is interesting to consider the rhythms of the ACF graphs, which have a fast and a slow component. A previous

author's study of periodic changes in psycho-physiological parameters in psychology students revealed that the period of oscillation is one year (Stepanova J.V., 2017[a]; Stepanova J.V., 2017[b]). The study of publications can be considered as a continuation of the study of phase mental processes, in particular, the mental activity of psychologists in the long term. The slow cycle is 15-20 years, and the fast cycle is 5-8 years. The first type of phase changes can be associated with academic cycles (undergraduate and postgraduate research), and also with a change in the direction of scientific activity.

3.3.3 Conclusion

The results of the study turned out to be very curious and unexpected, since several facts important for theoretical and practical psychology were discovered. Here is a general overview of the results with the corresponding conclusions:

- Based on the fact that changes in psycho-physiological indicators were found during the academic semester (with the values decreasing closer to the session), it can be recommended to organise the educational process more favourably for students, for example, it is better to take exams immediately after the end of the course.
- A fairly small coefficient of variation indicates that the psychological type (temperament) changes little, which confirms the statement of V.V. Belous about the invariability of the type of temperament. Further research in this direction will help create a new diagnostic test.
- In the scientific activity of the authors of the St. Petersburg (Leningrad) school of psychology during the period under review, phase changes of two types can be traced: firstly, this may be associated with educational cycles (research of students and graduate students), and also with a change in the direction of scientific activity.

3.4 General discussion

If we consider general results of the publication review of the leading representatives of the St. Petersburg school of psychology and all three studies, they allow us to do several important conclusions. One of the conclusions is the ability to determine diifferent periods of development of the natural-scientific domain:

- Origins (Sechenov – Pavlov school); during this period, psychophysiology (i.e., the biological aspect of the natural-scientific domain) developed most actively
- The classical stage (from V.M. Bekhterev to G.V. Sukhodolsky): the stage of formation of the most significant concepts of the St. Petersburg school of psychology

- The "transitional" stage, studied on the example of publications in the Bulletin of St. Petersburg State University: the leading research topics are the holistic and the systemic approaches, psychophysiology, mathematical psychology, study of ontogenetic development of psycho-physiological functions, engineering psychology and sports psychology.
- The modern stage, studied on the example of the abstracts of the conference "Ananiev's Readings": the leading research topics are the history and methodology of psychology, psychophysiology, educational psychology, studies of stress and coping.

To sum up, it should be concluded that at the moment there is a trend towards the integration of psychological knowledge. It is confirmed by the growing interest of psychologists to the theoretical and methodological aspects of psychological science (Fedorov A.A., 2018). It should also be noted the emergence of scientific research in psychology, to which, in particular, belongs the article by V.A. Mazilov and Y.N. Slepko. The authors identified the issues relevant for the development of scientometric analysis in psychology: the subject issue of the, the method issue and the issue of assessing the demand for psychological publications (Mazilov V.A., Slepko Y.N., 2021), of which the problems of the subject and method are among the most important issues of modern theoretical psychology. Review articles also prove the presence of integrative processes in psychology.

3.5 Conclusions to chapter 3

The results of the conducted research allow us to draw the following general conclusions:

1) In the scientific activity of the authors of the St. Petersburg (Leningrad) psychological school, phase changes are traced, associated either with educational cycles or with a change in the direction of scientific activity;
2) The authors of this school worked in the context of the natural-scientific domain as a whole, and did not apply elements of individual disciplines, as representatives of the Moscow school did;
3) The St. Petersburg (Leningrad) psychological school has historically used a comprehensive and systematic approach that came from the natural sciences;
4) The natural-scientific domain embraces in the St. Petersburg (Leningrad) school not private research, but entire branches of psychology;
5) Representatives of the St. Petersburg (Leningrad) psychological school have a focus on stability, preferring to use time-tested methods of research and data

interpretation, unlike the authors of the Moscow psychological school, focused on novelty.

All studies carried out have a number of significant limitations. For example, in the study of the abstracts of the Ananyev's Readings conference, it becomes necessary to expand the sample using collections of abstracts from other scientific conferences held at the Faculty of Psychology of St. Petersburg State University. Another serious limitation of the study is that apart from St. Petersburg authors psychologists from other cities belonging to other psychological schools and directions take part in the conference.

As for the comparison of the evolutionary development of the natural science paradigm in the Moscow and St. Petersburg (Leningrad) psychological schools, there are the following limitations:

- First of all, it should be noted the need to conduct an extended study on a larger sample of scientific publications. It is necessary to carry out a similar analysis of publications in other scientific journals published at Moscow State University and St. Petersburg State University.
- It is also necessary to pay attention to the unavailability of the journal "Moscow University Bulletin", published since 1946 to 1976, and the journal "St. Petersburg University Bulletin" ("Leningrad University Bulletin" until 1991) published since 1946 to 1948, which makes the study incomplete.
- In addition, due to the fact that the issues of the scientific journal "Moscow University Bulletin" since 1977 were taken for the study, and the issues of the journal "St. Petersburg University Bulletin" were taken since 1949, when calculating the correlation coefficients between the variables, we had to take only issues of the Bulletin of St. Petersburg University published between 1977 and 2019 are taken into account.

There are also limitations in the study of phase changes in psycho-physiological functions:

- Age groups differ in the number of participants, many small groups.
- A very narrow sample: the participants were only 2nd year students of the Faculty of Psychology, other groups were not represented.
- In its older part (over 24 years 2 months), the sample is not balanced and small, which does not allow us to speak about the plausibility of the results obtained from this part of the sample. The part of the sample over 25 years old is an outlier almost not reflecting the general trend.

Conclusions

This work has shown that throughout the history of the St. Petersburg (Leningrad) psychological school, its leading domain always remained the natural-scientific one. Based on the review of the conducted studies, the following conclusions can be done:

1) All three aspects of the natural-scientific domain are developed in the St. Petersburg (Leningrad) psychological school: biological (V.M. Bekhterev, B.G. Ananyev, B.F. Lomov, V.N. Myasishchev), physical (V.M. Bekhterev, A.F. Lazursky, M.Y. Basov, L.M. Wecker, B.F. Lomov, V.A. Hansen) and mathematical (V.A. Hansen, G.V. Sukhodolsky, L. N. Granovskaya and E.I. Stepanova).
2) The authors of the St. Petersburg (Leningrad) psychological school have a stability orientation, preferring proven research methods and data interpretation.
3) The St. Petersburg (Leningrad) psychological school uses a comprehensive and systematic approach that comes from the natural sciences.
4) In the St. Petersburg (Leningrad) school, the natural-scientific domain covers entire branches of psychology (psychophysiology, engineering psychology, sports psychology), and not private studies.
5) The study of psycho-physiological functions revealed the presence of phase oscillations in the indicators of all three parts of the nervous system. Paying qattention at the fact that scientific activity uses the same laws as psycho-physiological functions do, we can conclude that the phase law is applicable to the development of the natural-scientific domain in the St. Petersburg school of psychology.
6) In the scientific activity of the authors of the St. Petersburg (Leningrad) psychological school, phase changes are traced, which are connected with educational cycles, as well as with a change in the direction of scientific activity of the faculty of psychology of St. Petersburg State University.
7) In general, we can draw the following conclusions about the development of the St. Petersburg school of psychology. Firstly, the previously mentioned stability orientation is the result of a strong commitment to tradition. Secondly, nowadays, the role of the mathematical aspect of the natural-scientific domain has increased (there is an interest in mathematical modelling) because of computerisation and informatisation The complication of the physical aspect, probably associated with the progress of physics as a science, is also noted. It should also be noted that today there is a trend towards the integration of psychological and natural-scientific knowledge.

General conclusion

This work showed that the natural-scientific domain in the St. Petersburg (Leningrad) psychological school varies from V.M. Bekhterev's reflexology to G.V. Sukhodolsky's mathematical psychology. It can be argued with a certain degree of confidence that this domain is a tradition for the St. Petersburg school, which is expressed in a number of significant facts:

1. The following stages can be distinguished in the development of the St. Petersburg (Leningrad) psychological school:
    - Origins (Sechenov – Pavlov school of HNA); at this stage, psychophysiology was mainly developing, the leading authors of the school used physical laws in their scientific activities.
    - The "classical" stage (from V.M. Bekhterev to G.V. Sukhodolsky), characterised by the emergence of the most significant theories of the St. Petersburg (Leningrad) psychological school.
    - The "transitional" stage, at which the leading activity areas of the St. Petersburg (Leningrad) psychological school (theoretical psychology, psychophysiology, engineering psychology, sports psychology) developed.
    - The modern stage, at which there is a tendency to integration of psychological knowledge.
2. Working within the natural-scientific domain, the authors of the St. Petersburg school develop a unique concept that includes a number of interrelated doctrines and theories.
3. The tradition to adhere to the principles of the natural-scientific domain leads to the fact that the main research topics of the St. Petersburg school are psychophysiology, history and methodology of psychology, and coping with stress.
4. It should also be said that the Moscow and St. Petersburg psychological schools are largely independent of each other. However, among the representatives of the Moscow school there is an attitude towards novelty, and among the representatives of the St. Petersburg School there is an attitude towards stability.
5. There is a general law that leads not only the development of psycho-physiological processes, but also scientific activity (in particular, the activity of the St. Petersburg school of psychology). It can be defined as the phase change law.

6. The general orientation of the analysed studies demonstrates a progressive movement from psycho-physiological researches to modern publications of a methodological (and, as a result, integrative) orientation. This means that in the St. Petersburg Psychological School there is both a commitment to the traditions of the natural-scientific domain, and a tendency towards integration, which is generally psychological and, more broadly, scientific.

In conclusion, it should be emphasised that the St. Petersburg (Leningrad) psychological school is a scientific direction characterised by a strong adherence to traditions, the most important of which is the natural-scientific domain.

Further research can be carried out in two directions: the study of other domestic and foreign schools and trends using the author's method of semantic analysis and the application of this method to other domains in psychology.

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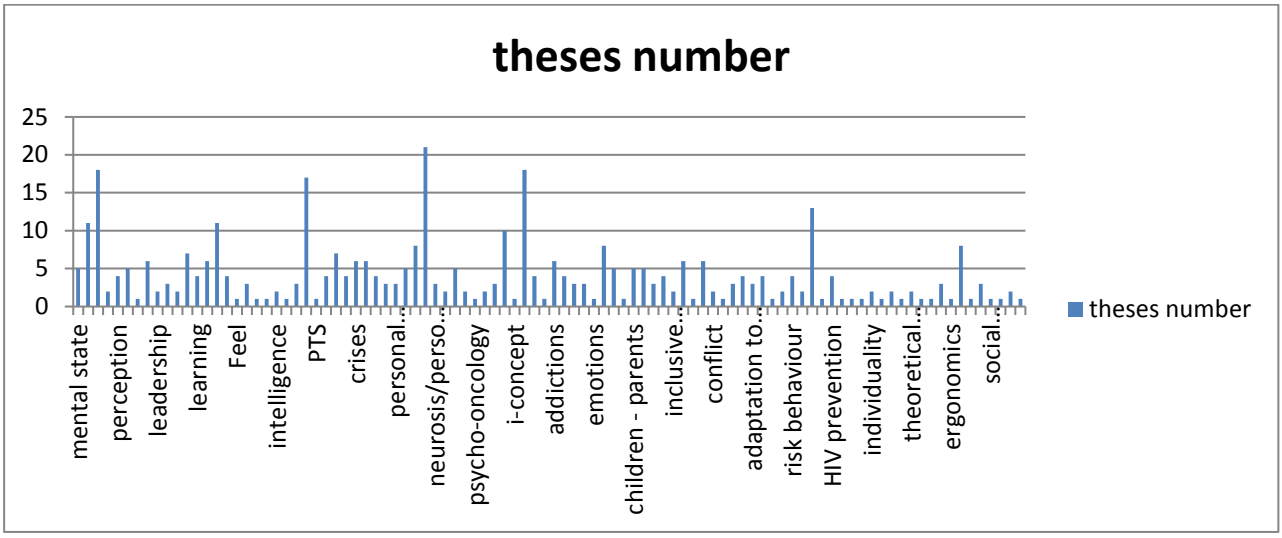
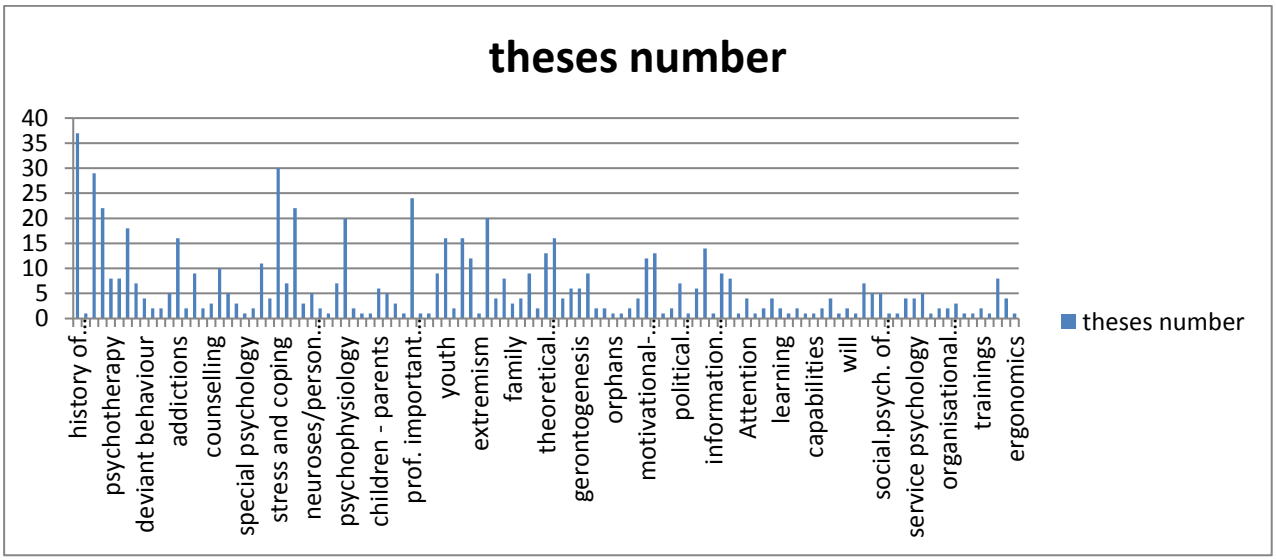
Appendices

Appendix A. The research of collections of theses of the scientific conference "Ananyev's Readings" since 2015 to 2020

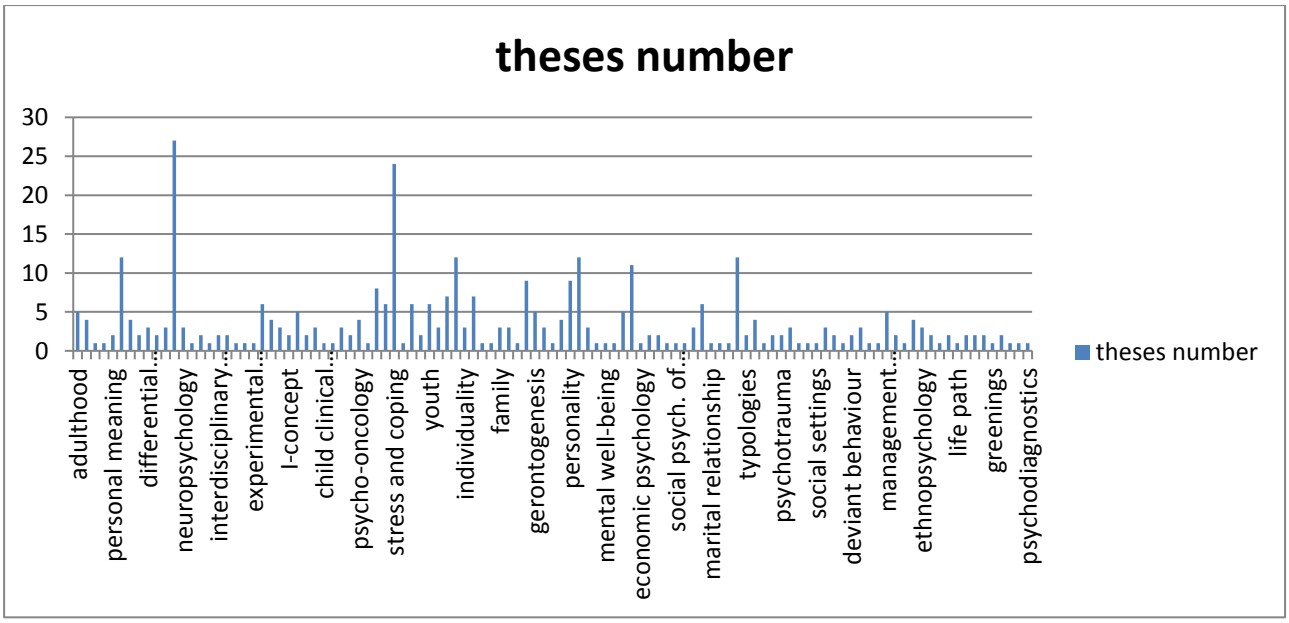
Diagrams (full)



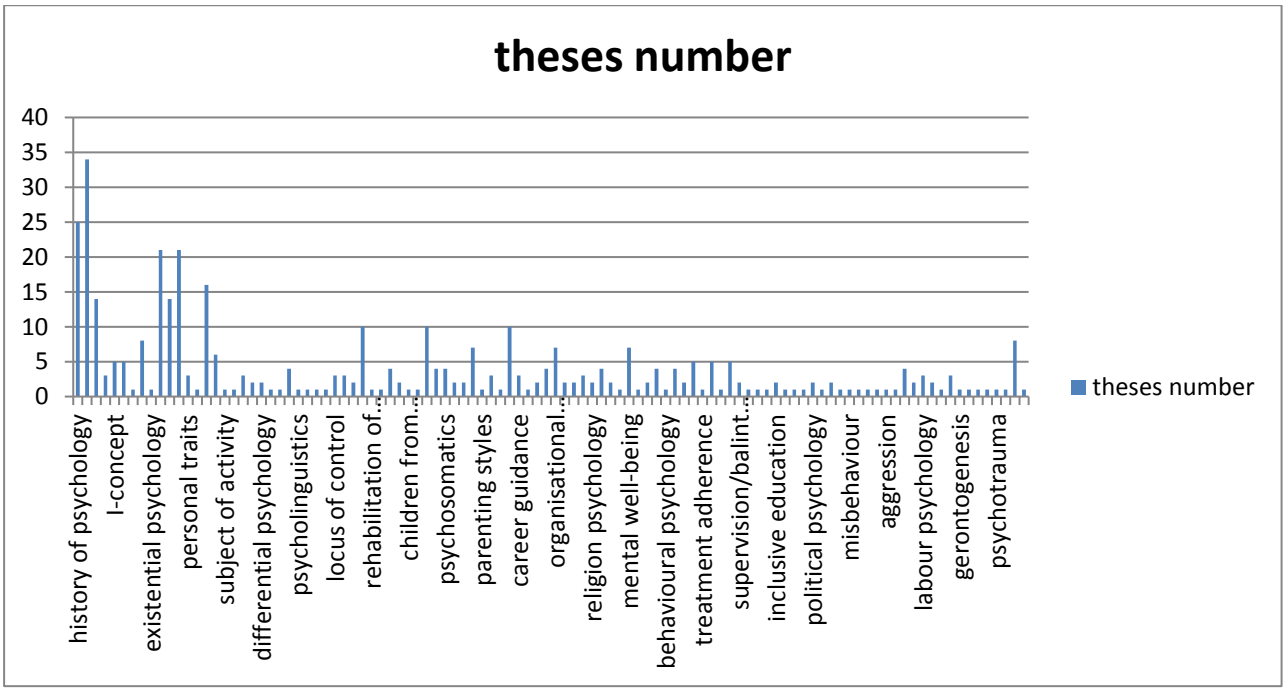
2015. The abscissa axis refers to the topic, and the ordinate axis refers to the number of theses.



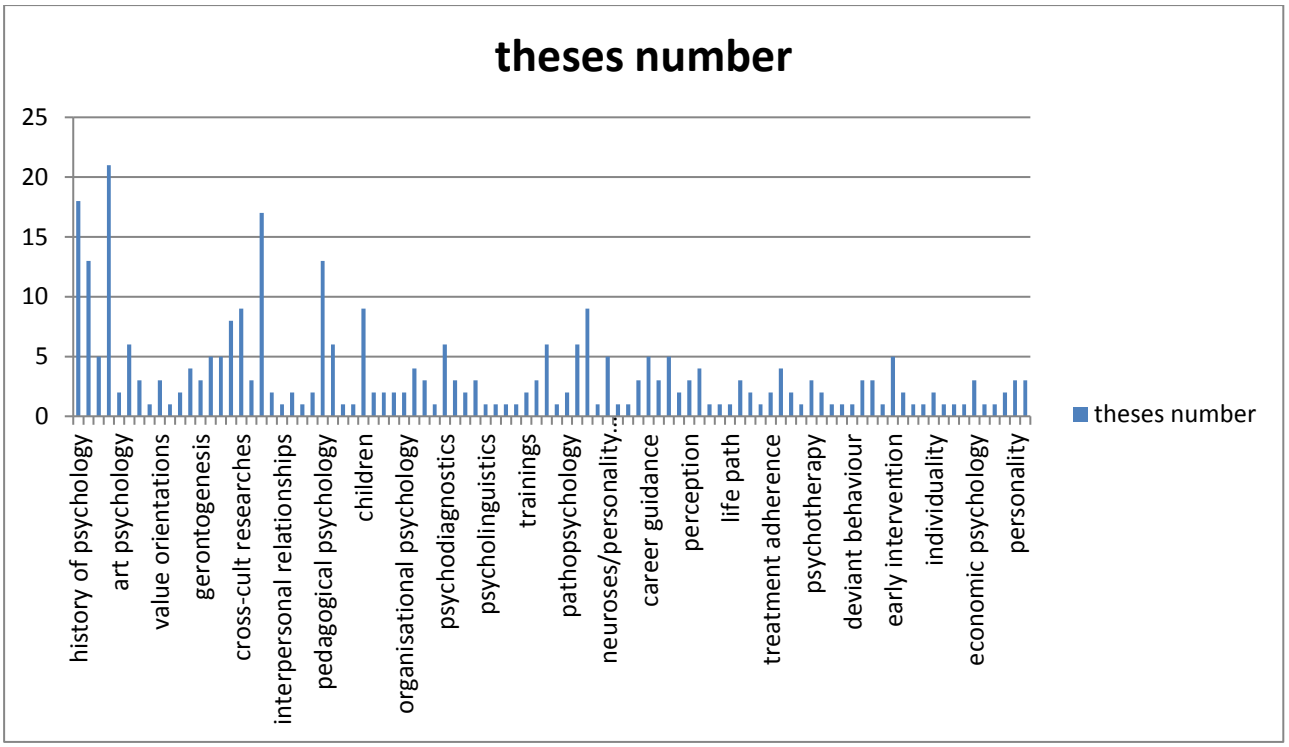
2016. The abscissa axis refers to the topic, and the ordinate axis refers to the number of theses.



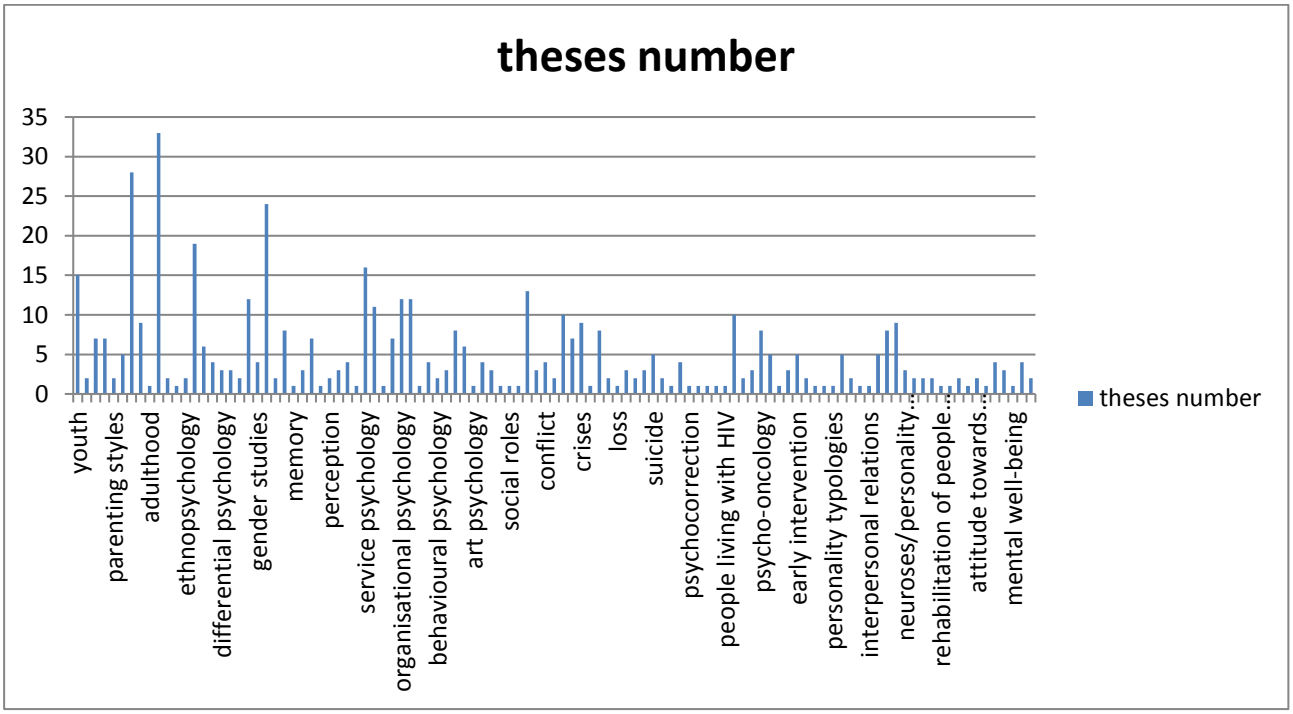
2017. The abscissa axis refers to the topic, and the ordinate axis refers to the number of theses.



2018. The abscissa axis refers to the topic, and the ordinate axis refers to the number of theses.



2019. The abscissa axis refers to the topic, and the ordinate axis refers to the number of theses.



2020. The abscissa axis refers to the topic, and the ordinate axis refers to the number of theses.

Leading research topics (tables)

topic	theses number
cross-cult researches	11
methodology	18
dysontogenesis	11
stress and coping	17
history of psychology	21
psycholody of art	10
pedagogical psychology	18
organisational psychology	13

2015

topic	theses number
history of psychology	37
methodology	29
dysontogenesis	18
addictions	16
abnormal psychology	10
gender studies	11
stress and coping	30
pedagogical psychology	22
psychophysiology	20
prof. important qualities	24
youth	16
teenagers	16
personality	12
cross-cult researches	20
theoretical psychology	13
ethnopsychology	16
motivational-need sphere	12
thinking	13
mental health	14

2016

topic	theses number
methodology	12
history of psychology	27
stress and coping	24
teenagers	12
cross-cult researches	12
organisational psychology	11
pedagogical psychology	12

2017

topic	theses number
history of psychology	25
methodology	34
pedagogical psychology	14
teenagers	21
youth	14
coping with stress	21
children	16
psychophysiology	10
dysontogenesis	10
motivational-need sphere	10

2018

topic	theses number
history of psychology	18
methodology	13
political psychology	21
stress and coping	17
dysontogenesis	13

2019

topic	theses number
youth	15
methodology	28
stress and coping	33
pedagogical psychology	19
social psychology of personality	12
history of psychology	24
work psychology	16
prof. important qualities	11
organisational psychology	12
motivational-need sphere	12
psychophysiology	13
emotions	10
occupational burnout	10

2020

Significant research topics (tables)

topic	theses number
mental state	5
psychodiagnostics	5
gender studies	6
psychophysiology	7
Attention	6
gerontogenesis	7
crises	6

adulthood	6
ethnopsychology	5
motivational-need sphere	8
personal mental health	5
addictions	6
service psychology	8
families of children with disabilities	5
children - parents	5
career guidance	5
interpersonal relationships	6
social psychology of personality	6
management psychology	8

2015

topic	theses number
psychotherapy	8
value orientationS	8
relation to disease	7
inclusive education	5
psychosomatics	9
psycho-oncology	5
neuropsychology	7
neuroses/personality disorders	5
families of children with disabilities	7
children - parents	6
psychodiagnostics	5
children	9
adulthood	8
career guidance	9
identity	6
gerontogenesis	6
interpersonal relationships	9
political psychology	7
social psychology of personality	6
occupational burnout	9
mental state	8
sports psychology	7
aggression	5
social.psych. of groups	5
management psychology	5
forensic psychology	8

2016

topic	theses number
adulthood	5
psychophysiology	6

gender studies	5
dysontogenesis	8
families of children with disabilities	6
children - parents	6
youth	6
children	7
motivational-need sphere	7
prof. important qualities	9
gerontogenesis	5
personality	9
interpersonal relationships	5
personal traits	6
management psychology	5

2017

topic	theses number
I-concept	5
family	5
social psychology of personality	8
personality	6
gender studies	7
organisational psychology	7
mental well-being	7
psychotherapy	5
prof. important qualities	5
trainings	5
sports psychology	8

2018

topic	theses number
theoretical psychology	5
social psychology of personality	6
memory	5
gender studies	5
youth	8
cross-cult researches	9
addictions	6
children	9
psychodiagnostics	6
teenagers	6
families of children with disabilities	6
dysontogenesis	9
neuroses/personality disorders	5
career guidance	5

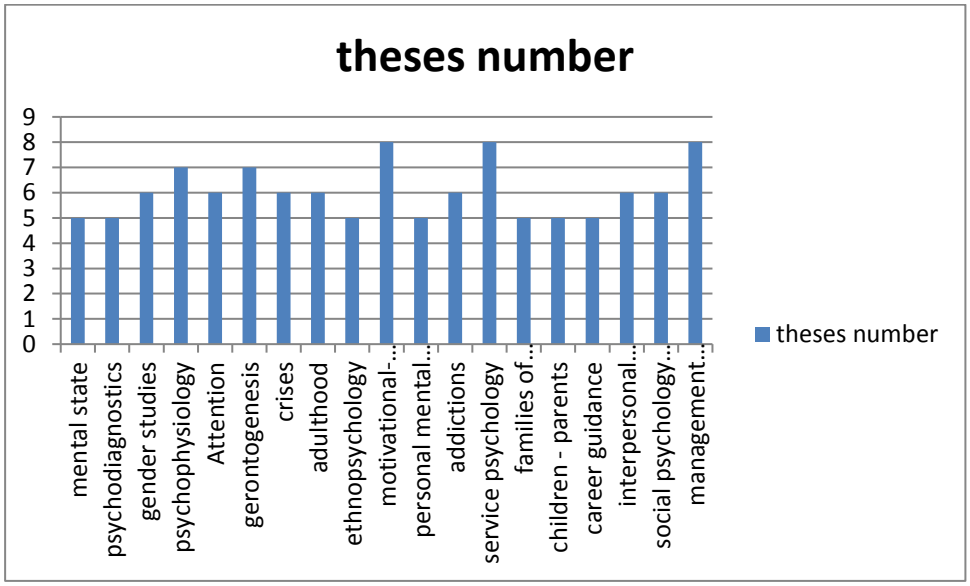
psychosomatics	5
early intervention	5
thinking	6

2019

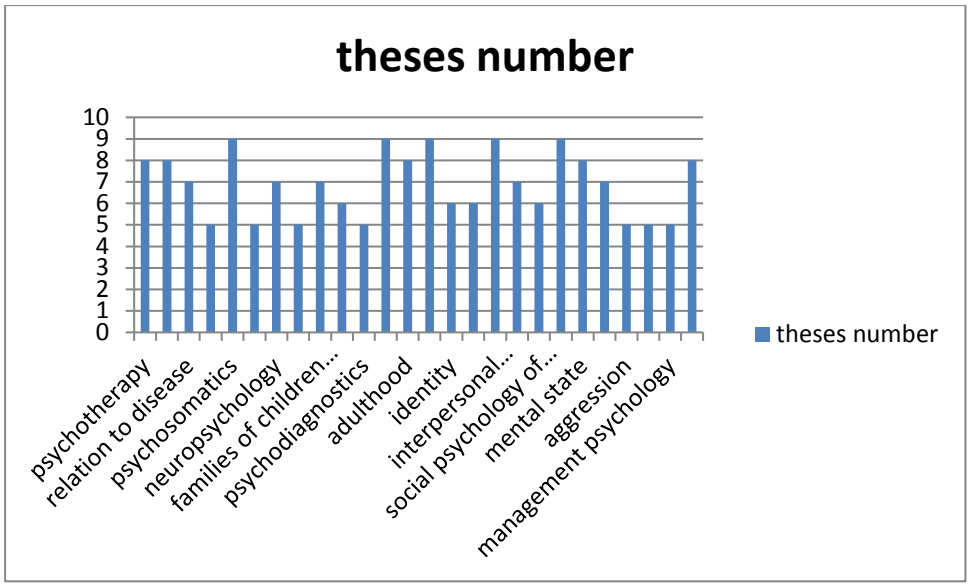
topic	theses number
cross-cult researches	7
children - parents	7
children	5
teenagers	9
dysontogenesis	8
I-concept	7
work psychology	7
career guidance	8
mental safety	6
counselling	7
crises	9
political psychology	8
suicide	5
psycho-oncology	8
extreme situations	5
early intervention	5
mental health	5
personality	5
health psychology	8
sports psychology	9

2020

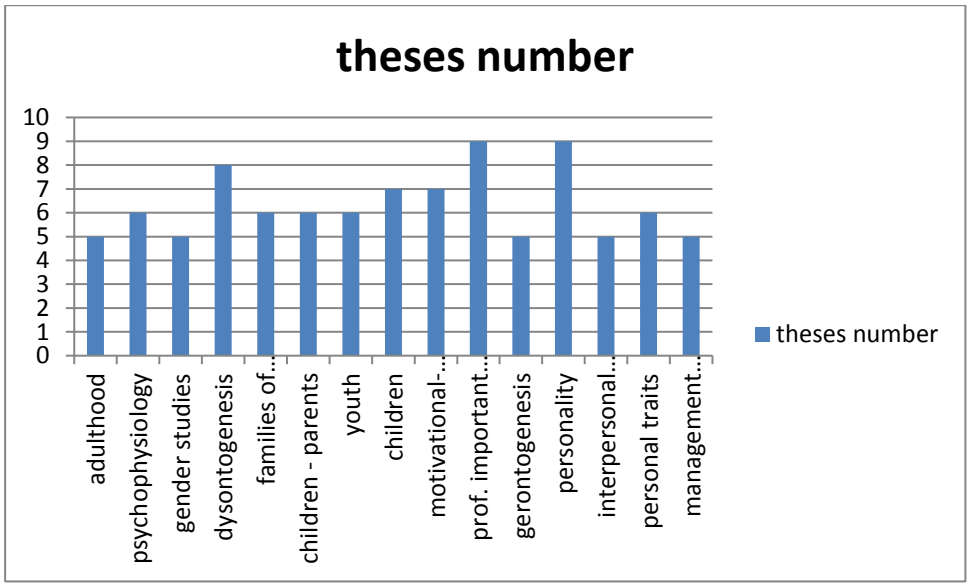
Significant research topics (diagrams)



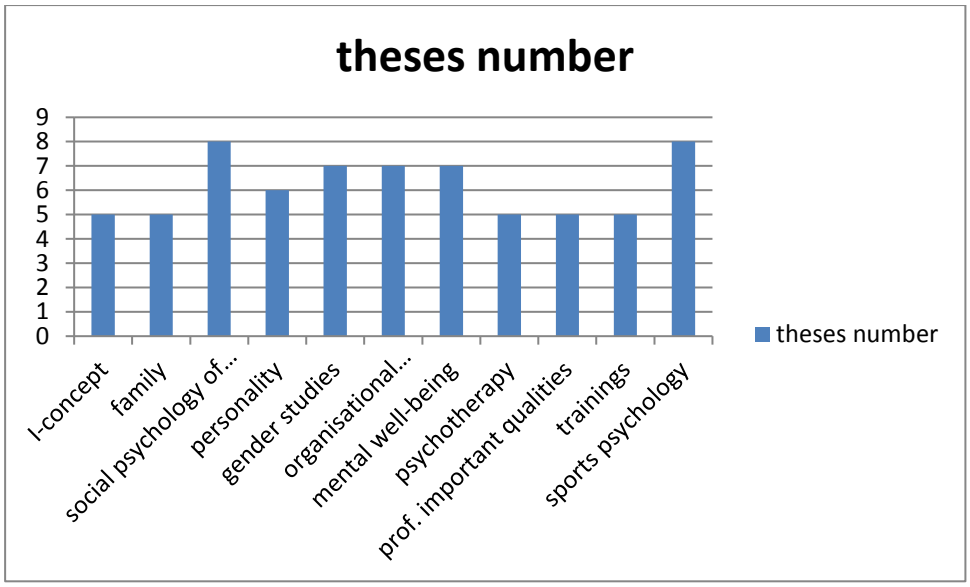
2015. The abscissa axis refers to the topic, and the ordinate axis refers to the number of theses.



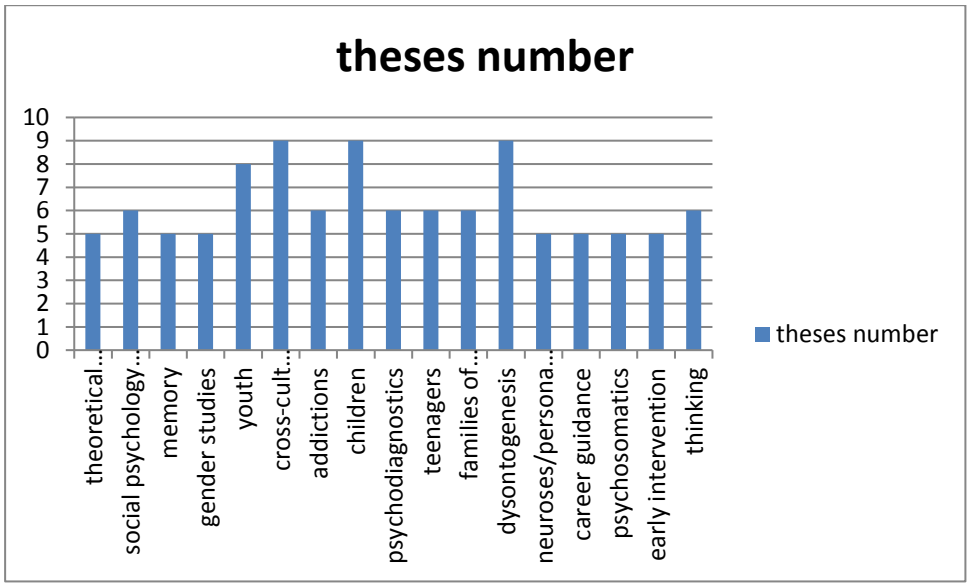
2016. The abscissa axis refers to the topic, and the ordinate axis refers to the number of theses.



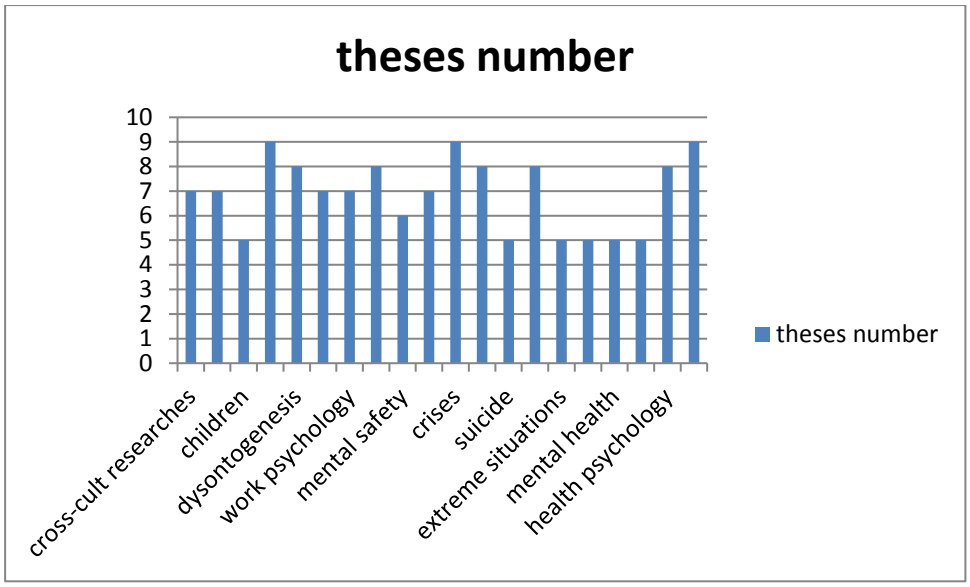
2017. The abscissa axis refers to the topic, and the ordinate axis refers to the number of theses.



2018. The abscissa axis refers to the topic, and the ordinate axis refers to the number of theses.



2019. The abscissa axis refers to the topic, and the ordinate axis refers to the number of theses.



2020.

Rarer research topics (tables)

topic	theses number
differential psychology	2
perception	4
animal psychology	1
leadership	2
creativity	3
cogn. styles	2
learning	4
pathopsychology	4
sensations	1
thinking	3
speech/language	1
capabilities	1
intelligence	2
imagination	1
personal traits	3
PTS	1
deviant behaviour	4
personality	4
youth	4
physicality	3
orientation	3
neuroses/personality	3
doctor - patient	2
suicide	2
psycho-oncology	1
personality typology	2
psychotherapy	3

i-concept	1
political psychology	4
extremism	1
family	4
psychocorrection	3
counselling	3
emotions	1
children from special Institutions	1
migration	3
prof. important qualities	4
inclusive education	2
mental safety	1
conflict	2
personality relationship system	1
children	3
teenagers	4
adaptation to the university	3
religion psychology	4
forensic psychology	1
value orientation	2
risk behaviour	4
extreme situations	2
aggression	1
HIV prevention	4
self-actualisation	1
behavioural psychology	1
meaning of life	1
individuality	2
sexual minorities	1
psychotrauma	2
engineer.psychology	1
theoretical psychology	2
psychosomatics	1
health psychology	1
occupational burnout	3
ergonomics	1
social roles	1
anomalous parenting styles	3
social psychology of groups	1
economic psychology	1
personal identity	2
early psychotrauma	1

topic	theses number
experimental psychology	1
deviant behaviour	4
children from special institutions	2
suicide	2
supervision/balint groups	2
people with HIV	2
counselling	3
psychocorrection	3
special psychology	1
PTS	2
health psychology	4
persons with disabilities	3
rehabilitation of people with disabilities	2
quality of life of patients	1
abnormal parenting styles	2
disorders of emotional sphere	1
corporality psychology	1
personality relationship system	3
HIV prevention	1
extreme situations	1
sexual minorities	1
self-actualisation	2
extremism	1
life path	4
family	3
early psychotrauma	4
marital relationship	2
differential psychology	4
adaptation to the university	2
crises	2
orphans	1
parenting styles	1
children from broken families	2
migration	4
mental safety	1
school readiness	2
intelligence	1
information security	1
attitude to health	1
Attention	4
consciousness	1
cognitive styles	2
memory	4
learning	2
unconscious	1

perception	2
differential diagnostics of child development	1
capabilities	1
existential psychology	2
personality traits	4
meaning of life	1
will	2
behavioural psychology	1
professional deformation	1
personal meaning	1
work psychology	4
service psychology	4
personality typologies	1
art psychology	2
organisational psychology	2
communication	3
man - animal	1
religion psychology	1
trainings	2
conflict	1
violence	4
ergonomics	1

2016

topic	theses number
mental state	4
consciousness	1
emotions	1
personal meaning	2
perception	4
psycholinguistics	2
differential psychology	3
learning	2
memory	3
neuropsychology	3
orientation	1
thinking	2
counselling	1
interdisciplinary researches	2
PTS	2
children from substitute families	1
differential diagnosis	1
experimental psychology	1
occupational burnout	3
I-concept	2
pathopsychology	2

neuroses/disorders	3
child clinical psychology	1
behavioural disorders	1
psychotherapy	3
suicide	2
psycho-oncology	4
treatment adherence	1
expertise	1
psychosomatics	2
corporality psychology	3
individuality	3
capabilities	1
early psychotrauma	1
family	3
meaning of life	3
children from broken families	1
school readiness	3
incomplete families	1
theoretical psychology	4
behavioural psychology	3
conflict	1
mental well-being	1
inclusive education	1
economic psychology	1
psychocorrection	2
migration	2
violence	1
social.psych. of groups	1
social psychology of personality	1
leadership	3
marital relationships	1
social-psychological assistance	1
communication	1
typologies	2
relation to the law	4
adaptation to the university	1
mental health	2
psychotrauma	2
persons with disabilities	3
attitude to health	1
addictions	1
social roles	1
value orientation	3
risk behaviour	2
sexual minorities	1
deviant behaviour	2

mental health	3
people living with HIV	1
mental safety	1
forensic psychology	2
lie detection	1
political psychology	4
ethnopsychology	3
existential psychology	2
crises	1
personality relationship system	2
life path	1
career guidance	2
work psychology	2
art psychology	2
trainings	1
sports psychology	2
aggression	1
professional selection	1
psychodiagnostics	1

2017

topic	theses number
mental state	3
identity	1
existential psychology	1
personal traits	3
international relationships	1
subject of activity	1
theoretical psychology	1
migration	3
memory	2
differential psychology	2
sexual minorities	1
experimental psychology	1
psychodiagnostics	4
psycholinguistics	1
psychomotoric activity	1
thinking	1
cognitive styles	1
locus of control	3
perception	3
Attention	2
rehabilitation of people with disabilities	1
pathopsychology	1
families of children with disabilities	4
children from special institutions	2

children from substitute families	1
marital relationship	1
occupational burnout	4
psychosomatics	4
early intervention	2
personal meaning	2
parenting styles	1
children - parents	3
meaning of life	1
career guidance	3
HIV prevention	1
mental health	2
suicide	4
personality typologies	2
deviant behaviour	2
value orientation	3
religion psychology	2
addictions	4
health psychology	2
people living with HIV	1
doctor - patient	1
neuropsychology	2
neuroses/personality disorders	4
mental behavior	1
cross-cult. researches	4
psycho-oncology	2
treatment adherence	1
loss	1
supervision/balint groups	2
counselling	1
differential diagnostics of child development	1
persons with disabilities	1
inclusive education	2
will	1
subject. picture of the world	1
forensic psychology	1
political psychology	2
conflict	1
ethnopsychology	2
foster families	1
misbehaviour	1
sexual/romantic relationships	1
children from broken families	1
leadership	1
aggression	1
economic psychology	1

management psychology	4
mental safety	2
work psychology	3
ergonomics	2
engineering psychology	1
professional selection	3
gerontogenesis	1
professional deformation	1
adaptation to the university	1
communication	1
psychotrauma	1
interdisciplinary researches	1
social.psych. of groups	1

2018

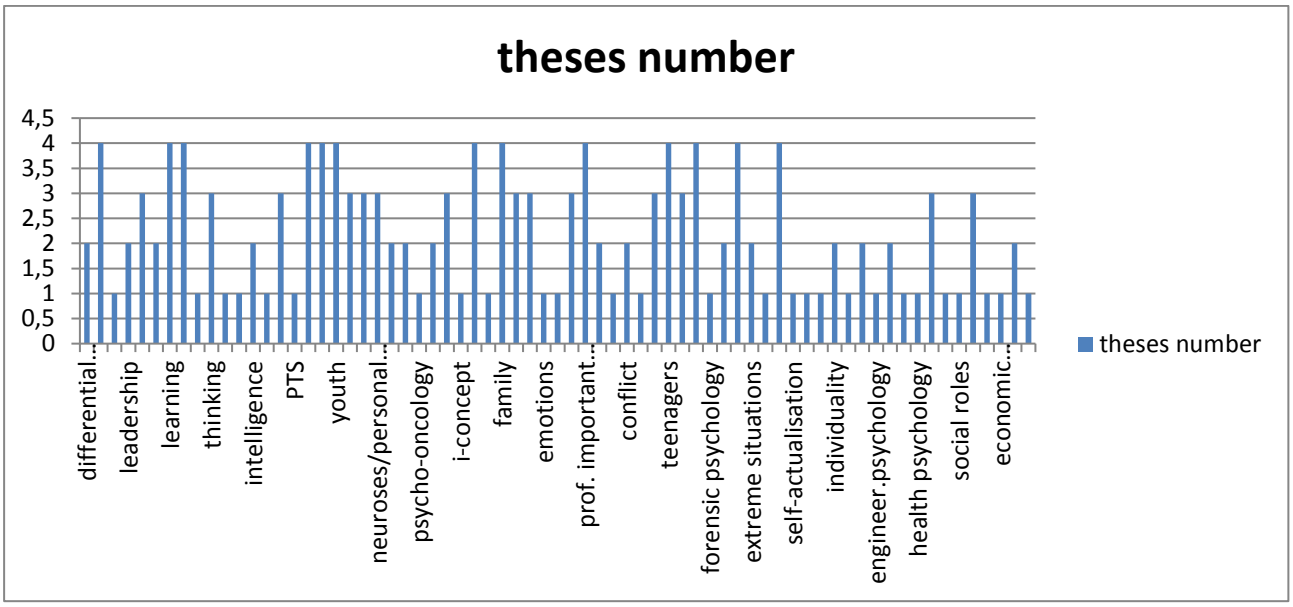
topic	theses number
art psychology	2
migration	3
relation to the law	1
value orientations	3
extremism	1
ethnopsychology	2
children - parents	4
gerontogenesis	3
communication	3
sports psychology	2
interpersonal relationships	1
experimental psychology	2
foster families	1
personality relationship system	2
sexual minorities	1
self-actualisation	1
psychotrauma	2
adulthood	2
violence	2
organisational psychology	2
prof. important qualities	4
emotions	3
engineering psychology	1
service psychology	3
mental state	2
motivational-need sphere	3
psycholinguistics	1
management psychology	1
mental health	1
differential psychology	1

trainings	2
health psychology	3
rehabilitation of people with disabilities	1
pathopsychology	2
children from broken families	1
consciousness	1
cognition	1
personality traits	3
expertise	3
psychophysics	2
perception	3
thinking	4
cognitive styles	1
professional deformation	1
life path	1
persons with disabilities	3
attitude towards illness	2
locus of control	1
treatment adherence	2
psycho-oncology	4
suicide	2
self-help groups	1
psychotherapy	3
family	2
marital relationship	1
PTS	1
deviant behavior	1
children from substitute families	3
children from special institutions	3
risk behaviour	1
psychophysiology	2
will	1
sexual/romantic relationships	1
individuality	2
mental well-being	1
counselling	1
forensic psychology	1
economic psychology	3
crises	1
behavioural disorders	1
existential psychology	2
personality	3
learning	3

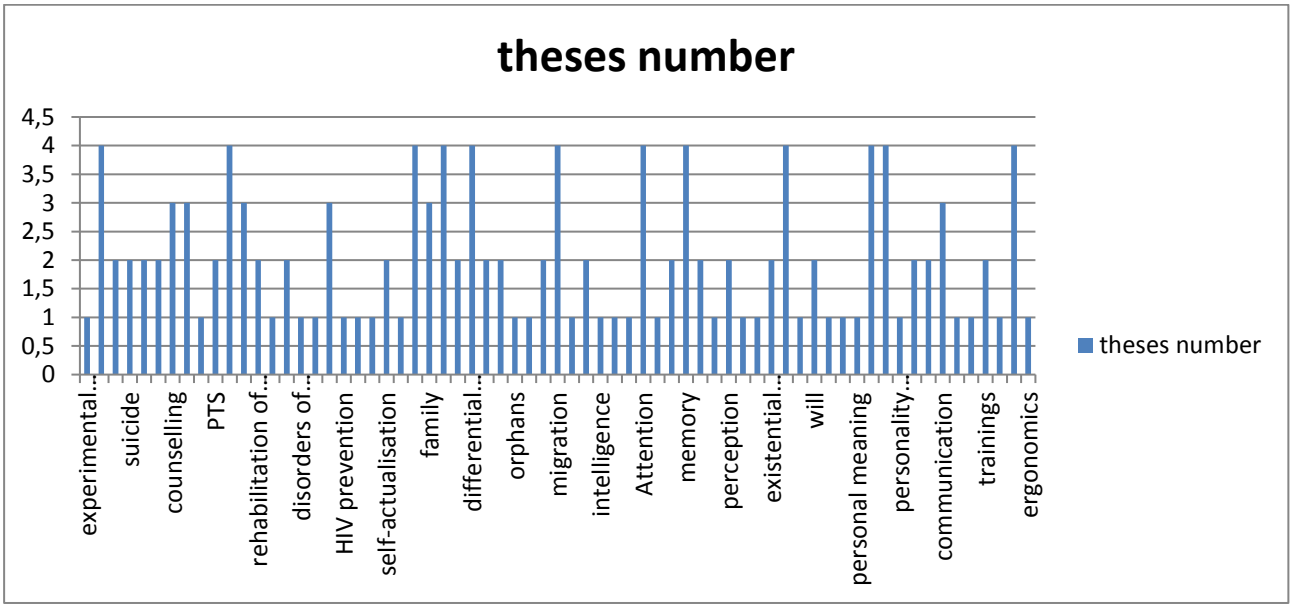
topic	theses number
environmental awareness	2
parenting styles	2
adulthood	1
personality orientation	2
sexual/romantic relationship	1
ethnopsychology	2
differential psychology	3
self-actualisation	3
families of children with disabilities	2
gender studies	4
corporality psychology	2
memory	1
psycholinguistics	3
imagination	1
perception	2
creativity	3
existential psychology	4
interdisciplinary researches	1
professional ethics	1
activity	1
mental state	4
behavioural psychology	2
management psychology	3
art psychology	1
social.psych.groups	4
supervision/balint groups	3
moral qualities of a person	1
social roles	1
engineer.psychology	1
personal traits	3
conflict	4
migration	2
religion psychology	1
value orientation	2
loss	1
inclusive education	3
will	2
economic psychology	3
PTS	2
expertise	1
psychodiagnostics	4
psychocorrection	1
sexual minorities	1
adaptation to the university	1
gerontogenesis	1

people living with HIV	1
forensic psychology	2
extremism	3
psychotrauma	1
pathopsychology	3
children's institutions	2
adaptation to professional activities	1
risk behaviour	1
personality typologies	1
individuality	2
leadership	1
interpersonal relations	1
neuroses/personality disorders	3
psychotherapy	2
family	2
deviant behaviour	2
rehabilitation of people with disabilities	1
comparative psychology	1
children from substitute families	2
children from special institutions	1
attitude towards motherhood	2
relation to the law	1
addictions	4
psychosomatics	3
mental well-being	1
neuropsychology	4
behavioural disorders	2

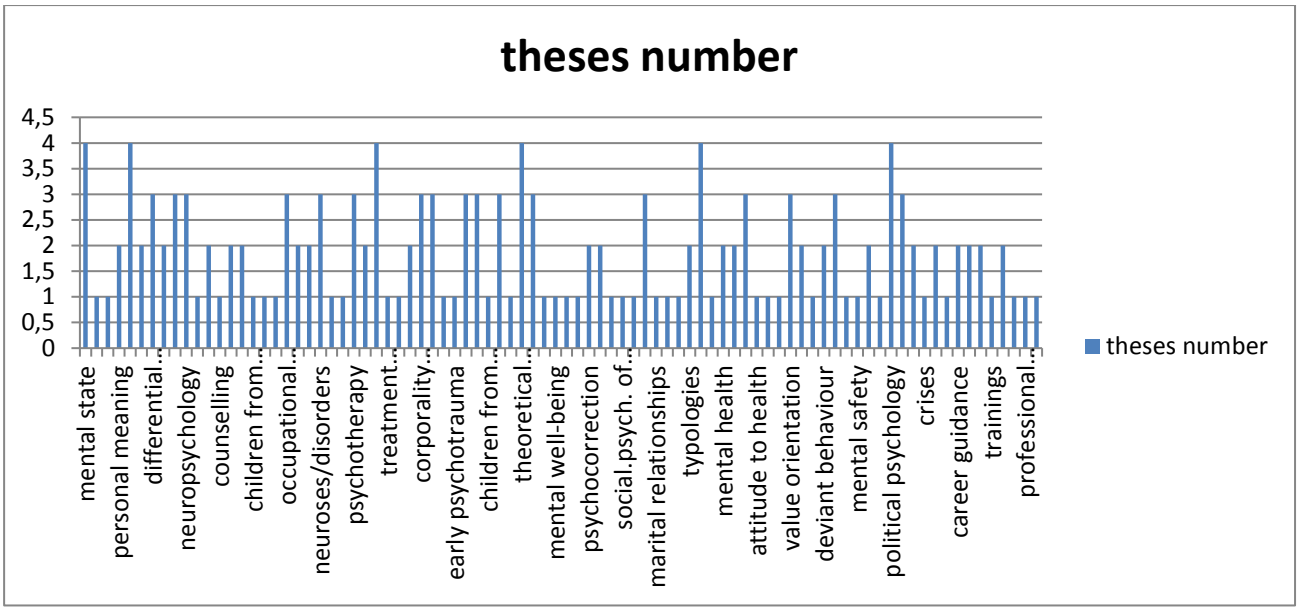
Rarer research topics (graphs)



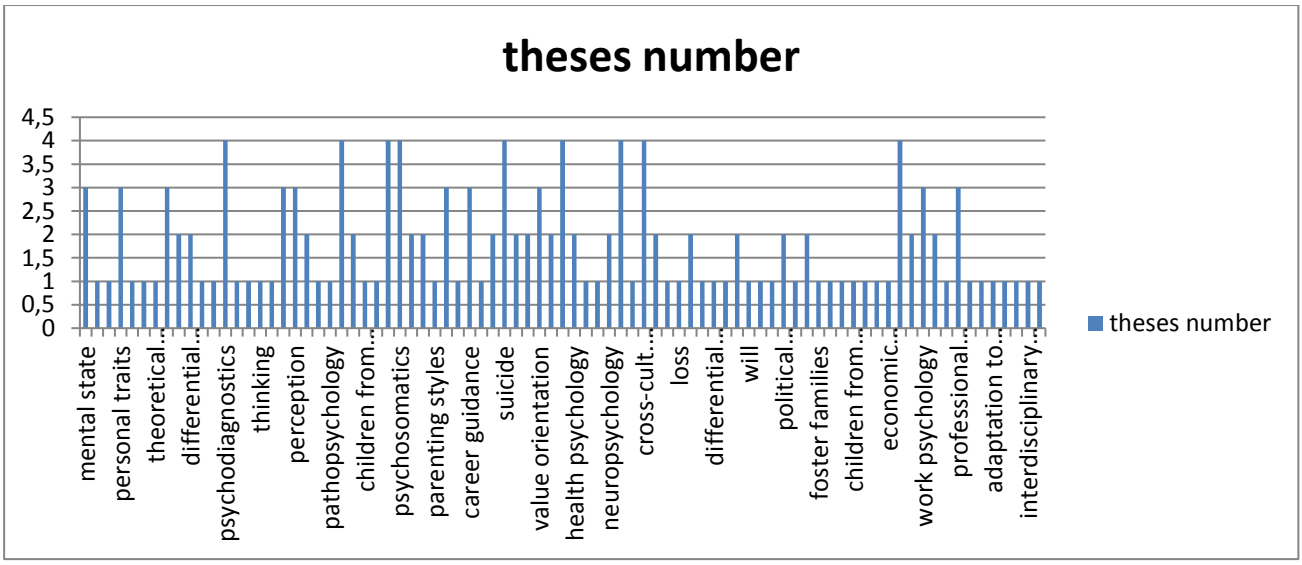
2015. The abscissa axis refers to the topic, and the ordinate axis refers to the number of theses.



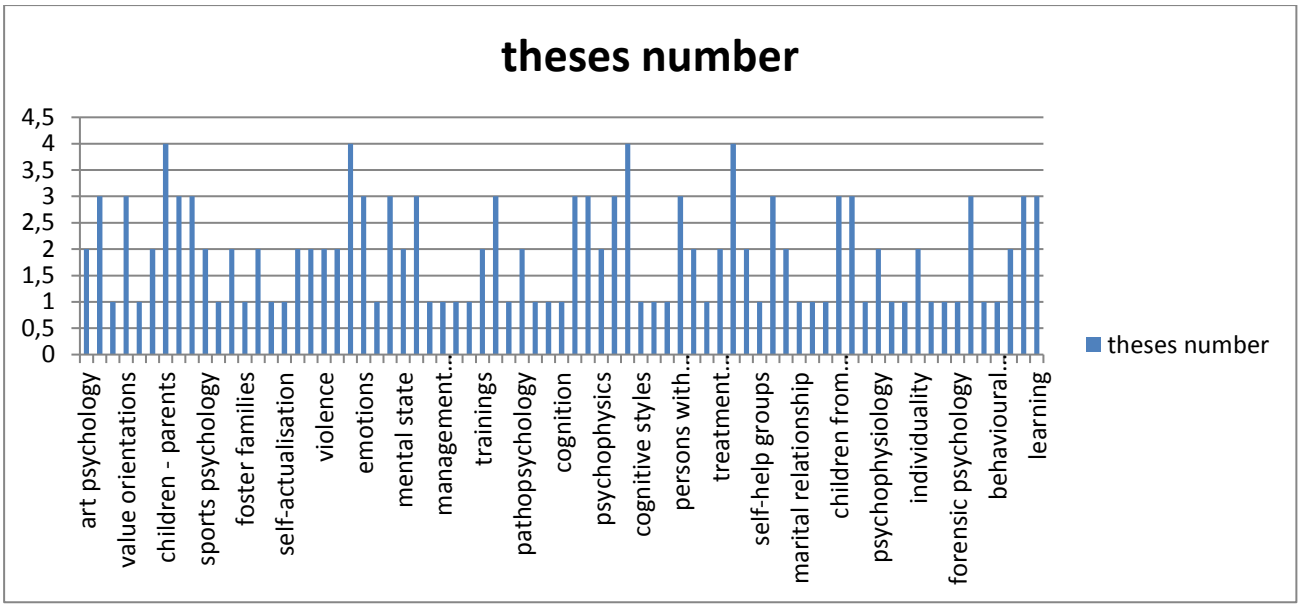
2016. The abscissa axis refers to the topic, and the ordinate axis refers to the number of theses.



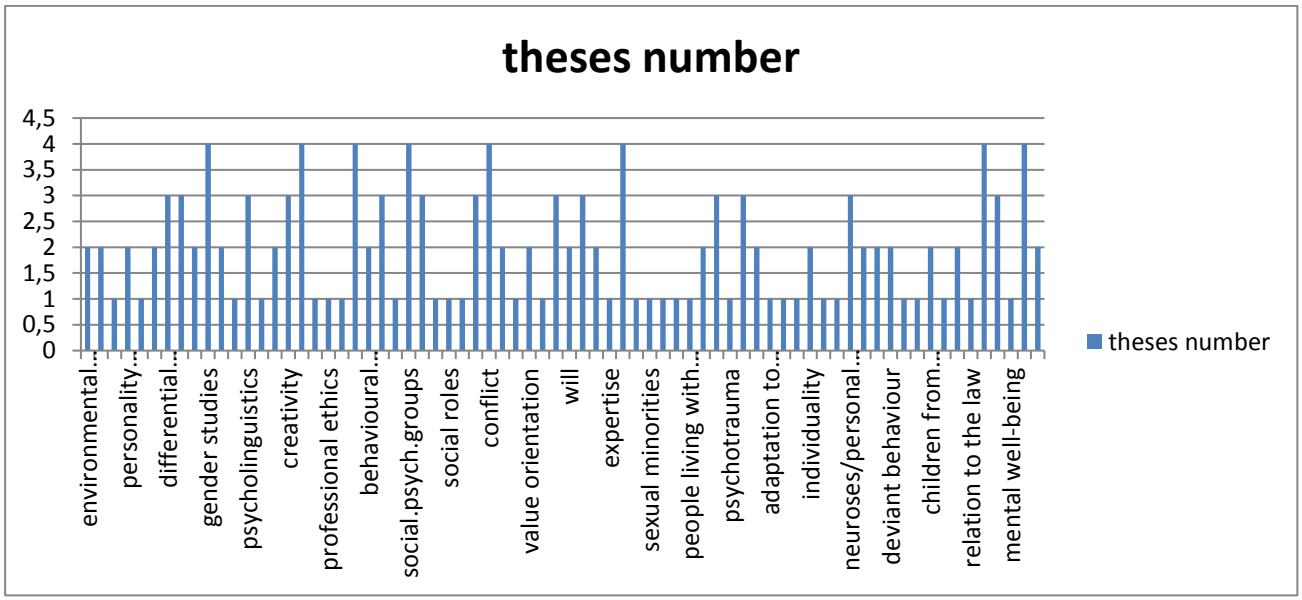
2017. The abscissa axis refers to the topic, and the ordinate axis refers to the number of theses.



2018. The abscissa axis refers to the topic, and the ordinate axis refers to the number of theses.



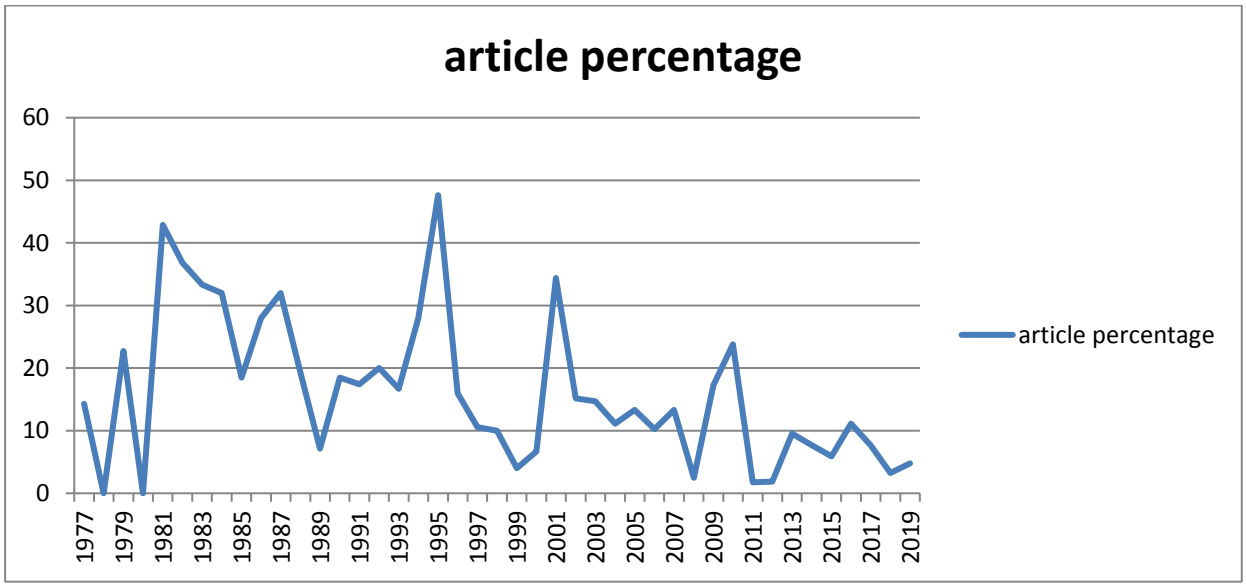
2019. The abscissa axis refers to the topic, and the ordinate axis refers to the number of theses.



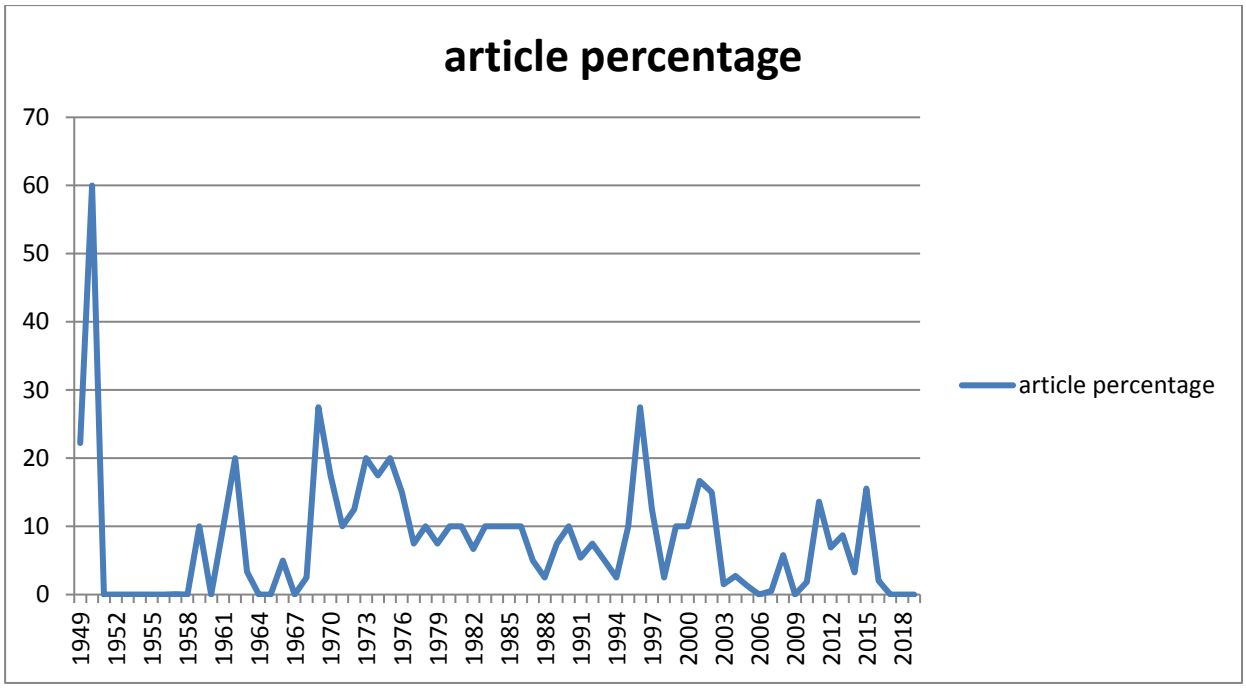
2020. The abscissa axis refers to the topic, and the ordinate axis refers to the number of theses.

Appendix B. The comparative study of the development of the natural-scientific domain in the Moscow and St. Petersburg (Leningrad) psychological schools (based on Moscow State University Bulletin and St. Petersburg State University Bulletin)

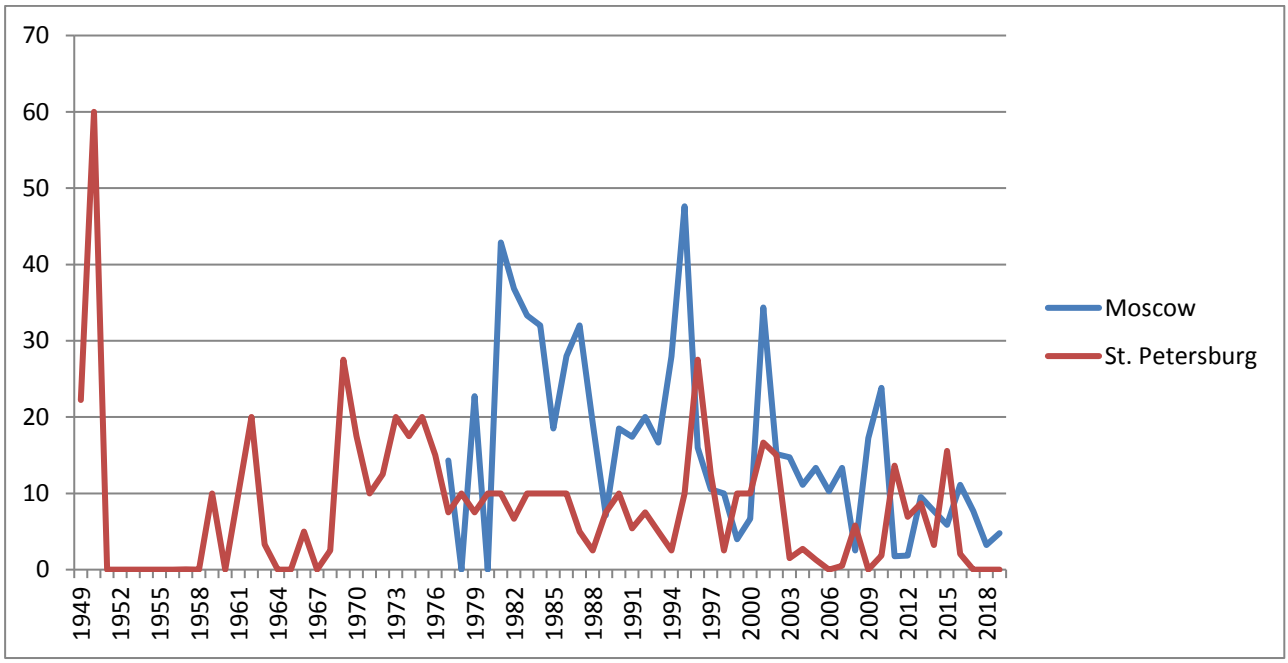
Percentage of the number of analysed articles to the total number of articles in the published journals



Moscow State University Bulletin (the abscissa axis refers to time, and the ordinate axis refers to percentage of the number of selected articles to the total number of articles)

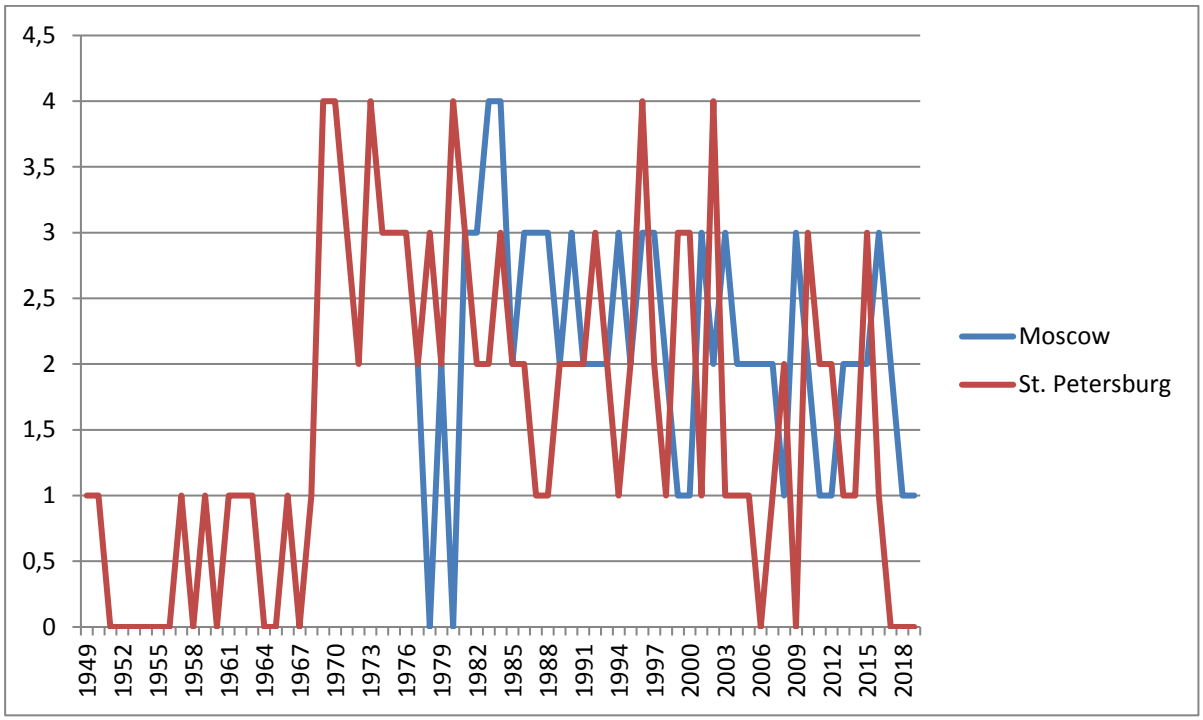


Bulletin of St. Petersburg State University (the abscissa axis refers to time, and the ordinate axis refers to percentage of the number of selected articles to the total number of articles)

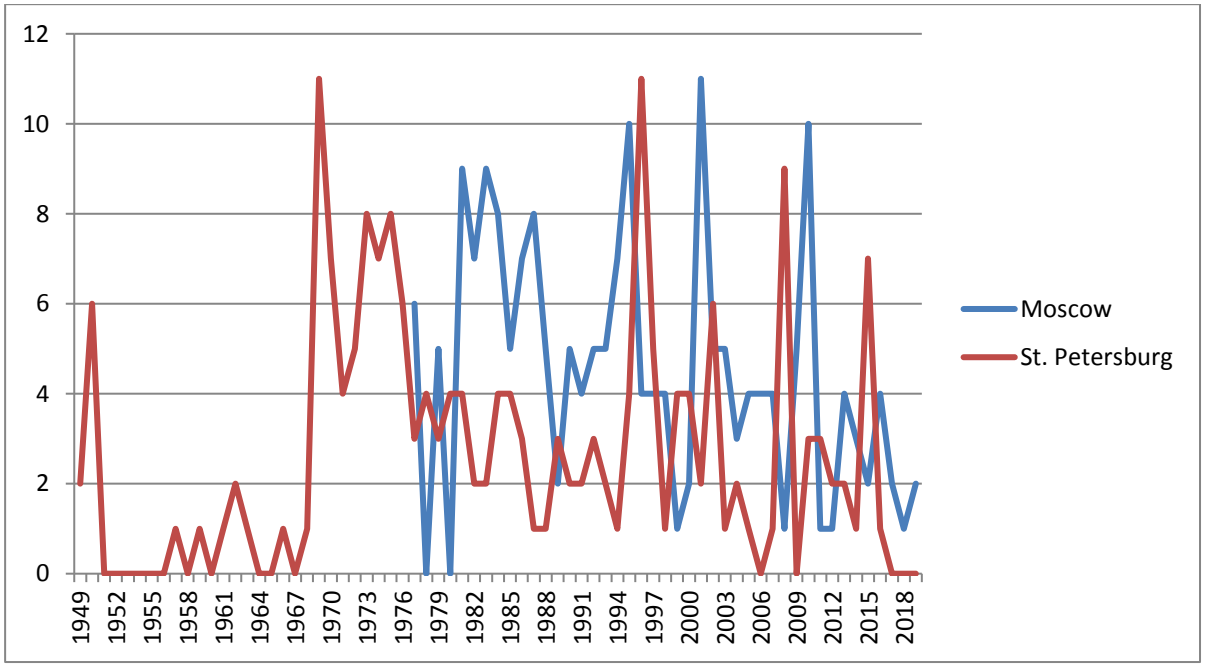


The combined graph (the abscissa axis refers to time, and the ordinate axis refers to percentage of the number of selected articles to the total number of articles)

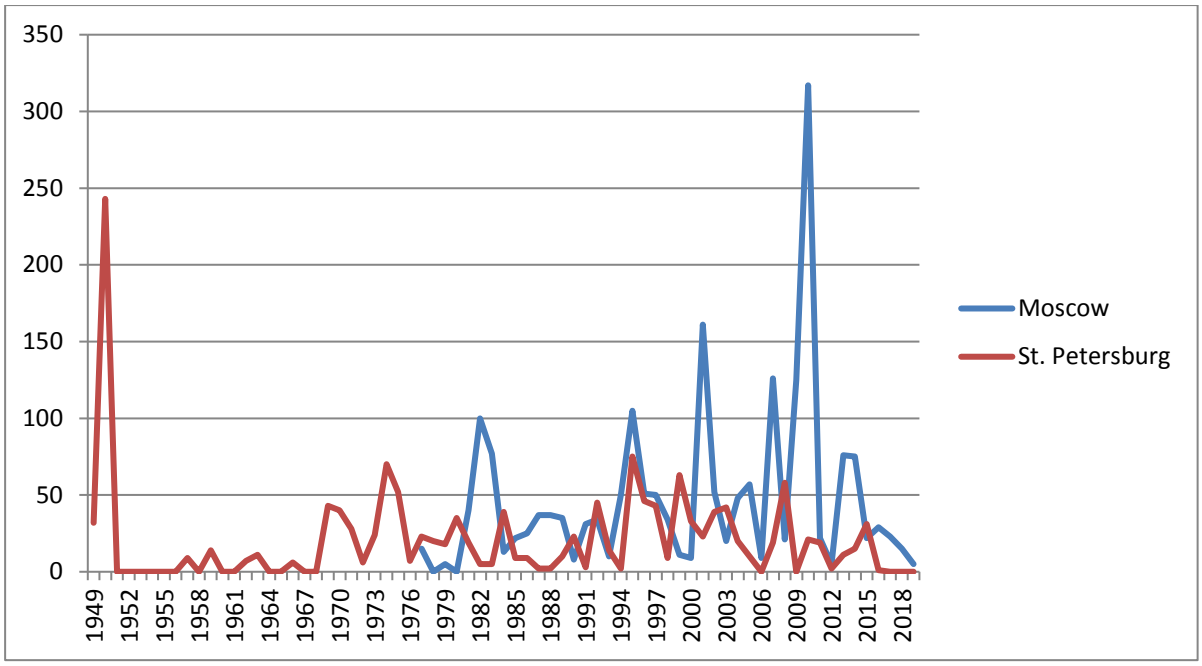
Combined graphs (publications of Moscow State University and St. Petersburg State University Bulletin)



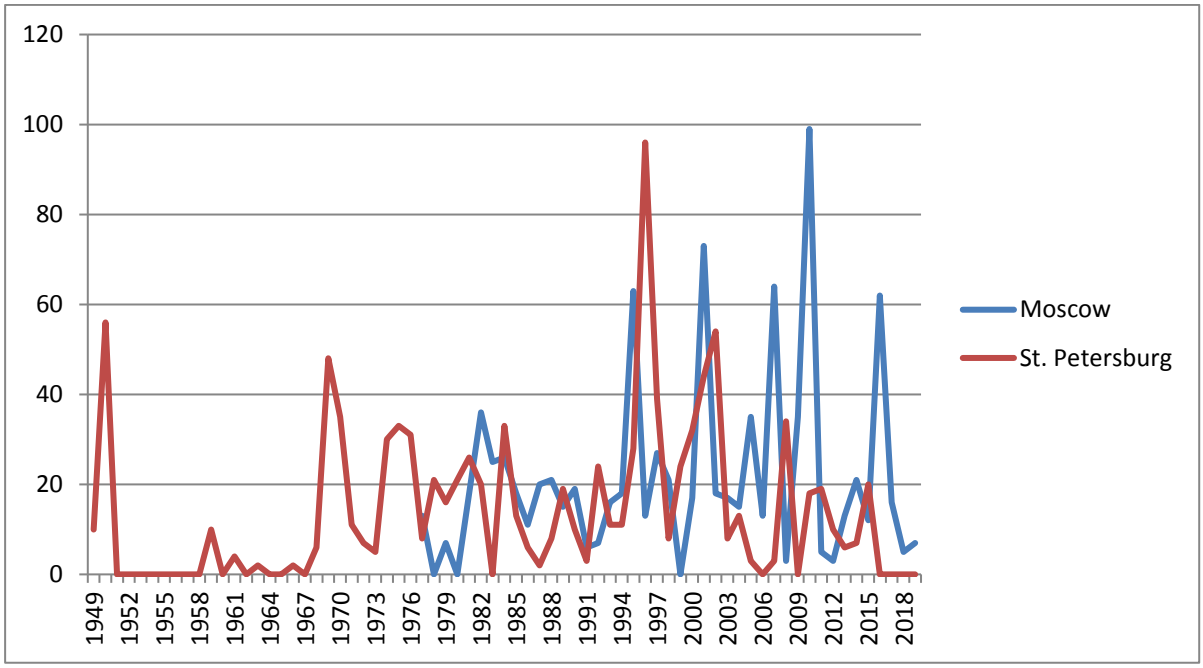
The number of journals (the abscissa axis refers to time, and the ordinate axis refers to the number of journals).



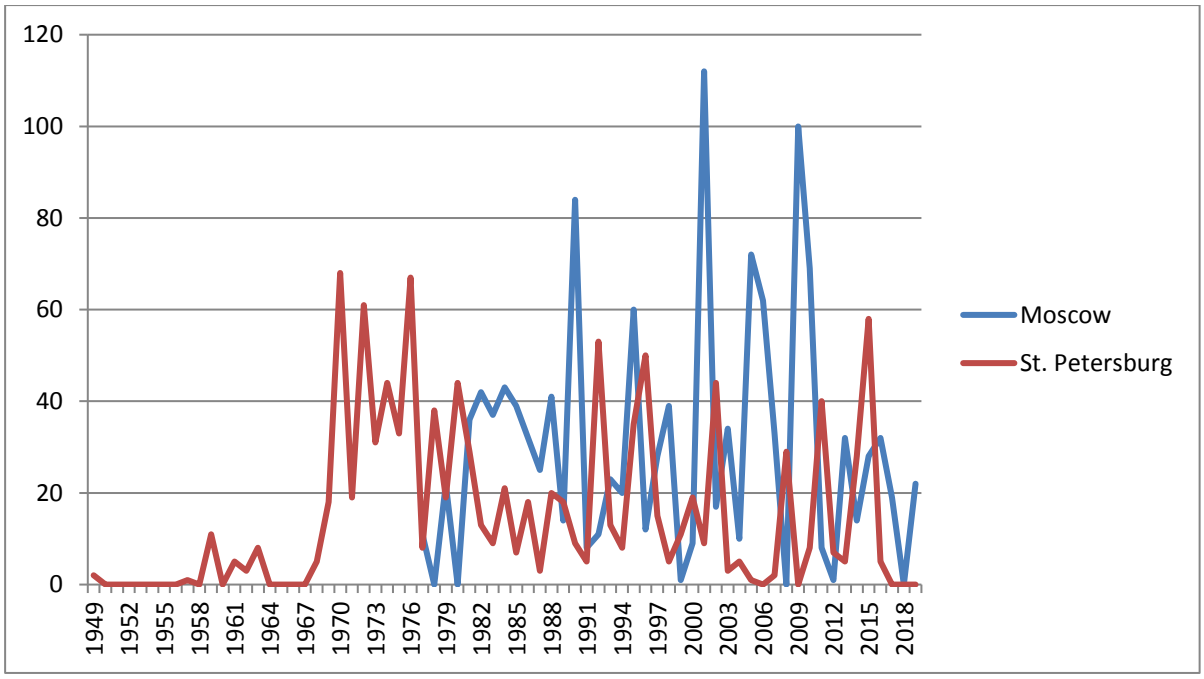
The number of articles (the abscissa axis refers to time, and the ordinate axis refers to the number of journals).



The number of biological terms (the abscissa axis refers to time, and the ordinate axis refers to the number of terms).



The number of physical terms (the abscissa axis refers to time, and the ordinate axis refers to the number of terms).



The number of mathematical terms (the abscissa axis refers to time, and the ordinate axis refers to the number of terms).

Appendix C. The study of the phase dynamics of psycho-physiological functions as an example of the operation of the law of phases at the individual level

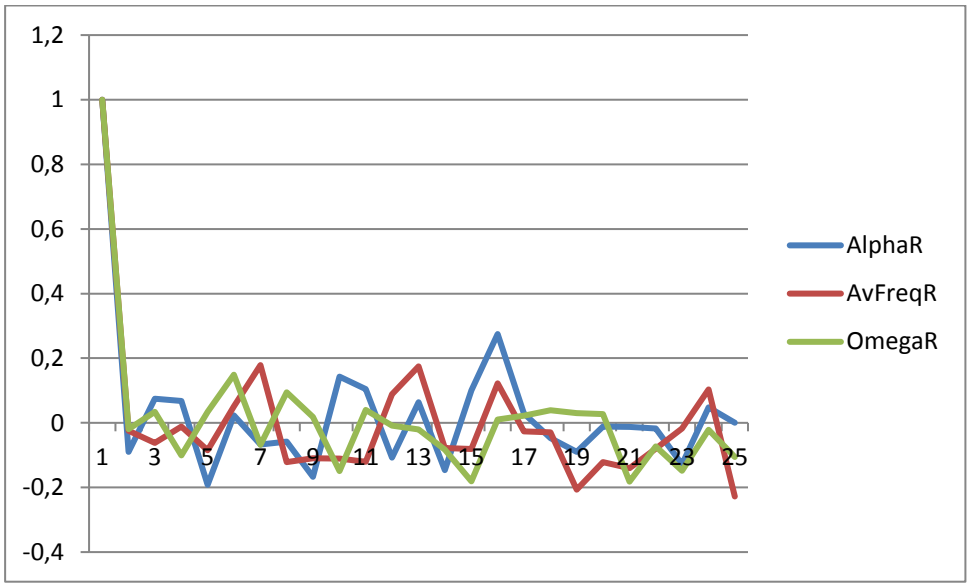
Number of participants by groups

age	number of participants
17 years 8 months	1
17 years 11 months	2
18 years	2
18 years 1 month	3
18 years 2 months	3
18 years 3 months	2
18 years 4 months	3
18 years 5 months	4
18 years 6 months	4
18 years 7 months	7
18 years 8 months	3
18 years 9 months	6
18 years 10 months	10
18 years 11 months	12
19 years	7
19 years 1 month	14
19 years 2 months	16
19 years 3 months	18
19 years 4 months	24
19 years 5 months	21
19 years 6 months	21
19 years 7 months	17
19 years 8 months	14
19 years 9 months	25
19 years 10 months	14
19 years 11 months	15
20 years	19
20 years 1 month	15
20 years 2 months	14
20 years 3 months	17
20 years 4 months	6
20 years 5 months	10
20 years 6 months	8
20 years 7 months	6
20 years 8 months	6
20 years 9 months	7
20 years 10 months	6
20 years 11 months	4
21 years old	3

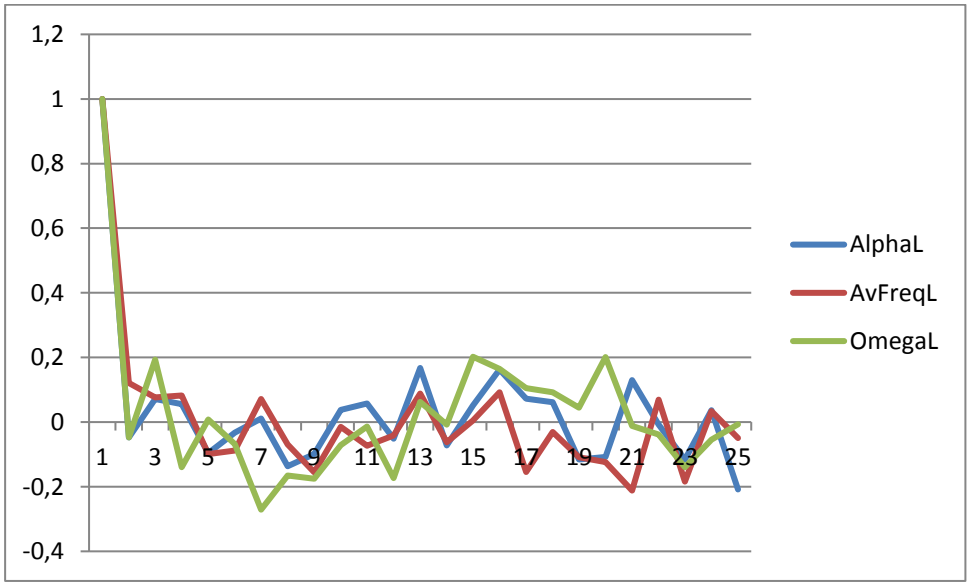
21 years 1 month	2
21 years 2 months	1
21 years 3 months	2
21 years 4 months	4
21 years 5 months	4
21 years 6 months	1
21 years 7 months	4
21 years 8 months	2
21years 9months	4
21 years 10 months	4
21years 11months	2
22	2
22 years 2 months	2
22 years 3 months	3
22 years 4 months	3
22 years 5 months	2
22 years 6 months	2
22 years 7 months	3
22 years 8 months	2
22 years 9 months	3
22 years 10 months	2
22 years 11 months	2
23 years old	5
23 years 1 month	3
23 years 2 months	3
23 years 3 months	1
23 years 4 months	2
23 years 5 months	1
23 years 6 months	1
23 years 7 months	3
23 years 8 months	2
23 years 11 months	1
24 years 2 months	1
24 years 5 months	1
24 years 6 months	1
24 years 10 months	1
25 years	1
25 years 3 months	1
25 years 4 months	1
25 years 5 months	2
25 years 9 months	1
26 years	1
26 years 3 months	1
26 years 4 months	1
26 years 9 months	1
27 years 5 months	1

27 years 10 months	1
28 years 2 months	1
29 years 3 months	1
36 years 8 months	1
40 years	1
41 years 2 months	1
42 years 6 months	1
44 years 1 month	1

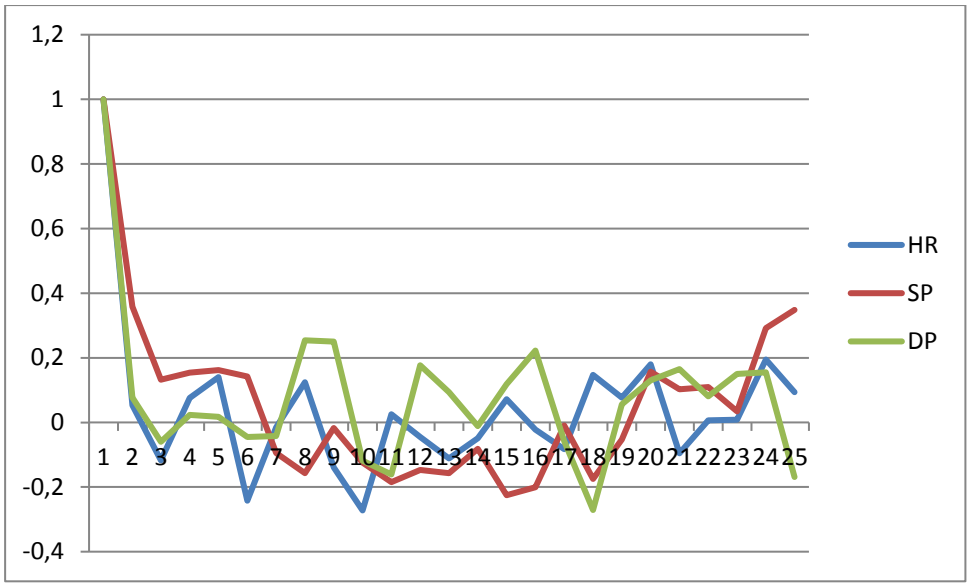
Combined charts (ACF)



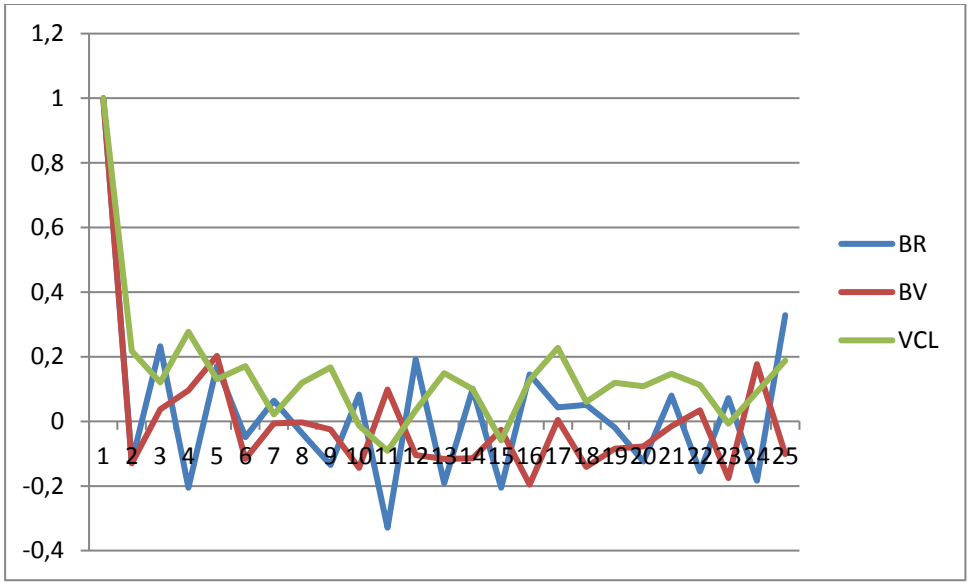
CNS (right hemisphere scaled scores). The ordinate axis refers to the correlation, the abscissa axis refers to time.



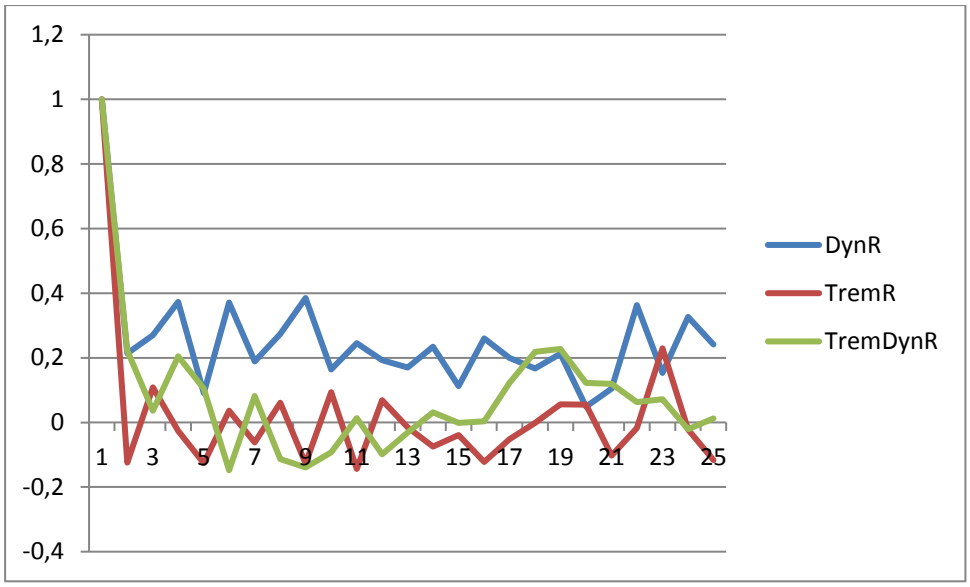
CNS (left hemisphere scaled scores). The ordinate axis refers to the correlation, the abscissa axis refers to time.



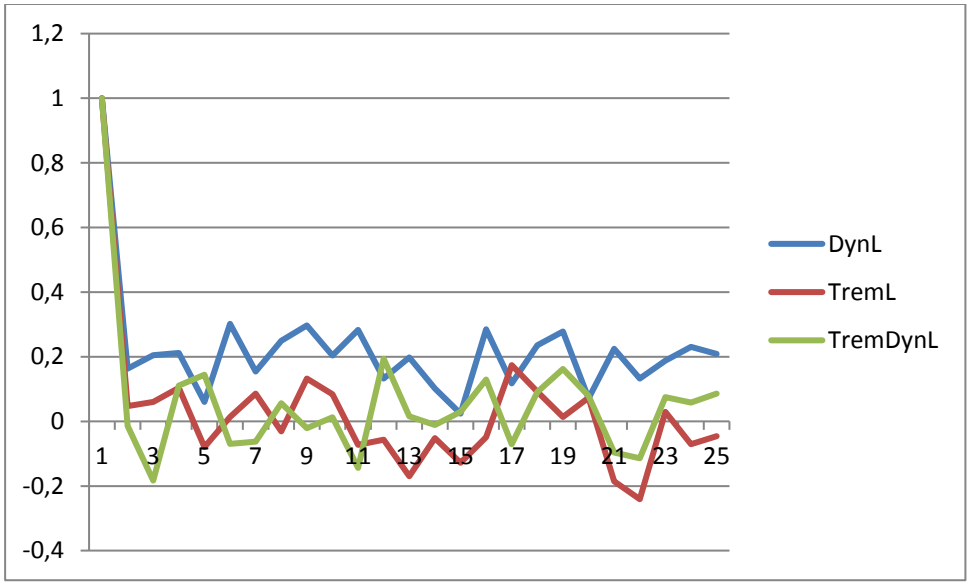
ANS (scaled scores of the cardiovascular system). The ordinate axis refers to the correlation, the abscissa axis refers to time.



ANS (scaled scores of the respiratory system). The ordinate axis refers to the correlation, the abscissa axis refers to time.



SNS (right hand scaled scores). The ordinate axis refers to the correlation, the abscissa axis refers to time.



SNS (left hand scaled scores). The ordinate axis refers to the correlation, the abscissa axis refers to time.