

PSYCHOLOGY IN RUSSIA: STATE OF THE ART

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Editorial

Special section of the third issue of the 6th volume *Psychology in Russia: State of the Art* presents the papers of the workshop and faculty meeting of the Parmenides Foundation — international scientific community for multi-disciplinary cognitive research building bridges between natural, computer sciences and humanities. The 10th Sino-German Workshop in the Neurosciences and Psychology with 80 participants from 15 countries, held in Hamburg, Germany (1–4 September 2013), was dedicated to the general topic of neglected questions in the field.

The section opens with “Unasked questions and unused answers in psychology” — an outlook of the most prominent methodological issues made up of comments by the international group of researchers. It discusses the “universal” conceptual problems — classification of functions, unified methodological approaches, explanation of the psychological phenomenon — in certain contexts such as use of single cases in cognitive research, misunderstanding the “Occam’s razor” principle, the nature of time, language, culture as research variables.

The other articles in the section provide the results of research implementing magnetic resonance, morphometric analysis, different methods for registration of brain electric activity as well as psychosemantic methods. The methods used allowed to gain some insights into the issues of working memory (Stanislav A. Kozlovskiy, Maria M. Pyasik, Aleksander V. Vartanov, Evgenia Yu. Nikonova), creativity (Pavel N. Ermakov, Oxana S. Saakyan), functional states (Vladimir V. Galatenko, Evgeniy D. Livshitz, Alexander M. Chernorizov, Yury P. Zinchenko, Alexey V. Galatenko, Vladimir M. Staroverov, Sergey A. Isaychev, Vyacheslav V. Lebedev, Galina Ya. Menshikova, Alexey N. Gusev, Ekaterina M. Lobacheva, Rozaliya F. Gabidullina, Vladimir E. Podol’skii, Victor A. Sadovnichy), illusions perception (Galina Ya. Menshikova), understanding of polysemous words (Vera I. Zabotkina, Elena Boyarskaya) and psychophysiological mechanisms of mental stress reactions in hypertension (Yu. P. Zinchenko, Elena I. Pervichko, Olga D. Ostroumova). Janna M. Glozman and Pavel Krukow discuss new neuropsychological theory of the social brain and its relationship to Luria’s and Vygotsky’s understanding of a human as a social and biological unity.

The idea of an individuum as a multi-layered level of a body-mind union is further elaborated in the articles “Proprioception as a basis for individual differences”

by Ludmila N. Liutsko and “Character and temperamental determinants of prosodic parameters of natural speech” by Anna S. Silnitskaya and Alexey N. Gusev in Psychology of Perception section. Alla K. Bolotova and Milana R. Hachaturova describe the role of time perspective in coping behavior; their article provides results, fruitful for counseling and training practice.

Work and Organizational Psychology section also deals with highly relevant practical issues, especially important in a modern megalopolis. Traffic psychology is still an emerging sphere of research in Russia while there is a wide field of its application. Alexander I. Dontsov and Alexandra I. Kabalevskaya investigated gender stereotypes among road users. The article “Determinants of professional distortion development in medical personnel, teachers and psychologists, working in the industrial disaster zone” by the group of researchers headed by Anna B. Leonova deals with the consequences of the most psychologically hazardous events and suggests prevention strategies for professional burnout and distortion. Andrey V. Sidorenkov and Irina I. Sidorenkova describe the model of trust in work groups.

Yuri P. Zinchenko
Lomonosov Moscow State University, Russian Psychological Society

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SPECIAL SECTION: “SCIENCE IN DIALOGUE” — 10th SINO-GERMAN WORKSHOP SELECTED PAPERS

Unasked questions and unused answers in psychology

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Contemporary psychology and cognitive neuroscience create many opportunities for studying the brain functions, but also generate numerous challenges. To date, scientists face common conceptual problems which are relevant to almost every research study/case such as: classification of functions, unified methodological approaches, explanation of the psychological phenomenon etc. The Sino-German Workshop which took place in Hamburg in 2013 aimed to address unasked questions and unused answers, attracting scientists from different countries and different fields of psychology, neuroscience, medicine, history, and philosophy. The present discussion on the 9 unasked questions was initiated by Professor Ernst Poeppel and was held on by Russian participants from various academic institutions.

The international Sino-German Workshop in the Neurosciences and Psychology with 80 participants from 15 countries, held in Hamburg, Germany (1-4 September 2013), was dedicated to the general topic of neglected questions in the field. In addition it discussed the knowledge available in psychology that is applied in different fields of medicine, education, technology, economics, politics, humanities or the arts. The largest delegation at this workshop came from Russia, and Russian

participants comment below on nine unasked questions that were made available before the workshop to each participant. In fact, there are many more such unasked questions which should be made transparent, in order to protect psychology from unnecessary prejudices.

One: The lack of taxonomy or classification of functions

We do not have a taxonomy of functions in psychology. Compared to biology, chemistry or physics, psychology lacks a classificatory system which everybody agrees upon. What do we refer to in empirical work or theoretical considerations? For some it is physical “reality” (as conceived in classical physics), for some it is language (using “words” as representatives of subjective phenomena), for some it is behavioral catalogues (as described in human ethology), for some the repertoire of human needs, for some it is just common sense as reflected in everyday psychology. As there is no generally accepted taxonomy, we operate within predefined frames of models. This results in an increasing diversity, leading to “speechlessness” between the members of the psychological community.

Comment by Professor Alexander Chernorizov (Head of the Department of Psychophysiology, Lomonosov Moscow State University):

Properties of objects are determined by research methods. Thus, the number of properties is proportional to the number of methods and stimuli used in research, and therefore can be infinite. In this situation, researchers need a convention concerning standardization of research methods of studying of the brain, and a standard classification of the corresponding brain functions, respectively.

Comment by Artem Kovalev (Student of faculty of Psychology, Lomonosov Moscow State University):

We know about psychical phenomena from our subjective experience and people's reports. However, nobody sees or touches cognitive processes, character or personality traits. How can we classify something that we cannot grasp? The classical nouns used in general psychology, such as memory, perception, and attention, describe only the general principles of the system's functioning. In other words, the problem of taxonomy lies in the determination of object and subject. Since 1879, progress in psychology was dependent on the methods of measurement. W. Wundt conceived psychological reality in the light of introspection. I.P. Pavlov perceived the world through the conditional and unconditional reflexes of his dogs. Now, we analyze cognitive processes BOLD signals and spike numbers. Consequently, psychology and psychophysiology have become only descriptive sciences, but the taxonomy of function can help not only to describe psychological phenomena but also to explain brain activity in functional terms.

Comment by Yuliya Zaytseva (Research Associate of Institute of Medical Psychology, LMU; Senior Researcher at Moscow Research Institute of Psychiatry):

It has been proposed by Luria (1976) that cognitive processes, being higher cortical functions, may represent functional systems and are not localized in narrow, circumscribed areas of the brain, but rather take place through the participation of groups of concertedly working brain structures, each of which makes its own particular contribution to the organization of the functional system. The notion that different functions are represented in different brain areas or have different algorithms which are interconnected leads to the question of how the activity of these different regions is temporarily coordinated. To understand brain function, one must understand how brain areas extract information from perceptual input, integrate that information over time and sources, and make decisions and plan motor actions. For many years, the spatial connections and their temporal coordination in cognitive functioning were difficult to grasp as the technology in this field was quite limited. Since neuroimaging methods were introduced, new possibilities to study more precise mechanisms of cognitive processing appeared. Modern technology as well as experimental evidence may indeed help us to understand the brain better and lead us towards creating a new classification of cognitive functions. However, the limitations of the technology must be also taken into the account. Also, multidisciplinary approaches must be used in order to stratify the components of cognitive functions, thereby giving an insight into cognitive machinery. An approach which might be pursued following the work of Luria has been suggested by Pöppel (1989), distinguishing between content and logistical functions using neuropsychological observations.

Two: Time as a discrete or continuous variable

In 1868 the Dutch physiologist Karl Donders came up with the idea that differences in reaction times can be used to analyze cognitive processes. This method of chronometric analysis is used probably in every psychological laboratory in the world, but it suffers from an implicit assumption, in that time (temporal processing) is treated as a continuous variable. However, there is clear evidence for discrete temporal processing, and such a mode of processing would create a different frame for theoretical concepts (Pöppel, 1997). The view on whether time is treated as a continuous or a discrete variable has also important implications for experimental work, like the selection of bin widths when measuring reaction times. An oscillatory component in the 30-Hz domain which could indicate discrete processing would remain undetected with a bin width of 30 ms when reaction times are measured.

Comment by Professor Alexander Chernorizov (Head of the Department of Psychophysiology, Lomonosov Moscow State University):

The roots of the concept of time and the formulation of the evolutionary paradigm are placed in natural sciences. The main physical aspects of the 'concept of time' are as follows (I. Prigogine, I. Stengers, 2005): in physics, the dynamic description is fundamentally different from the corpuscular one. The continuous nature of the acceleration described by the equations of dynamics is in contrast to the discrete instant collisions of solid corpuscles underlying the dynamic changes.

At the end of the XIX century, with the introduction of the kinetic theory of gases, atomic chaos re-entered physics, and the problem of dynamic law and statistical description became one of the central problems. Science is rediscovering time. Due to this, there are two unresolved questions: classical or quantum physics describe the world as reversible and static. In this description there is no place for evolution, neither to order nor to chaos. Information extracted from dynamics remains constant over time. On the other hand, the famous law of increasing entropy (2nd law of thermodynamics) describes the world as constantly evolving from order into chaos. However, from the evidence of social and biological evolution we know that the complex arises from the simple. How may chaos be structured? So, there is a clear contradiction between the static view on the dynamics and thermodynamics of the evolutionary paradigm. Another, even more fundamental question is: what is the essence of the contradiction between the static view of the dynamics and thermodynamics of the evolutionary paradigm? What is 'irreversibility'? What is 'entropy'? Matter becomes "active": it produces irreversibility and irreversibility organized matter (I. Prigogine, I. Stengers, 2005). As in physics, time as a new natural stimulus variable should be rediscovered in neurosciences.

Three: Space being homogeneous or inhomogeneous

Like continuity of time, homogeneity of visual space is also generally assumed to be evidenced by constancy of brightness throughout the visual field; both assumptions, continuity of time and homogeneity of space, may reflect the powerful tradition of Newtonian physics. But there is a paradox: Empirical evidence suggests an inhomogeneity of visual space, if one looks at perceptual processing as a function of the eccentricity of visual stimuli (Bao and Pöppel, 2007), or the dissociation of spatial coordinates in neglected patients. Furthermore, it is still an open question in spite of substantial research, as to how intermodal maps are constructed to create *one* perceptual space; the challenge remains to integrate the retinocentric visual map and the head-centered auditory map, and not to forget the importance of the vestibular and the somatosensory systems in constructing peri-personal and extrapersonal spaces. The problem of a homogeneous or inhomogeneous space may be irrelevant when one studies object recognition for near-fovea targets, but it is an important problem for spatial attention and navigation. Particularly in this area of research one gets the impression that we depend on technical limitations: Because computer screens have only a certain diameter, the far periphery of the visual field may escape the necessary attention; because the spatial resolution in fMRI is still rather limited, neuronal mechanisms are preferably identified in the cortical mantle, and subcortical structures which are involved in the control of spatial attention may not create sufficient neuronal activity to become detectable.

Comment by Professor Alexander Chernorizov (Head of the Department of Psychophysiology, Lomonosov Moscow State University):

Presumably, the intermodal interaction underlying the construction of the complete picture of the world may be fulfilled in the "time domain". It arises from

some counterexamples providing evidence on direct anatomical intermodal interactions: (a) phenomenon of synesthesia; (b) surgically created neural pathways in newborn hamsters that mediated visual pattern discrimination via ascending auditory pathways (Frost et al., 2000, 2002). Investigation into oscillatory brain nets and pacemaker neurons may bring up an answer to this question.

Four: The language trap in the misguided use of nouns

Most likely we are caught in a language trap. Some years ago the neuroscientist Valentino Braitenberg said that if somebody wants to work on “consciousness”, he should not be allowed to use the word “consciousness” for ten years. And this recommendation applies to the majority of terms which are used in psychology. The use of these terms as *nouns* indicates the tendency to “ontologize” neuronal or psychological processes. As the English philosopher Bertrand Russell once remarked: “We are justified in saying that there is thinking. We are not justified, however, in saying further that there is a *thing* which thinks, and that this thing is my mind.” This human tendency to ontologize (“the” mind, “the” attention, “the” self, ...) has catastrophic consequences for our research. Higher activities (as judged from BOLD signals) in circumscribed areas “attract” psychological attributes and interpretations that result in confusion or mental chaos. An example: in well respected journals one can read (in different publications) that the insular cortex represents: negative emotions, interoception, attentional shifts, pain, sex, craving, and time perception (and perhaps others). This does not make sense. This is worse than phrenology 200 years ago.

Comment by Professor Alexander Chernorizov (Head of the Department of Psychophysiology, Lomonosov Moscow State University):

There are the following possible explanations of this issue. Firstly, we deal with complex (integral) brain functions like “attention”, “thinking” etc. Secondly, we haven’t correctly reflexed and formulated classification system of terms (see Question 1). Most likely, the reasons are both 1) and 2).

Comment by Professor Dmitry Ushakov (Head of the Psychology and Physiology of Creativity Lab., Institute of Psychology, Russian Academy of Sciences):

It seems that we are often caught in a language trap in the area of behavioral genetics. We particularly tend to ontologize the heritability of individual differences. Behavioral genetic models often attribute heritability coefficients to different mental abilities or personality traits as if they were their inner properties.

However, terms like “genetic variance” or “environmental variance” are relevant for populations but not for individuals. Heritability or percent of genetic variance can be calculated only if we investigate a population with a given genetic diversity living in given environmental conditions. These concepts are senseless for neurophysiological analysis. Moreover, the conception of environmental variance that is added to genetic variance contradicts the biological view on this problem. Genes encode proteins and the conditions under which the proteins are

produced in the cell. Proteins in turn influence the properties of neural cells, including their properties of proliferation and building networks. Neural networks process information, and their processing capacities seem to depend on neural cells properties.

Environment provides the organism with the tasks to be solved. Neural networks process information to solve these tasks. The functioning of the network requires the expression of genes. Whereas environment provides a purpose for building a neural network or its clusters, genes supply this construction with building blocks. The quality of information processing by a network depends of course on both genes and their environment. But it would be erroneous to conclude that they are added one to the other, as is currently stated in behavioral genetic models. In mathematical terms they are rather multiplied.

A thorough examination reveals the correlates of this biological view on the behavioral level. As was reported at the workshop, increased social requirements for a given type of intellectual behavior are associated with higher heritability of this behavior. This corresponds to the model of “multiplication” of genes by environment, and contradicts the additive model.

Five: The power and neglect of single cases

Important discoveries have been made with single cases. It may have started with the famous “tan tan” case by Paul Broca some 150 years ago. Other cases would be Phineas Gage, HM with his loss of referential memory, the shattered-mind patient of Alexander Luria, or the blindsight patients like DB, GY or FS. Such exploratory studies sometimes lead to tests of hypotheses in confirmatory studies using statistical methods. One gets the impression that psychologists have become blinded by statistics giving more credit to an ANOVA than harvesting unique constellations of phenomena in a patient allowing unique insights into cognitive functions. One of the founders of modern neuropsychology, Hans-Lukas Teuber, used to say that brain-injured patients are unfortunate experiments of nature; on the basis of their brain injuries a specific path of research is opened that allows a better understanding of mental processes. Exploratory single-case studies and confirmatory hypothesis-testing studies should be looked at on an equal level, in a complementary way. My own work has gained a lot from studying in detail single cases as on residual vision or “blindsight” (Pöppel et al., 1973), restitution of function (Pöppel et al., 1978), color vision (Pöppel, 1986) or plasticity or rigidity of representation (Pöppel et al., 1987).

Comment by Professor Alexander Chernorizov (Head of the Department of Psychophysiology, Lomonosov Moscow State University):

Along with “isolated cases”, the investigation of the “mistakes” of the brain’s functioning, such as illusions, can assist in the understanding of brain activities in the norm. So, illusions may serve as a good example of “isolated cases” — as “special cases”.

Comment by Yuliya Zaytseva (Research Associate of Institute of Medical Psychology, LMU; Senior Researcher of Moscow Research Institute of Psychiatry):

The balance between case studies and large samples is currently biased and puts them at a disadvantage within most disciplines. However, the main benefit of conducting a case study lies in the particular details and holistic understanding researchers gain from a specific case.

Six: binding and debinding of functions

Scientific literature is full of contributions on binding (on a neuronal level) or blending (on a conceptual level). But how about “debinding”? Neuroanatomical evidence indicates massive interconnections between distributed neurons. The eminent neuroanatomist Walle Nauta emphasized a minimal distance between neuronal elements, i.e., every neuron in the cortical mantle not being farther away from any other neuron than four synaptic contacts. This strong interconnection requires neuronal algorithms to separate local activities, to “debind” them in order to prevent computational chaos; selective binding is at the same time efficient debinding. And a further question which remains unanswered: What is the binding force which controls binding? Another point: Where there is no strong selective debinding, there is no longer any independence of local activities, with the consequence that, for instance, every perceptual act is always flavored with emotional evaluations or mnemonic components.

Comment by Professor Alexander Chernorizov (Head of the Department of Psychophysiology, Lomonosov Moscow State University):

On the one hand, the answer could lie in the process of formation of synaptic contacts in neuron networks. Examples of approaches to the explanation: a) Connectionist model relying on “Hebb’s synapse” (Kohonen’s networks; vector model of synaptic interaction, offered by E.H. Sokolov; mathematical models of artificial neural networks); b) Time synchronization of activity of different parts of the brain through mechanisms of frequency modulation (rhythms of the brain); c) On the other hand, the selective activation of local synaptic combinations in widely branched neural networks (for example, the problem of selective reproduction of memory traces).

Seven: Explicit and implicit knowledge

It is said that the visual cortex receives much more input from other cortical areas (extrastriate cortex) than from the lateral geniculate nucleus. It has been observed that a lack of direct input from the geniculate nucleus results in blindness, although some residual vision (“blindsight”) has been found in such patients (Pöppel et al., 1973). If the cortical structure is still intact, only lacking direct retinal input, why is blindsight only blindsight? Why should it not be possible to again create conscious vision? As this appears to be almost impossible, the question arises of whether one is forced to conclude that to create states of being conscious, a direct

link to the external world via the sensory channels is necessary. This would apply similarly to the other sensory channels when they are deafferented. This may sound trivial and may support the classical view that nothing is in the mind which has not been in the senses (“Nihil est in intellectu quid non ante fuerit in sensu”; Thomas Aquinas, John Locke). However, is it not also possible that we put too much emphasis on states of being conscious? To always stress the importance of “consciousness” may be over-emphasizing only a partial set of mental activities. Most of the activities usually remain “tacit” or on an implicit level not reaching reportability (Pöppel and Bao, 2011).

Comment by Professor Alexander Chernorizov (Head of the Department of Psychophysiology, Lomonosov Moscow State University):

The cognitive activities of the brain (perception, thinking, consciousness) depend on the prevalence of actual (current) inputs into the neural systems of interpretation. Under “normal” conditions the brain is working under the control of sensory inputs on line. This means of interaction between intact sensory systems and the brain is formed during the pre- and early postnatal development of the nervous system. The restructuring of established sensory inputs alters the properties of the corresponding cortical neurons, even in the adult brain. Some demonstrative examples: experiments by M. Merzenich with cutting sensory afferent fibers innervating the tactile sensitivity of a monkey palm; experiments by Douglas O. Frost et al. (2000, 2002) on newborn hamsters with an artificial, surgically formed afferent path from the retina to the auditory cortex; as a result, the neurons of the auditory cortex exhibited properties of neurons in the visual cortex. Similar experiments were conducted by P. Flourens (1794–1867), a French physician and physiologist by cutting off a cock’s nerves controlling the flexor and extensor muscles. In the absence of intact sensory inputs brain has to work with what is left — with ‘traces of memory’ (e.g., contents of dreams, and experiments with artificial stimulation of the brain). During REM sleep, the mechanisms of consciousness can turn on from time to time in absence of striate cortex activity (so called ‘lucid dreaming’).

Eight: Occam’s razor misunderstood in monocausal explanations

One gets the impression that scientists are often victims of Occam’s razor, i.e., to look always for the simplest explanation. The simplest explanations are monocausal explanations, and these may often be too simple. Possibly, we can adopt the thought pattern of complementarity from theoretical physics. To give just two examples of where this thought pattern would apply: Perceptual processes as reflected in object recognition or face perception are necessarily both bottom-up and top-down; this does not mean that components of the process cannot be just this or that (transduction at the receptor level vs attentional control), but “at the end of the day” they have to come together. Another example of complementarity as a thought pattern can be taken from the nature / nurture debate: There is good evidence for genetic factors, as for the experience of the emotions of pain and pleasure, or of the phonetic repertoire in language; but there is also evidence for the importance of imprinting, i.e., the selection or confirmation of a partial set of

these repertoires in different environments. Here epigenetics enters the field, and one is forced to conclude that it is both, the genetic endowment and the cultural frame, that determine subjective realities. Having said this, it becomes clear that complementarity would not only be a “thought pattern”, but that complementarity is a generative principle for cognitive processes; thus, monocausal explanations would be misleading.

Comment by Professor Alexander Chernorizov (Head of the Department of Psychophysiology, Lomonosov Moscow State University):

The problem addresses the nature of the relationships between a “gestalt” (system) and its “parts”, or in another words, between “system” and “system’s functions”. One can draw an analogy between this problem in the neurosciences and the problem of the relationships between the laws of classical (Newtonian) physics and the laws of quantum physics. For a discussion of the problem, the following its aspects are of special interest: The opposition of the views of A. Einstein (determinism, causality) and the views of N. Bohr (probability is not a “measure of ignorance of real determinants”, but the one of the laws of nature). The ‘uncertainty principle’ formulated by W. Heisenberg. I. Prigogine’s acts on nonlinear dynamics involving terms “chaos”, “bifurcation”, “arrow of time” etc. (in fact, the development of ideas of N. Bohr).

Comment by Artem Kovalev (Student of faculty of Psychology, Lomonosov Moscow State University):

It is possible to reformulate this unasked question into a task: How could we use the system paradigm in psychology? With an increase of complexity and the enhancement of a new organizational level, the amount of the features is increasing. This is called an emergence. I suppose this is a simple rule about which researches usually forget. They start to solve an experimental task, i.e. from cell registration level in the animal brain. Then, they compare spike data from animal cells with human brain functioning. At this level researchers use terms known as general brain functions. The final point of this way is a consciousness problem following the pattern: from simple facts to complementarity. Obviously, there is an attempt to move regularity from one level to another. The elements of which regularity consists are changed, but sometimes researches do not notice it. There are many experiments that possess a strong methodological basis and clear results. How can we integrate many descriptions of reality from different organizational levels? This is a well known question in psychophysics. The psychophysics regularity and fMRI or EEG signals from the same tasks have a strong correlation. In fact, there are substituted data of people providing subjective feedback, and objective data based on the brain activity. How can we argue that activations in different areas or on different frequencies explain our subjective world, our sense of contrast, of colour? “Entia non sunt multiplicanda sine necessitate”, Occam said. So, let us explain the whole psychological reality in simple physiological terms. This is not a progressive way, unfortunately. Therefore, we have to use the maximum extent of criticism, when we extrapolate our results on all levels of the brain.

Nine: Languages used are not neutral with respect to content

A very practical question: Is it true, as is implicitly assumed, that it does not matter in which language scientific thoughts are expressed and experimental results are described? Personal experience shows that this is not a trivial question: I cannot express myself the same way in English as in my mother tongue (German). And publishing together with colleagues whose first language is Chinese or Russian is always a linguistic challenge. It is a great advantage that we can use a common language, but it would be a mistake to believe that the language is neutral with respect to content to be communicated. The language does not only refer to the *way* content is communicated, but also to the *selection* of content itself.

Comment by Professor Alexander Chernorizov (Head of the Department of Psychophysiology, Lomonosov Moscow State University):

It would be interesting to know the opinion of linguists. This problem is closely related to another problem, already reflected upon the scientific mind — the problem of cross-cultural differences in approaches. The most famous opposition here is the opposition between the Eastern and Western styles of thinking.

Other unasked questions:

Ten: Experimental conditions (Are lab experience and real life experience the same?)

Artem Kovalev (Student of Faculty of Psychology, Lomonosov Moscow State University):

The experimental paradigms require the registration of all factors and a strong determination of dependent and independent variables. However, real life has different processes. Investigations in natural conditions are characterized by their low extent of reproducibility. In addition, they are often devoted to unethical themes. In research into deception with using eye-tracking technology, there are no questions about unfaithfulness or burglary. Usually, the question batteries are very simple and neutral. The results show that strong indices in eye-movement or pupil diameter in these laboratory experiments are not detected. The example from my own experience: subjects in a CAVE virtual reality system perform the same task differently compared to subjects in front of PC monitors. What do we study? Real people or real people in experimental rooms? L. Vigotsky noted that psychology must pay more attention to practical tasks. This is a very important methodological remark. In my opinion, usability development confirms his words well. Although marketing studies are far from scientific ideals, the fact of their existing is an alarm bell for academic psychology. Maybe, it is time to round psychologists, their intellectual potential, and devices toward practical real tasks on town streets, carrier decks and sport stadiums. Perhaps, we have to direct our efforts to optimization experimental schemes and the reduction of extraneous factors.

Eleven: Cultural influences on brain functioning, and does brain activity manifest simultaneous actualization of individual experiences?

Alexey A. Sozinov (Researcher at the Shvyrkov's Lab. Neural Bases of Mind, Institute of Psychology, Russian Academy of Sciences):

Recent discoveries in cultural and social neuroscience are of importance. On the one hand, cultural differences in functional neuroanatomy are not national, but correlate with individual traits that are also variable within cultures (Han et al., 2013). On the other hand, such differences are often derived from the diversity of teaching methods (Tang et al., 2006) and other cultural factors of personal history. One of the unused answers in this field is that brain activity manifests simultaneous actualization of individual experiences, acquired at consecutive stages of learning and development (Shvyrkov, 1990) — which is based on the definition of function devoid of uniform localization or ontologization (Anokhin, 1974; see also Forbes, Grafman, 2013; Luria, 1976). Contemporary research methods reveal implicit social interactions (Yun et al., 2012), brain synchronization during common happenings (Nummenmaa et al., 2012), etc. Considering the implementation of systems theory in an evolutionary view of culture and “complementarity of cultures” (Alexandrov, Alexandrova, 2007), we may assume that an individual is too close-bodied for a function. A function is not confined to an individual. An issue that may further address an unasked question is whether “brains can work together” is not just an inspiring metaphor.

Twelve: Highlighted questions in the specific field: visual illusions phenomenon.

Professor Galina Ya. Menshikova (Head of the Department of Perception, Lomonosov Moscow State University):

One of the interesting phenomena of visual perception is that of visual illusions. It provides researchers with important insights into the rules of visual system processing. Although visual illusions have been investigated for more than 150 years, their causes remain poorly understood. There are numerous questions which may help us better understand the problems of perception of visual illusions.

One of them is the question of the classification of illusions. Several different types of its taxonomy have been proposed, based on neurophysiological and psychological mechanisms of illusion formation (Coren, Girgus, 1978), rules of “appearances & kinds of causes” coupling (Gregory, 1997), or predictions of future movements of the observer (Changizi et al., 2008). Currently there is no generally accepted classification of visual illusions. The question arises as to whether *brain-activity data can be used as an appropriate basis for the classification of visual illusions?*

Another question concerns the problem of temporal processing of visual illusions. Visual illusions (except after-effects and ambiguous figures) are considered to be stable phenomena forming within 100-150 ms and perceived without any changes over time. However, in some cases their perception is pronounced at a

glance, and in other cases the illusion pattern should be considered within a longer period of time to notice an illusory effect. Furthermore, some empirical data show that long-term observation of illusion patterns leads to a reduction of illusion strength. As visual illusions are significantly variable in the time domain, the question arises: what is the “temporal window” for illusion strength measurements?

Another issue concerns the use of the mono/multicausal principle of the explanation of the illusion formation. Most previous studies have focused on a single mechanism underlying illusion perception. However, in a number of works the integration of different mechanisms has been suggested to explain the results. So the multicausal explanation should be applied, i.e. bottom-up and top-down processes should be considered to describe the process of illusion perception. Accordingly, the question arises concerning the binding rules of different mechanisms underlying the illusion perception.

It is possible to solve some of the listed problems using modern technology, possessing a number of advantages against traditional methods (Zinchenko et al., 2010). Lately, virtual reality systems were applied successfully to investigate 3D visual illusions. This technology allowed the creating and presenting of patterns of 3D illusions within a wide (near 180 °) field of view to find out the role of disparity and eccentricity cues in illusion perception.

Thirteen: The Sense disambiguation in polysemous words.

Professor Vera Zabotkina (Vice Rector of Russian State University of the Humanities):

In response to the unasked question number 9 that Ernst poses regarding “selection of the content communicated by the language”, I would like to pose another unasked question. It has to do with sense disambiguation in polysemous words.

Resolving polysemy has always been and remains one of the key issues both in traditional semantics and in cognitive semantics. In cognitive semantics a polysemous word is interpreted as a mental structure resulting from the complex nature of human experience, and our understanding and interpretation of it.

We are trying to address the question of polysemy resolution in our paper “Cognitive Modelling of sense disambiguation in polysemous words” with my post-doctoral student Elena Boyarskaya. We put polysemy, studies into the broader context of research in mental lexicon, conceptual priming and probabilistic conceptual modelling. We adopt a novel approach to the resolution of polysemy and put it to an empirical test. We argue that priming plays a key role in the activation of an adequate meaning of a polysemous word. Mental structure, represented by a prime lexical unit, contains relevant conceptual information about the target polysemous word. Since most words in natural languages are polysemous, we may assume that every word has a complex mental representation associated with it. This complex mental structure presents a combination of cognitive contexts which store information about all types of situations of words we use, real or potential participants, their actions, the sequence of these actions, etc. Thus, a cognitive context is a men-

tal phenomenon of a complex nature. Cognitive contexts are not static properties; they reflect the dynamic character of human cognition as such.

We employ the method of conceptual modelling of the mental lexicon to reconstruct the process of the formation of certain fragments of cognitive context related to perception, processing, storage and retrieval of information linked to particular senses of a polysemous word.

Special attention should be paid to culture-specific cognitive context, which includes information about the cultural specificities of the situation that the meaning of a polysemous word is associated with. This is a kind of knowledge that is characteristic of a particular community sharing the same physical and social environment.

Thus, returning to unasked question number 9 that Ernst poses, we can say that the “selection of the content communicated” by a polysemous word depends on the cognitive context triggered by the prime.

Fourteen: Vygotsky- Luria school traditions and postnonclassical perspective in clinical psychology research.

Professor Yury Zinchenko (Dean of the Faculty of Psychology and Chair of Department of Methodology of Psychology at Moscow State University, Corresponding member of the Russian Academy of Education).

The present state of affairs (in general science, and clinical psychology, in particular) provides an illustrative example of the increasingly differentiated structure of scientific knowledge. The state is characterized by the marked ‘methodological liberalism and pluralism’, shaping in plenty various theoretical and applied branches of the science. Under certain conditions the increase in methodological pluralism may be regarded as a sign of crisis (L. Vygotsky, 1997). Hence, the issues of methodological reflection come to the foreground of scientific endeavors.

In recent times the Russian psychology has witnessed repeated attempts of methodological analysis of psychological accomplishments with conducted on the basis of a widely-known classification of the types of scientific rationality, suggested by V.S. Styopin. The classification provides grounds for designation of the following types (and stages) in development of scientific knowledge: classical, nonclassical and postnonclassical (Styopin, 2003, 2011; Zinchenko, 2011; Zinchenko & Pervichko, 2012, 2013, etc.).

V.S. Styopin suggests the following criteria for the types of rationality: 1) distinctive features of a systemic organization of investigated objects and different types of world view; 2) certain distinctions of means and operations of activity, represented in ideals and norms of a science; 3) peculiar values and purposes of the subject and their reflectional assessment, expressed in specificity of philosophical foundations of the scientific world view (V. Styopin, 2003). To study objects represented in elementary systems the means of classical science will suffice; non-classical science should operate with self-regulating systems, and postnonclassical science may cope with complex self-developing systems (V. Styopin, 2003).

In accordance with the theoretical principles of postnonclassical model of scientific rationality, the research object of clinical psychology is an open self-developing

system, capable of selecting the aims and purposes of its development and the criteria for their achievement and of reestablishing its parameters, structure, and other features within the course of development. These characteristics imply a methodological scheme of research, congruous with the complexity of the object.

Psychological syndrome analysis (Vygotsky-Luria school), as a system of principles for conducting a study and interpreting its results, is in tune with the epistemological multiplicity and complexity of the subject of clinical psychology, considered from the perspective of the postnonclassical academic view.

It was shown in our studies that the applying modern philosophical concepts which allow distinguishing between types of scientific rationality (classical, non-classical and postnonclassical) might be used for psychological field analysis in its historical evolution establishment and further development. Moreover, all this brings an opportunity to define theoretical and methodological principles of the clinical psychology functioning and development (Zinchenko & Pervichko, 2012; Zinchenko, Pervichko & Martynov, 2013).

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Verbal working memory: magnetic resonance morphometric analysis and a psychophysiological model

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Neuropsychological characteristics of verbal working memory (memory capacity, permanency, and different types of memory errors) of 43 healthy subjects of older age were compared with the anatomical characteristics of their brain structures (volume of the hippocampi and the caudate nuclei, size of the cingulate-cortex regions of both hemispheres). The obtained data demonstrate a correlation between the permanency of verbal-information maintenance and left caudate-nucleus volume and a positive correlation between associative-memory capacity and left hippocampus volume. A decline in the number of verbal-memory errors (confabulations) is related to the increased size of the left anterior cingulate cortex. Furthermore, verbal working-memory capacity and permanency correlate negatively with the size of the left posterior dorsal cingulate cortex, whereas the number of fluctuations and word replacements correlate positively with the increased size of this brain region. We suggest a psychophysiological model of verbal-stimulus maintenance in working memory based on the results of our study and published research data.

Keywords: magnetic resonance morphometric analysis, working memory, verbal memory, caudate nucleus, cingulate cortex, hippocampus, working-memory model

Neurophysiological mechanisms of verbal information processing are traditionally related to the functioning of the temporal cortex of the left hemisphere of the brain. This hypothesis is supported by the fact that a lesion in this brain region usually causes trouble in speech perception, as well as other problems with audio-verbal information processing, including severe verbal-memory impairment. However, the temporal cortex is not the only brain structure that takes part in this cognitive process; moreover, from all appearances, verbal memory is related to the combined functioning of several brain regions.

It has been revealed that verbal memory is related to the hippocampus, which is a part of the limbic system of the brain. According to the results of fMRI studies, the hippocampus is activated during the performance of verbal-memory tasks. Furthermore, it is activated more frequently in the stage of information retrieval than in the stage of its consolidation (Karlsgodt, Shirinyan, van Erp, Cohen, & Can-

non, 2005). Abnormal activation of this brain structure is seen in patients with multiple sclerosis (Sweet, Rao, Primeau, Durgerian, & Cohen, 2006) and epilepsy (Campo et al., 2009). Also, hippocampus size is related to verbal-memory capacity in patients with epilepsy (Kalviainen et al., 1997) and Alzheimer's disease (de Toledo-Morrell et al., 2000).

Furthermore, an important role in verbal-memory functioning belongs to the cingulate cortex, which is also a part of the limbic system along with the hippocampus. For example, some studies show that the anterior cingulate cortex is involved in the process of semantic coding in verbal working memory (Kaneda & Osaka, 2008). Also, the posterior cingulate cortex activates recognition of familiar words, objects, and places (Sugiura, Shah, Zilles, & Fink, 2005; Heun et al., 2006).

Some studies also show that the caudate nuclei activate during the functioning of working memory (Hart et al., 2013; Moore, Li, Tyner, Hu, & Crosson, 2013). Lesions in this structure in humans result in working-memory impairment (Partiot et al., 1996).

Recent studies of different brain regions involvement in cognitive processes use magnetic resonance morphometric analysis. For example, some studies show that the size of the hippocampus and its subdivisions correlates with memory processes (Kozlovskiy, Sozinova, Skvortsova, & Vartanov, 2009; Maguire, Woollett, & Spiers, 2006; Vartanov, Kozlovskiy, Skvortsova, & Sozinova, 2009). It has also been demonstrated that reduced hippocampus size in elderly people is accompanied by verbal-memory decline (Hackert et al., 2002). Moreover, anterior hippocampus volume is related to delayed verbal memory, whereas posterior hippocampus volume is associated with spatial memory (Chen, Chuah, Sim, & Chee, 2010). Decreased size of the hippocampus and the amygdala is found in close relatives of schizophrenia patients, who also tend to have trouble with delayed verbal memory while immediate verbal memory remains intact (O'Driscoll et al., 2001).

Far less is known about the correlation between the size of different cingulate-cortex regions and verbal-memory processes. Some studies show that anterior cingulate-cortex atrophy, such as in Alzheimer's disease, can cause severe confabulations (Lee et al., 2009); anterior cingulate-cortex atrophy is also seen in schizophrenics, who suffer from memory errors, such as confabulations (Choi et al., 2005; Koo et al., 2008; Mitelman, Shihabuddin, Brickman, Hazlett, & Buchsbaum, 2005). According to some studies, an increase in several areas of the cingulate cortex correlates with a decrease in the number of errors in memory tests. However, a decrease in the number of errors not only does not improve overall memory performance but actually tends to deteriorate total recall (Kozlovskiy, Vartanov, et al., 2012; Kozlovskiy, Velichkovsky, et al., 2012).

According to some studies, a decrease in caudate-nuclei volume leads to a decline in performance on most verbal and visual memory tests, mostly because of a decline in cognitive control (Bartrés-Faz et al., 2002; Kozlovskiy, Skvortsova, Sozinova, Vartanov, & Nikonova, 2010).

However, such morphometric studies usually compare working-memory processes with a single brain structure, whereas, as demonstrated above, verbal-memory functioning is defined by simultaneous activation of several brain structures. In the present study we explored the relationship between the sizes of a range of brain structures (the hippocampus, the caudate nuclei, and the cingulate cortex)

and different aspects of the verbal-memory process. We used neuropsychological memory tests to assess a variety of verbal-memory properties, such as verbal-memory capacity and permanency and different types of verbal-memory errors. Neuropsychological methods also allow comparison of the received data with the results of other studies. The present study included healthy elderly subjects, which provides valuable information, due to the fact that the individual anatomical and psychological differences become even more expressed in older age.

Method

Participants

Participants in the study were 43 right-handed women (the mean age was 60.4 +/- 16.6 years) with no previous brain trauma, strokes, psychological or neurological diseases.

Procedure

The study consisted of two parts, an MRI study and a neuropsychological assessment.

During the MRI study all participants were scanned on a 3.0 MRI scanner; T1 three-dimensional images of the brain were obtained. On standardized sagittal slices of the images in each direction we highlighted the relevant areas, which included the left and right hippocampus, and measured their volumes (in mm³). We also calculated the volume of the left and right caudate nucleus. Furthermore, we highlighted relevant areas, including the cingulate cortex of both hemispheres. In each hemisphere we divided the cingulate cortex into three regions—anterior (Brodmann areas 24, 33), posterior ventral (Brodmann area 23), and posterior dorsal (Brodmann area 31). Then we calculated absolute squares of the surfaces of all highlighted cingulate-cortex regions (in mm²).

The neuropsychological part of the study included Luria's neuropsychological assessment of cognitive processes as modified by Glozman (1999) to allow quantitative analysis of memory processes. The following tests were used to assess the verbal working-memory process: immediate and delayed recall of 10 words, two groups of words and sentences, semantic coding (memorizing 12 words by including them in random sentences and recalling them in 10 minutes of heterogenic interference), associative memory tests (memorizing pairs of words, recall of the second word after hearing the first one). For each memory type we defined memory capacity (total of recalled elements), permanency (total of delayed recall), and the number of memory errors. We separated several kinds of errors, such as replacement of one element with another one, confabulations (including new elements), contaminations (mixing several elements), perseverations (recalling a single element more than once), and sequence errors.

Obtained data were statistically analyzed by calculating nonparametric correlations (Spearman correlation coefficient) between individual behavioral and anatomical measurements. Further analysis included only statistically significant correlations ($p < 0.05$).

Results

The obtained data revealed significant correlations between various neuropsychological aspects of verbal working memory and the anatomical characteristics of several brain structures.

Table 1 shows significant correlations between the size of different brain structures and the capacity and permanency of verbal working memory.

Table 1. Significant correlations between the size of brain structures and the capacity and permanency of verbal working memory

Brain structures	Recall of 10 words			Recall of 2-word or 2-sentence groups
	Memory capacity	Memory permanency	Instant memory capacity	Memory permanency
Left caudate nucleus	—	0.39	—	0.38
Left posterior dorsal cingulate cortex	–0.35	–0.33	—	–0.31

According to Table 1, verbal-memory capacity correlates negatively with the size of the left posterior dorsal cingulate cortex. Thus, an increase in the size of this brain region leads to a decline of verbal-memory capacity. Verbal-memory permanency correlates positively with the volume of the left caudate nucleus, whereas its correlation with the left posterior dorsal cingulate cortex is negative both for the recall of 10 words and for the recall of two groups of verbal stimuli.

Table 2 indicates significant correlations between the size of several brain structures and the number of different types of verbal-memory errors in the neuropsychological tests.

Table 2. Significant correlations between the size of brain structures and the number of verbal-memory errors

Brain structures	Recall of 10 words		Recall of 2-word or 2-sentence groups	
	Fluctuations	Replacement of words	Replacement of words	Contaminations of stimuli groups
Left caudate nucleus	—	—	—	–0.31
Left posterior dorsal cingulate cortex	0.46	—	0.32	—

Table 2 shows that the size of the left posterior dorsal cingulate cortex correlates positively with the number of fluctuations during the 10-word recall and with the number of word replacements during the recall of the two stimuli groups. Thus, an increase in the size of this cingulate-cortex region is related to an increase in the number of these verbal-memory errors. Fewer contaminations of stimuli groups are related to an increase in the size of the left caudate nucleus.

Table 3 shows the significant correlations between the sizes of several brain structures and different characteristics of associative memory.

Table 3. Significant correlations between the size of brain structures and the characteristics of associative memory

Brain structures	Associative-memory test	Semantic-coding test		
	Memory capacity	Memory capacity	Semantic errors	Confabulations
Left hippocampus	0.31	—	—	—
Left anterior cingulate cortex	—	—	—	–0.35
Left caudate nucleus	—	0.31	—	—

According to Table 3, the size of the left hippocampus correlates positively with associative-memory capacity. Moreover, an increase in the size of the left caudate nucleus is related to increased memory capacity on the semantic-coding test, whereas an increase in the size of the left anterior cingulate cortex leads to a decrease in the number of confabulations on the same test.

Discussion and Conclusions

The results of the present study demonstrate significant correlations between the anatomical characteristics of different brain structures and the ability to maintain a trace in verbal working memory. However, these correlations vary for different memory characteristics and brain structures.

According to our data, the volume of the caudate nucleus in the left hemisphere correlates with the permanency of maintaining verbal information after the introduction of interfering stimuli in different memory tests, but it does not correlate with verbal-memory capacity. Thus, we can suggest that the role of this brain structure in verbal memory is to resist external interference. In order to permanently maintain a trace in verbal memory, the influence of external sensory interference should be decreased. Furthermore, other studies show that lesions or malfunctioning of the caudate nuclei in rats (Döbrössi, Svendsen, & Dunnett, 1995) and humans (Partiot et al., 1996) leads to trouble in delayed-reaction tests, which require the functioning of working memory. Moreover, working-memory dysfunctions related to trouble in the selection of relevant information and the suppression of irrelevant information are registered in various diseases, which lead to caudate-nuclei lesions. For example, working-memory dysfunctions are noted in patients with Parkinson's disease (Lewis, Slabosz, Robbins, Barker, & Owen, 2005) and Huntington's disease (Lawrence, Watkins, Sahakian, Hodges, & Robbins, 2000), as well as in patients with Tourette's, ADHD, and schizophrenia (Keri, 2008; Ross, Harris, Olincy, & Radant, 2000). Our data correspond well with the model of information maintenance in the working memory created by Ashby, Ell, Valentin, and Casale (2005). According to this model, which is called FROST, there is an activation loop between the prefrontal cortex, the caudate nuclei, the globus pallidus, and the thalamus (FROST is an abbreviation for FRONTAL–Striatal–Thalamic). The authors of the model suggest that this loop is responsible for trace maintenance in working memory. However, this model does not account for differences in the functions of

the prefrontal cortex and the basal ganglia in the working-memory process. According to some studies (Awh & Vogel, 2008; Koziol & Budding, 2009), during the working-memory process the prefrontal cortex supports the activation level and the attention focus on the relevant information, while the basal ganglia—for example, the caudate nuclei—provide information filtration, selection of relevant stimuli, and suppression of irrelevant ones. This filtration is possible because the caudate nuclei suppress the thalamic nuclei through the globus pallidus, while the thalamic nuclei allow the entrance of sensory information into the brain. It is known from the literature that the left and right caudate nuclei have slightly different functions. For example, a lesion in the left caudate-nucleus head leads to impairment of verbal working memory, whereas a lesion in the right caudate nucleus results in visual-memory decline (Buklina, 1999; Kumral, Evyapan, & Balkir, 1999). Our data also support inter-hemispheric asymmetry in caudate-nuclei functioning. We suggest that a better-developed left caudate nucleus, which receives a signal from the prefrontal cortex, more effectively suppresses the left thalamus, which allows the entrance of verbal information into the left hemisphere. As a result, the impact of external sensory interference is slightly less, and, in turn, the permanence of verbal-information maintenance is increased.

The obtained data also demonstrate a relationship between the sizes of different cingulate-cortex regions and the characteristics of verbal working memory. Furthermore, different cingulate-cortex regions probably have different functions in this cognitive process. Thus, according to our data, the left anterior cingulate cortex is related to resistance to confabulations in the semantic-coding test. We suggest that the role of the left anterior cingulate cortex in verbal-memory functioning is to suppress irrelevant information and to resist internal semantic interference. This hypothesis is supported by the results of other studies. If the anterior cingulate cortex is seen as the “noise”-suppression system, it becomes clear why this structure is activated in most tasks that require the filtration of irrelevant information. This role of the anterior cingulate cortex also applies to information recall because this process includes filtering and denying false and uncertain memories, imagination, and so forth. Such filtering explains anterior cingulate-cortex activity in information recall from working memory (Schöning et al., 2009), verbal-declarative memory (Bremner, Vythilingam, Vermetten, Vaccarino, & Charney, 2004), spatial memory (Teixeira, Pomedli, Maei, Kee, & Frankland, 2006), episodic memory (Herrmann et al., 2001), and emotional memory (Tang et al., 2005). The role of information filtering and resistance to internal interfering stimuli is also highlighted in the inhibitory-control theory of Kane and Engle (2000). According to this theory, proactive interference has an influence on total working-memory capacity, while smaller capacity leads to the greater influence of interference on task results. Despite these facts, the ability to resist interference depends not only on memory but also on inhibition—that is, on the mechanism that suppresses irrelevant information (Conway, Cowan, & Bunting, 2001). However, the authors of the inhibitory-control theory did not account for the neurophysiological data and did not propose any hypothesis about the role of different brain structures in interference-resistance processes.

According to our data, the size of the left posterior dorsal cingulate cortex correlates negatively with verbal working-memory capacity and permanency. It also

correlates positively with the number of different memory errors. We suggest that the role of this brain region is to subtract relevant information and to receive a “signal” from the informational “noise.” This hypothesis explains some results of other studies, such as those regarding the activation of the posterior cingulate cortex during the recognition of familiar words, objects, or places (Heun et al., 2006; Sugiura et al., 2005).

The results of our study also revealed positive correlations between hippocampus volume and associative-memory capacity. However, these correlations are present only for the left hippocampus. This fact corresponds well with the results of other studies. For example, hippocampus lesions in rats lead to associative-memory impairment (Peinado-Manzano, 1994). A decline in associative-memory functioning is found in patients with Alzheimer’s disease, as well as in normal aging, which leads to a decrease in hippocampal volume (Atienza et al., 2011). Associative-memory decline in patients with mild cognitive impairment is related to atrophy of the left anterior hippocampus or to hypoactivation (Hanseeuw et al., 2011). Recent fMRI data show that different working-memory processes are provided by the functioning of several brain structures, but hippocampus activation is revealed particularly in associative-memory tasks (Hales & Brewer, 2010).

To summarize, information processing, classification, and cataloging are important parts of trace maintenance in verbal working memory. According to the obtained results, along with the data in the literature, this process is provided by such structures as the left posterior dorsal cingulate cortex and the left hippocampus. Our suggestion of the significance of information classification is partly in line with the SIMPLE memory model (Brown, Neath, & Chater, 2007; Hulme et al., 2006). According to this model, the speed of the retrieval of objects from memory depends on the amount of the specific qualities of that object. Thus, the more specific qualities the object has, the faster it is retrieved. However, this model explains only free retrieval, not sequence recall (Lewandowski, Brown, Wright, & Nimmo, 2006; Nimmo & Lewandowsky, 2005). Along with the inhibitory-control theory, the SIMPLE model was not connected to any neurophysiological data.

Therefore, according to the obtained results and the experimental data described in the literature, trace maintenance in working memory appears to be a more complex process than those described in existing working-memory models. The FROST model emphasizes the role of the fronto-striato-thalamic interaction in the signal-maintenance process in working memory (Ashby et al., 2005); the inhibitory-control theory (Kane & Engle, 2000) points out the significance of internal, proactive interference resistance; the SIMPLE model (Brown et al., 2007; Hulme et al., 2006) demonstrates the significance of signal amplification by subtracting specific characteristics of the recalled object; and, finally, Baddeley’s working-memory model (2003) revolves around the control block, the so-called central executive.

We suggest the following psychophysiological model of verbal-information maintenance in working memory. In our opinion, this model, on the one hand, conforms to the results of our study and, on the other hand, is consistent with experimental data from other studies described in the literature. Moreover, our model combines already-existent memory models. Thus, we hypothesize that verbal-information maintenance in working memory is provided by the functioning of five subsystems:

1. Sensory filter: partial blocking out and filtering of extrasensory information at the moment of information maintenance in memory. This blocking function is probably related to the activity of the left caudate nucleus, which slows down the thalamic nuclei (responsible for the entrance of sensory information into the left hemisphere of the brain) through the globus pallidus.
2. Sensory screen: temporary verbal-information storage, from which the information is directed to the other subsystems for processing.
3. Semantic filter: suppression of internal interference, such as other stimuli, thoughts, associations, attention fluctuations. This subsystem functioning is probably related to the activity of the left anterior cingulate cortex.
4. Central executive: voluntary control over incoming information according to the present task. The central executive plays an important part in controlling sensory and semantic filters and the sensory screen. Generally, this block is similar to Baddeley's working-memory block of the same name. Presumably, its functioning is related to the activity of the left prefrontal cortex.
5. Archiver: information processing (collection, classification, cataloging) for long-term storage. This processing consists of the creation of associative links. The maintained information is transferred to long-term memory from this block. Supposedly, this subsystem functions because of the activity of the left posterior cingulate cortex and left hippocampus.

Figure 1 describes the psychophysiological model suggested above.

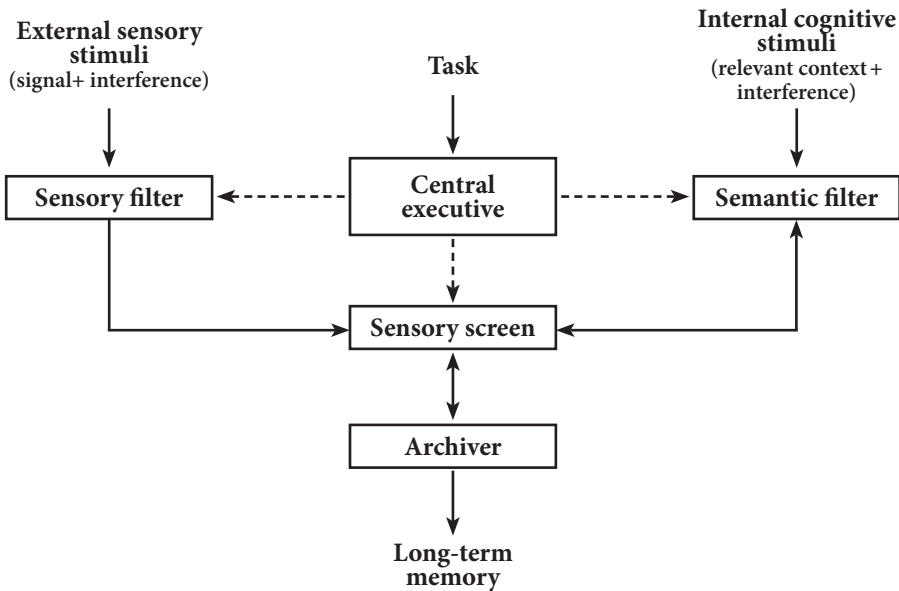


Figure 1. Psychophysiological model of verbal-information maintenance in working memory

It is necessary to point out several limitations of the proposed working memory model. Firstly, it describes only the maintenance of a verbal stimulus in working memory and does not concern information input and primary processing or the retrieval of information in working memory, the role of emotions and functional state, and so forth. Secondly, the present working-memory model was the basis for choosing the data in the verbal working-memory tests in the first place. This sequence probably explains the fact that the results of our study include correlations of working-memory test results only with the left hemisphere brain structures. We can hypothesize that the present model can also be applied to nonverbal stimuli maintenance in working memory, but this statement requires further research.

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Peculiarities of brain electric activity in young males and females of different creativity levels

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This article shows that the peculiarities of divergent and convergent thinking in young males and females of various creativity levels are stipulated by a definite EEG frequency-and-spatial arrangement. Young males and females of mixed and left lateral arrangement profiles demonstrate an expressed activity of occipital, central, and temporal areas of both cerebral hemispheres. In young males and females of right LAP (lateral arrangement profile), connections are clearly localized in case of solution of both convergent and divergent tasks. Solution of divergent and convergent tasks may condition certain frequency-and-spatial arrangement of EEG in young males and females with different levels of academic progress and a different lateral arrangement profile (LAP).

Key words: creativity, lateral arrangement profile (LAP), intrahemispheric and interhemispheric coherent connections, convergent tasks, divergent tasks, academic progress, gender.

1. Introduction

The problem of brain mechanisms in creative thinking is among the most prominent in modern psychophysiology (Bekhtereva, 2006; Volf, Razumnikova, 2009, 2010; Fink, 2010; Mihov, Denzlerb, Försterb, 2010; Zenasni, Lubarta, 2011, etc.).

There are currently quite a number of investigations devoted to the peculiarities of interhemispheric action, and the specific roles played by each hemisphere in creative thinking and individual diversities (Razumnikolva, 2001; Hoppe, 1988; Zenasni, Lubarta, 2011, etc.). Some other investigations show the role of the prefrontal areas in both hemispheres, the frontal and temporal areas in the right hemisphere, the occipital zone in the left hemisphere, the parietal and central areas in both hemispheres, and the frontal temporal areas in both hemispheres in verbal and non-verbal creative thinking (Bekhtereva, 2006; Volf, Razumnikova, Bryzgalov, 2010, etc.).

The existing data on the roles of the right and left brain hemispheres in creative thinking are rather contradictory: on the one hand, the right hemisphere is involved in creation in divergent thinking (Razumnikolva 2001, 2009; Shamay-Tsoorya, Adlera, Aharon-Peretz, Perrya, Mayseless, 2011, etc.); on the other hand, the activation of the right cortex is also possible in convergent thinking (Hoppe, 1988).

There is also data from many researchers indicating a closer interhemispheric integration and a less expressed brain asymmetry in creative individuals.

The topicality of studying the professional behavior of the personality, specifically its creative potential, development and formation mechanisms, has greatly increased under the conditions of the economy of Russia (Barysheva, 2006; Guselnikova, 2008; Petrova, 2009, etc.).

However, there are practically no investigations concerning specific brain mechanisms (EEG correlates) in people of different creativity levels, and concerning their connection with individual typological peculiarities.

The objective of this investigation is to study brain electric activity peculiarities in young males and females of different creativity levels in solving cognitive tasks.

2. Subject and research methods

2.1 Subject of research

The subject under examination is the frequency-and-spatial EEG characteristics in young males and females of different creativity levels and lateral arrangement profiles (LAP) in the solution of cognitive tasks.

The test group included 2nd to 5th year students of the Southern Federal University majoring in humanities: 190 people aged between 18 and 23, among them 93 males and 97 females. In accordance with the above objective, all the test subjects were subdivided into smaller groups depending on creativity level, academic performance level, lateral arrangement profile (LAP), and gender. The grouping was done after a number of psychological and psychophysiological methods were applied to the test subjects.

2.2. Research methods

Research methods: literature analysis, psychological tests, talks, method of electroencephalography (EEG), expert evaluation method.

Psychodiagnostic methods. Guilford methods in the Tunik modification (to diagnose verbal creativity) and Torrance picture completion test (to diagnose non-verbal creativity); T.A. Bragina and N.N. Dobrokhotova's functional interhemispheric asymmetry profile determination methods.

To diagnose non-verbal creativity, a brief version of the Torrance test was applied, modified at the ability diagnostics lab of the Psychology Institute of the Academy of Education of Russia by A.N. Voronin. The short version of the Torrance test is a set of 6 pictures with a certain number of elements which are to be used by the test subject to complete the picture, so that it can finally become a sense-bearing image (see Fig. 1).

The test enables the following creativity factors to be determined:

- originality (Or), i.e. non-likeness of the given picture to the pictures created by other test subjects, i.e. statistical infrequency of the reply;
- uniqueness (Un), i.e. singularity of the given picture type in the whole series.

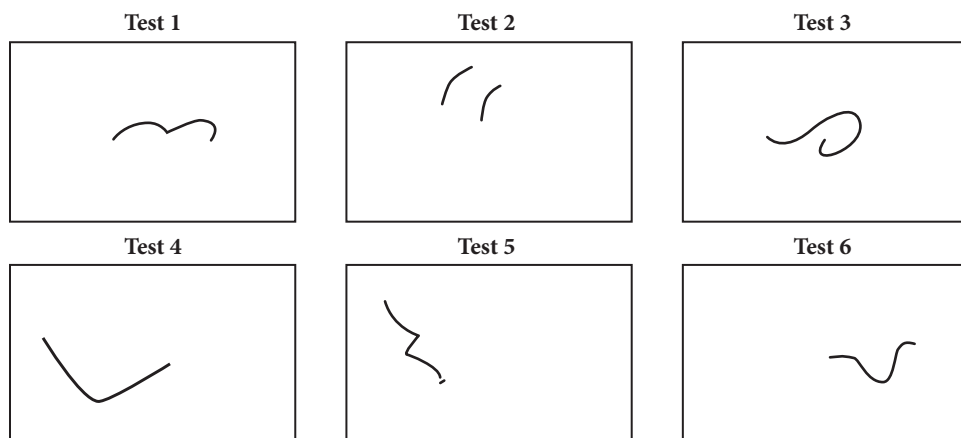


Figure 1. Example of test material

As the results obtained after the data from all the test subjects had been treated, these results could be resolved into the following three groups.

Group 1: persons demonstrating a low level of non-verbal creativity; results lower than the originality level $Or \leq 0.48$, uniqueness level $Un = 0.5$;

Group 2: persons demonstrating a middle level of non-verbal creativity; results within the following limits: originality level $0.48 < Or \leq 0.76$, uniqueness level being $0 < Un \leq 2$;

Group 3: persons demonstrating a high level of non-verbal creativity; results exceeding the originality level $Or > 0.76$, uniqueness level being $Un > 2$.

To diagnose verbal creativity, the investigation applied the J. Guilford method in the Tunik modification.

After the results obtained after the data from all the test subjects had been treated, these results could be resolved into the following three groups:

Group 1: persons demonstrating a low level of verbal creativity; results lower than the originality level $Or \leq 0.81$, uniqueness level $0 < Un \leq 2$;

Group 2: persons demonstrating a middle level of verbal creativity; results within the following limits: originality level $0.82 < Or \leq 0.93$, uniqueness level being $2 < Un \leq 5$;

Group 3: persons demonstrating a high level of verbal creativity; results exceeding the originality level $Or > 0.94$, uniqueness level being $Un > 5$.

T.A. Bragina and N.N. Dobrokhotova's functional interhemispheric asymmetry profile determination methods. The said methods comprise a number of questions and assess motor asymmetry (hand, foot) and sensor asymmetry (ear, eye) with a further determination of the profile: right, left, mixed, ambidextrous.

Psychophysiological methods. The investigation applied the EEG (electroencephalography) method. EEG recordings were carried out according to international standards 10–20%, in line with the standard procedure of registering EEG background, eye-opening and eye-closing tests. To register brain electric activity, 21 electrodes were used, a monopolar scheme with ipsilateral ear referents.

2.3. Research procedure

Investigation procedure description. All those who took part in the investigation were subdivided depending on gender, lateral arrangement profile (LAP), and academic progress level. According to LAP, the test subjects were subdivided into those representing left, right, and mixed LAP. They were subdivided according to academic progress level into high progress, moderate progress, and low progress.

Before the EEG examination started, the test subjects were instructed on how to accomplish the verbal and non-verbal tasks. Four types of tasks were used in the investigation:

- verbal convergent (remembering proverbs on a specific topic);
- verbal divergent (inventing one's own original proverb, or a free creative search task);
- non-verbal convergent (making a drawing on a definite topic out of the offered geometric figures, e.g. a circle, a square, a triangle, of the Tunik test);
- non-verbal divergent (making one's own drawing out of the offered geometric figures, e.g. a circle, a square, a triangle, of the Tunik test, or a free creative search task).

The above tasks were presented during EEG recording. EEG was also marked at the beginning and end of the presentation; also registered was the signal 'test subject's reply' if this person was ready to give a reply. Test subjects' replies to verbal tasks were recorded in the study protocols, while replies to non-verbal tasks were drawn by the test subjects themselves after the 'reply' signal. Also, while EEG was being recorded, the test subjects were offered background tests (EO — eyes open, EC — eyes closed). All the documented data on each test subject were assessed according to the factors of velocity, flexibility, originality, productivity, and a complex factor of creativity, which permitted the test subjects to be subdivided into high creativity, average creativity, and low creativity.

After this, the EEG data was analyzed. In our investigation we used the mean time spent by the test subject to solve each given task. The said time was the lapse between the end of the task presentation and the 'reply' signal given by the test subject.

Each functionally relevant EEG period underwent a spectral and a coherent analysis within the frequency ranges: theta1 (4.0–6.0 Hz), theta2 (6.0–8.0 Hz), alpha1 (8.0–10.5 Hz), alpha2 (10.5–13.0 Hz), beta1 (13.0–24.0 Hz), and beta2 (24.0–35.0 Hz).

Mathematical treatment of the data was carried out with mathematical statistical methods: T-test for independent samples, ANOVA/MANOVA analysis of variance, post hoc analysis. Treatment was done with the help of the STATISTICA 6.0 computer program pack.

3. Results of research

Results. Irrespective of frequency range, it was stated that highly creative young males and females demonstrate the highest (by value) coherent connections in parietal, temporal, and frontal brain areas; for young males and females of right LAP, those were the frontal and temporal areas of the left hemisphere, and for those of left LAP and mixed type in the right or left hemisphere in the solution of divergent tasks in the appropriate brain areas (see Fig. 2).

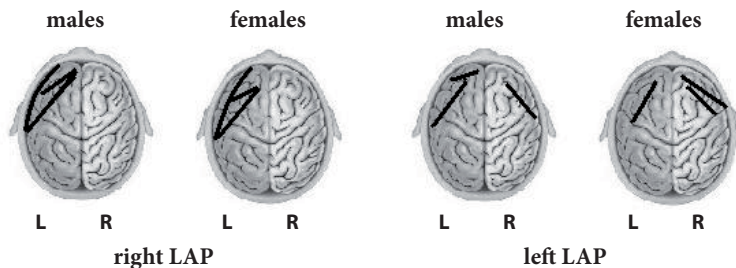


Figure 2. Statistically significant differences in the localization of intra- and inter-hemispheric EEG coherence relations when comparing students with a high level of creativity in solving problems of divergence ($p < 0.05$)

During the solution of convergent tasks, the relevance of coherent connections grew in the frontal, central, and cervical brain zones. At the same time the test subjects of right and mixed LAP show symmetric coherence growth in the central brain zones. The tendency mentioned could also be traced in the young males and females of high creativity, regardless of the level of their progress in studies.

Regarding young males and females of low and average creativity and average and low progress levels, during the solution of convergent tasks, coherence growth was not localized, but diffusely distributed among the central, frontal, and parietal zones of both hemispheres, especially as these groups were solving divergent tasks.

The solution of non-verbal convergent tasks by test subjects of low creativity is characterized by the appearance of highly coherent connections between the middle frontal zone of the left hemisphere and the lateral frontal zone of the right hemisphere, the back cervical and the central left zones; in those of average creativity: between the left frontal and back temporal zones of the left hemisphere, the right cervical and the back temporal zones of the left hemisphere; in those of high

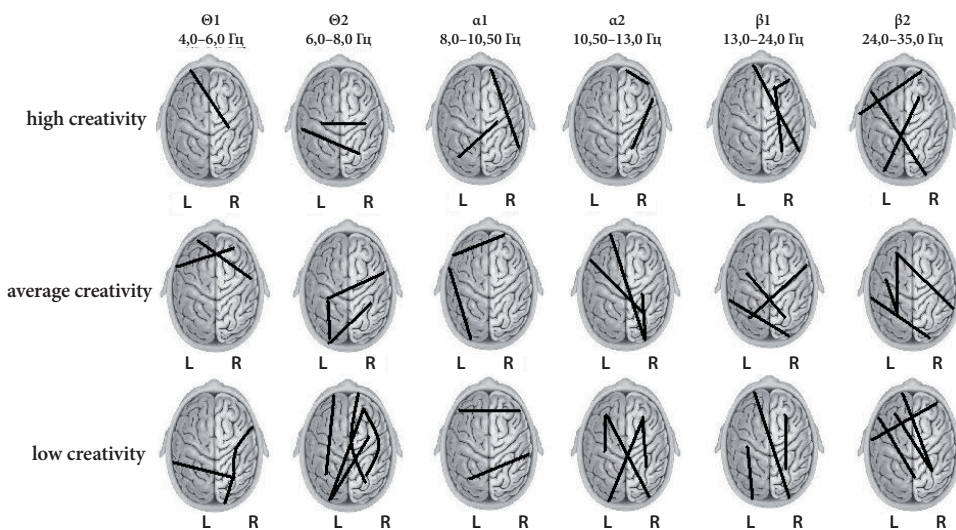


Figure 3. Statistically significant differences in the localization of intra- and inter-hemispheric EEG coherence relations when comparing students with different levels of creativity in solving non-verbal tasks ($p < 0.05$)

creativity: between the left frontal and middle frontal zones, central zone of the left hemisphere, and the parietal zone of the right hemisphere (see Fig. 3).

During the solution of non-verbal divergent tasks, test subjects of low creativity show characteristic connections between the parietal zones of both hemispheres, the anterior frontal right, the central zone of the right hemisphere, the middle frontal left brain zones. In test subjects of average creativity: between the parietal zone of the right hemisphere and the lateral frontal zone of the left hemisphere. In test subjects of high creativity: in symmetric parietal zones, between the right frontal and right parietal zones (see Fig. 4).

It was found that high values of cortico-cortical connections in the solution of a verbal convergent task, regardless of the frequency range in test subjects of low creativity of the left LAP, can be traced between the left frontal and lateral frontal zones of the right hemisphere.

In test subjects of average creativity it takes place between the back zones of both hemispheres, the left occipital and the right frontal zones.

In test subjects of high creativity, high-value coherent connections are predominantly localized in the frontal zones of both hemispheres, the left frontal and the right lateral frontal brain zones.

Test subjects of right LAP and low creativity levels are characterized by highly coherent connections between the right and left frontal zones; in test subjects of average creativity: between the left frontal and parietal left brain zones; in those of high creativity: between the left occipital and right lateral frontal brain zones.

During the solution of verbal divergent tasks, regardless of the frequency range, test subjects of low creativity and left LAP revealed high cortico-cortical connections between the right frontal and central left brain zones; those of average creativity: between the middle frontal and parietal zones of the left hemisphere; in those of high creativity: connections were predominantly localized between the central zones of both hemispheres, the left frontal and right lateral frontal zones.

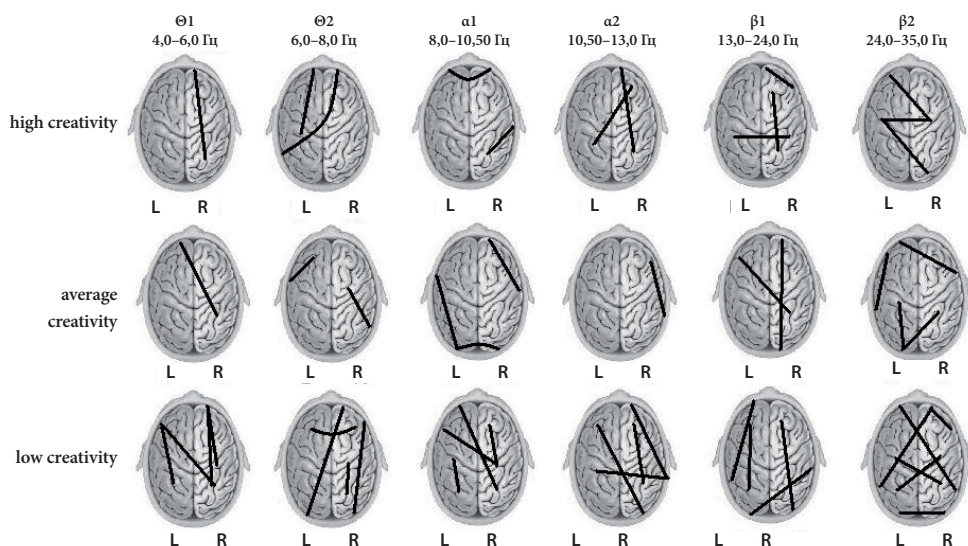


Figure 4. Statistically significant differences in the localizations of intra- and inter-hemispheric EEG coherence relations when comparing students with different levels of creativity in solving non-verbal divergent tasks ($p < 0.05$)

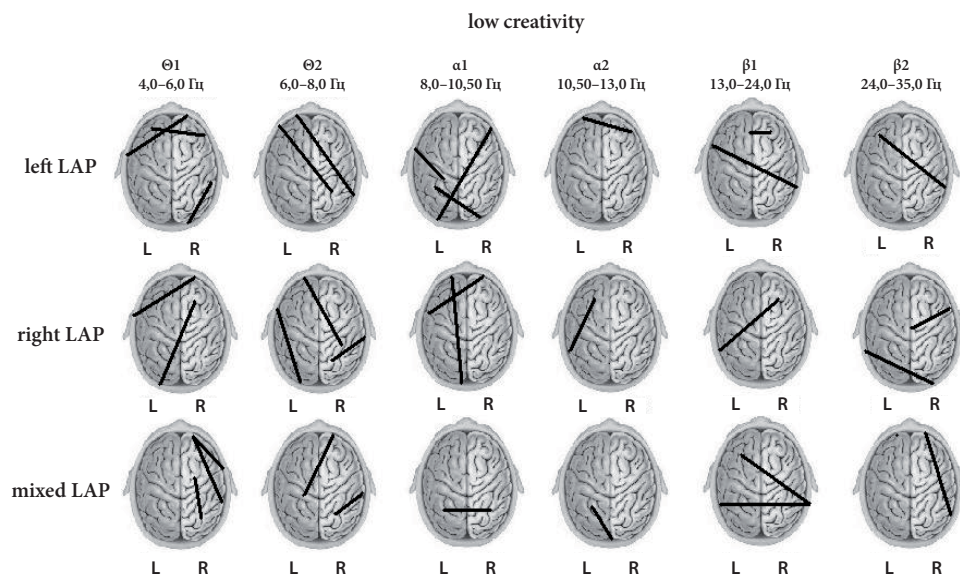


Figure 5. Statistically significant differences in the localization of intra- and inter-hemispheric EEG coherence relations when comparing students with different levels of creativity and LAP in solving a verbal divergent task ($p < 0.05$)

In test subjects of low creativity and mixed LAP it was between the parietal and back temporal zones of the right hemisphere, in those of average creativity: between the back temporal right and left frontal, the middle frontal and lateral frontal zones of the right hemisphere; in those of high creativity: between the right frontal and right parietal brain zones.

The test subjects of the right LAP and low creativity level were characterized by highly coherent connections between the back temporal left and middle frontal zones; in those of average creativity: between the lateral frontal left and right frontal zones; in those of high creativity: between the left occipital and lateral frontal left brain zones (see Fig. 5).

It was revealed that during the solution of verbal tasks, regardless of the frequency range, in test subjects of low progress, the high coherent connections were mainly localized in the anterior frontal zones of both hemispheres, the central zone of the left hemisphere and the anterior frontal zone of the right hemisphere, the central and anterior frontal zones of the right hemisphere.

In test subjects of average progress: in the left anterior frontal zone of the left hemisphere and the frontal temporal zone of the right hemisphere, the posterior temporal right zone and the middle frontal zone of the left hemisphere.

Test subjects of high progress showed interaction between the occipital and frontal zones of the right hemisphere, the cervical zones of the right and left hemispheres. During the solution of a divergent verbal sample, the test subjects of low progress revealed connections between the central and frontal temporal zones of the left hemisphere. Those of high progress showed connections between the right occipital zone and central zone of the right hemisphere, parietal and temporal zones of the left hemisphere.

During the solution of non-verbal convergent tasks, test subjects of low progress showed high coherent connections between the right occipital and central left, right occipital and right hemispheric anterior frontal zones.

Test subjects of high progress showed connections between the anterior frontal left and lateral frontal right brain zones. In the solution of a non-verbal divergent task those of low progress showed connections between the right occipital zone and middle frontal left, anterior temporal zone of the right hemisphere.

Test subjects of average progress showed connections between the left anterior frontal zone of the left hemisphere and the lateral frontal zone of the right hemisphere.

Test subjects of high progress showed connections between the back temporal zone of the left hemisphere and the lateral frontal zone of the right hemisphere.

During the solution of a non-verbal convergent sample, regardless of the frequency range, test subjects of low creativity of left LAP revealed high cortico-cortical connections between the central left and back temporal right zones;

those of average creativity revealed connections between the parietal and temporal zones of the left hemisphere;

in those of high creativity, connections were mainly localized between the parietal zones of both hemispheres, the right frontal and right lateral frontal brain zones.

In those of low creativity and mixed LAP it was between the back temporal and left central zones, in those of average creativity it was between the right central and frontal temporal zones; in those of high creativity it was between the middle frontal right and back temporal brain zones.

For test persons of right LAP and low levels of creativity, characteristics were highly coherent connections between the back temporal and frontal zones of the left hemisphere; in those of middle creativity it was between the central and middle

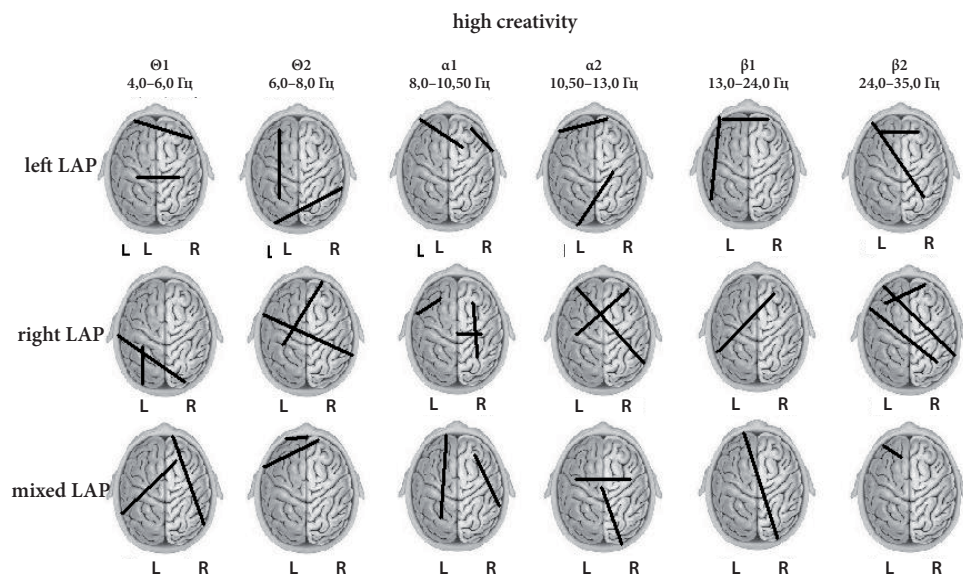


Figure 6. Statistically significant differences in the localization of intra-and inter-hemispheric EEG coherence relations when comparing students with different levels of creativity and LAP in solving a verbal divergent task ($p < 0.05$)

frontal zones of the left hemisphere; in those of high creativity it was between the lateral frontal and parietal zones of the left hemisphere.

During the solution of a non-verbal divergent sample, regardless of the frequency range, test subjects of low creativity and left LAP showed high coherent connections between the left frontal and temporal right zones; those of average creativity showed connections between the middle frontal zones of both hemispheres; and those of high creativity showed connections essentially localized between the left frontal and right parietal zones.

In those of low creativity and mixed LAP it was between the frontal right and temporal anterior zones of the left hemisphere; in those of average creativity it was between the central and frontal temporal zones of the right hemisphere; in those of high creativity it was between the parietal and lateral frontal zones of the right hemisphere. For test persons of right LAP and low creativity, characteristics were highly coherent connections between the right frontal temporal and lateral frontal zones, the left occipital and frontal temporal left brain zones; in those of average creativity it was between the back temporal left and parietal right zones; in those of high creativity it was between the lateral frontal left and middle frontal right brain zones.

During the solution of verbal convergent tasks, high coherence rates (0.8–1) increased in the frontal, middle frontal, temporal, and parietal brain zones in young females of left LAP. Meanwhile, with young males of left and mixed LAP, the same picture of connection distributions is less localized compared to young males of right LAP, where connections are primarily localized in the left hemisphere. With young females, a picture of coherence intensification in the cervical, parietal, temporal, central, and middle frontal brain zones is typical. The picture of frequency-and-spatial EEG arrangement in young females of right, left and mixed LAP is less clearly localized than in the young males of the appropriate LAP. During the solution of a non-verbal convergent sample, both males and females show an increase of interaction in the back, central, and frontal cerebrum areas. During the solution of divergent tasks, the coherence values for young males and females of high creativity increase in the parietal and anterior frontal brain areas.

Thus the brain electric activity characteristics differ depending on type of task (either divergent or convergent) and creativity level.

The solution of divergent and convergent creative tasks may condition a definite frequency-and-spatial EEG arrangement in young females of different academic progress levels and lateral arrangement profiles.

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Automated real-time classification of functional states: significance of individual tuning stage

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Automated classification of a human functional state is an important problem, with applications including stress resistance evaluation, supervision over operators of critical infrastructure, teaching and phobia therapy. Such classification is particularly efficient in systems for teaching and phobia therapy that include a virtual reality module, and provide the capability for dynamic adjustment of task complexity.

In this paper, a method for automated real-time binary classification of human functional states (calm wakefulness vs. stress) based on discrete wavelet transform of EEG data is considered. It is shown that an individual tuning stage of the classification algorithm — a stage that allows the involvement of certain information on individual peculiarities in the classification, using very short individual learning samples, significantly increases classification reliability. The experimental study that proved this assertion was based on a specialized scenario in which individuals solved the task of detecting objects with given properties in a dynamic set of flying objects.

Key words: human functional state, EEG data, automated classification, individual tuning, stress.

1. Introduction

Classification of the human functional state of an individual (Danilova, 1992; Hockey et al., 2003) is an important problem in modern psychology. It is a key subject of the EU FP integrated project “Advanced sensor development for attention, stress, vigilance and sleep/wakefulness monitoring (SENSATION)” (Maglavera et al., 2006), The Research and Technology Organization (RTO of NATO) program “Operator Functional State Assessment” (Hockey et al., 2003; Veltman et al., 2004), and a number of other projects. Applications of the automated classification of functional states include stress resistance evaluation, supervision over operators of critical infrastructure (air traffic controller, power plant operator, engine-driver,

etc.), teaching, and phobia therapy. Such classification is particularly efficient in systems for teaching and/or phobia therapy that include a virtual reality module (e.g., virtual cave) and provide the capability for dynamic adjustment of task complexity: in this case the implementation of feedback based on real-time automated functional state classification can be used for the automated optimal selection of task complexity, and such a selection is a key factor for successful teaching and therapy.

Standard mathematical approaches to the automated classification problem are based on the detection of characteristic patterns of classes, and on the construction of classifier functions that give close values for elements of the same class, and distinguishable values for elements from different classes. If characteristic patterns and classifier functions cannot be revealed using solely specific expert knowledge of the domain, automated and semi-automated machine-learning methods are used: Artificial Neural Networks (Wasserman, 1989), Support Vector Machine (Cortes and Vapnik, 1995), Logistic Regression (Hosmer and Lemeshow, 2000), Random Forest (Breiman, 2001), etc.

However, these methods can be efficiently applied only if the size of learning samples is considerably larger than the dimension of the feature (measurement) arrays used for the classification. In the case of functional state classification based on electroencephalographic (EEG) data, this limitation is violated: the typical size of learning samples here does not exceed a few hundred (in most cases — several dozen), and the number of measurements associated even with short (e.g., one second) time windows exceeds one thousand (and generally exceeds ten thousand). Recently we developed a specialized method for the automated construction of classifier functions for binary functional state classification, which provided reliable classification of stress vs. state of calm wakefulness (also referred to as a normal functional state) despite the relatively small size of learning samples (Galatenko et al., 2012). Along with the efficient procedure for dimension reduction, this method included an individual tuning stage that allowed the involvement of certain information on individual peculiarities in the classification. This stage is non-standard for conventional machine-learning methods. In this paper we show that the individual tuning stage significantly increases the reliability of the classification.

The rest of the paper is organized as follows. In the section “Algorithm scheme” a short description of the algorithm for automated real-time classification of a functional state based on EEG data is given. A detailed description of the algorithm was given (Galatenko et al., 2012). In the section “Experiment design”, an outline of an experiment for evaluating the importance of the individual tuning stage for classification reliability is given. In the section “Results”, experiment results are discussed.

2. Algorithm scheme

2.1 Dimension reduction

Measurements of EEG signals are performed independently by N sensors with frequency F Hz, where a typical value of N is several dozen (up to 256) and the typical value of F is several hundred (up to 5000). Hence, $N \cdot F \cdot L$ measurements

are performed in each L -second time window. However, strong dependencies are present between signals corresponding to closely located sensors, and between data corresponding to close measurements. EEG data contains noise and artifacts that are generally localized in high- and low-frequency domains, or have a good localization in time domain (e.g., artifacts induced by winking).

The procedure for dimension reduction and simultaneous artifact filtration can be described as follows. Measurements associated with different sensors are processed independently. For a given time window (the typical length of a time window here is 30–90 seconds), a signal corresponding to one sensor is decomposed using discrete CDF 9/7 wavelet transform (Daubechies, 1992: Ch. 5, Sec. 5.1; Cohen et al., 1992). Low- and high-frequency terms are discarded (this leads to noise filtration in frequency domain), and for the remaining fragment of the decomposition, the absolute and relative energy values of a signal for each scale component (i.e., for the fixed frequency band) are computed. The typical number K of scale components after the decomposition truncation is 8, so $2K$ energy values are identified (K absolute and K relative values). Median averaging is used in energy computation for the reduction of errors associated with time-localized artifacts.

An array of energy values is a result of dimension reduction for a given sensor and a given time window. Such reduction decreases data array length by a factor of 150–25 000, but keeps the information required for functional state classification.

2.2 Global learning stage

Even after dimension reduction, the length of data arrays associated with each time window is large (its typical value is 1024). At the same time, most of the entries in these arrays carry no information that is essential for functional state classification, and therefore can be excluded from further analysis and discarded. If a learning sample is available, entries that can be efficiently used for binary functional state classification can be detected by the following fully automated procedure, without using any prior expert knowledge of the psychological domain. For a fixed individual, available data corresponding to each functional state is split into non-overlapping time windows with a standard length (e.g. one minute). All data array entries (i.e. energy values) are computed for each time window. A data array entry is called informative for an individual if its values for one functional state turn out to be always higher (or always lower) than for the other functional state. A data array entry is called informative (with respect to a learning sample) if it is informative for a given fraction (e.g., $2/3$) of individuals in this learning sample, with the same inequality sign between values associated with different functional states. Only informative entries are considered in the further analysis. For each informative entry f , its weight (in other words, its significance) $w(f)$ is computed based on the fraction of individuals for which this entry is informative and on the size of the gap between values associated with different functional states for these individuals.

2.3 Individual tuning

If a sufficiently large learning sample is available for an individual, the global learning stage can be avoided and machine learning focusing directly on this individual can be performed. However, in most applications, including teaching and phobia

therapy, learning samples that can be provided for individuals that were not involved in the global learning stage are very small: generally they contain only one fragment of a standard length (e.g., one minute) associated with one functional state (e.g., stress), and a similar fragment associated with another functional state (e.g., state of calm wakefulness). These samples are not sufficient for machine learning, but they can still be efficiently used to increase the classification reliability for an individual. It can be done in the following way. All informative data array entries are computed. Entries that turn out to be higher for one state (while they were lower for this state for most individuals in the learning sample group) are excluded from further analysis for the individual. Other entries are called applicable to the individual, and used in the functional state classification. For entries that are applicable to an individual, the values of these entries for both functional states are recorded as typical values for each state for this individual.

2.4 Individual testing

For a given individual, functional state classification is performed using a voting scheme (Littlestone, 1994). A time window of standard length is taken, all informative entries applicable to the individual are computed, and a vote $V(f)$ is associated with each entry f :

$$V(f) = \max \{-1, \min\{1, v(f)\}\},$$

where

$$v(f) = s(f) \frac{(\log_2 h - (\log_2 h^s + \log_2 h^c) / 2)}{|\log_2 h^s - \log_2 h^c| + 0.05},$$

$s(f)$ equals 1 if for a learning sample, values of f associated with the first functional state (e.g., stress) are generally higher than values of f associated with the second functional state (e.g., state of calm wakefulness), and equals -1 otherwise; h is the value of the entry for the analyzed time window, h^s and h^c are the typical values of this entry for this individual in the first functional state and in the second functional state respectively, 0.05 is a regularization parameter.

The weighted sum

$$S = \sum_f w(f) V(f)$$

of votes for all informative entries applicable to the individual is calculated. If S turns out to be negative, the classification result for the individual and the analyzed time window is set to the second functional state (e.g., calm wakefulness), otherwise it is set to the first functional state (e.g., stress).

3. Experiment design

The study was performed at Moscow State University and was approved by the Ethics Committee of the MSU Faculty of Psychology. The goal of the study was to determine whether the individual tuning stage actually increases the reliability of the classification.

A special scenario for the virtual cave implemented by staff of the MSU Faculty of Psychology was used. In this scenario, individuals solved the task of detecting objects with given properties (shape and color) in the dynamic set of flying objects.

The difficulty of the task was varied by changing time limits for the detection, frequency of object generation, fraction of objects with required properties in the set of all objects, fraction of objects similar to the objects of interest in the set of all objects, etc. The scenario also included disturbing elements such as sudden irritating sounds and punishments (e.g., the threat of mild electric shock) in case of errors (false alarms and misses).

EEG data was measured using BrainAmp equipment, including BrainAmp Standard amplifiers and BrainCap with 64 sensors and frequency 2500 Hz. The segmentation of data and identification of functional states corresponding to segments (stress / calm wakefulness / other) was performed manually by experts of the MSU Faculty of Psychology. Only segments corresponding to stress and calm wakefulness were used for automated classification, and for classification reliability evaluation.

A learning sample at the global learning stage included data corresponding to 19 individuals of both genders (m:f 9:10) aged between 18 and 25, with different levels of stress resistance. For each individual, the learning sample included six non-overlapping 1-minute fragments associated with stress and six non-overlapping 1-minute fragments associated with calm wakefulness. Forty two data array entries were identified as informative with respect to this learning sample. The informative entries included both absolute and relative energy values, but the fraction of relative energy values was considerably higher than the fraction of absolute energy values (73.8% vs. 26.2%). The total number of sensors associated with the informative data array entries was 21. Ten sensors were associated with a single informative entry, 6 — with two informative entries, 3 — with three informative entries, one — with four informative entries, and one — with 7 informative entries.

In further analysis, the dimension of EEG data was reduced by splitting the signal into fragments with duration of approximately one minute, and using informative data entries identified at the global learning stage instead of initial EEG.

Classification reliability was evaluated using a test sample that included data corresponding to 17 individuals of both genders (m:f 8:9) aged between 18 and 25, with different levels of stress resistance. Data corresponding to each individual (associated with both stress and calm wakefulness) was split into several non-overlapping fragments (at least 6 stress fragments and 6 calm wakefulness fragments) of a standard length (approximately 1 minute). Two of these fragments (one corresponding to stress and one corresponding to calm wakefulness) were used for individual tuning (or simply discarded if individual tuning was not performed). For other fragments, automated functional state classification was performed and results were compared with the results of classification performed manually by experts of the MSU Faculty of Psychology. For each individual, automated classification reliability was evaluated as a fraction of fragments for which automated classification and manual classification gave the same result.

In order to assess the significance of the individual tuning stage, a similar evaluation of classification reliability for individuals from the same testing sample was performed, in which the individual tuning stage was avoided, all informative data array entries were used for each individual at the individual testing stage, and values h^s and h^c of these entries, typical to an individual, were replaced by the mean values of these entries for the learning sample.

In this approach, both optimizations provided by the individual tuning stage — selection of informative entries applicable to an individual and identification of typical values of these entries for this individual — were discarded, and weights obtained at the global learning stage were used for the classification. Poor results of the classification could be explained in this case mainly by a poor weights selection: a weight evaluation scheme was optimized for the specialized classification method that was corrupted by avoiding one of its stages (moreover, weights selection in this method is only a secondary result of a the global learning stage, whose main task is the detection of informative data array entries among all entries), and hence classification reliability can be essentially increased by a simple recalculation of weights. In order to test this hypothesis, an additional classification reliability evaluation was performed for a case where an individual tuning stage was avoided and a classic optimization method for the weights selection was used. In this test, the Support Vector Machine (Cortes and Vapnik, 1995) with linear kernel was trained using the same learning sample (in which dimension reduction was performed by a transition to informative data entries detected at the global learning stage) and applied to the same testing sample. The software implementation for this approach used LIBSVM (Chang and Ling, 2011); error-cost parameter C was determined using a standard cross-validation technique (Hastie et al., 2011: Sect. 7.10).

4. Results

The results of classification reliability evaluation are summarized in Table 1. The first column contains identifiers of individuals, the second column contains classification reliability for the classification method with the individual tuning stage, the third column contains classification reliability for a similar method in which the individual tuning stage was discarded, and the forth column contains classification reliability for an SVM-based classification method.

The results show that the presence of the individual tuning stage, which is non-standard for classical machine learning methods, significantly increases the classification reliability.

In rare cases (e.g., individual M14_A7), individual tuning slightly reduces reliability. This effect is generally associated with individuals without distinct individual peculiarities, and the decrease is negligible. The decrease in reliability by the individual learning stage is explained by the low quality of data fragments used for individual tuning.

However, in most cases individual tuning does not decrease the classification reliability, and for individuals with distinct individual peculiarities this stage essentially increases classification quality (e.g., individuals M5_A1, M18_B5).

A similar situation was revealed in a study focused on binary functional state classification based of the analysis of physiological data (ECG, Galvanic skin response, respiratory parameters, etc.) instead of EEG data. The Gradient Boosted Trees algorithm (Breiman et al., 1984) was used for classifier construction, and decision trees that gave incorrect results for data fragments with a known answer (i.e., associated functional state) were discarded at the individual tuning stage. In a few cases, this individual tuning procedure slightly reduced classification reliability, but in these cases both initial and reduced reliability were relatively high. How-

Table 1. Classification reliability

IndID	Rel_IndTuning	Rel_NoTuning	Rel_SVM
M5_A1	0.88	0.38	0.50
M5_A2	0.69	0.40	0.50
M7_A3	1	1	0.83
M7_A4	1	1	0.86
M11_A5	1	1	0.90
M11_A6	1	1	0.91
M14_A7	0.96	1	0.75
J3_A8	1	0.68	1
J3_A9	1	1	0.75
J12_A10	1	1	0.42
M12_B1	1	1	1
M15_B2	0.74	0.37	0.5
M15_B3	1	1	1
M18_B4	1	1	0.6
M18_B5	1	0.65	0.50
J4_B6	1	1	0.50
J4_B7	1	0.30	0.63

Note. Column IndID contains identifiers of individuals from the testing sample. Column Rel_IndTuning contains classification reliability for the standard implementation of the classification method with the individual tuning stage. Column Rel_NoTuning contains classification reliability for a similar method, in which the individual tuning stage is discarded. Column Rel_SVM contains classification reliability for an SVM-based classification method.

ever, cases where individual tuning reduced the classification quality were rare, and cases where the classification quality was essentially increased by the application of individual tuning (particularly, from a relatively low value to a high value) were essentially more frequent. The details of this study and the analysis of its results are given in the volume dedicated to the V Congress of Russian Psychological Society (Lobacheva et al., 2013).

Data availability

The details of the study, as well as EEG data and additional physiological data, are available upon request from the authors.

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An investigation of 3D images of the simultaneous-lightness-contrast illusion using a virtual-reality technique

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This article investigates the problem of lightness perception. To clarify the role of depth in lightness perception two current models—the albedo hypothesis and the coplanar-ratio hypothesis—are discussed. To compare them the strength of the simultaneous-lightness-contrast (SLC) illusion was investigated as a function of three-dimensional (3D) configurations of the test and background squares. In accordance with both hypotheses the changes in the depth arrangements of the test and background squares should result in changes in the illusory effect. However, the reasons for and the directions of these changes should be different. Five different types of 3D configurations were created in which the test squares were tilted at different angles to the background squares. A virtual-reality technique was used to present stereo pairs of different 3D configurations. Thirty-seven observers took part in the experiment. The method of constant stimuli was used to obtain psychometric functions. The displacements of these functions for 3D configurations in comparison with the 2D configuration allowed the estimation of illusion strength. The analysis of individual values of illusion strength revealed two groups of subjects. For the first group (38% of all participants) the strength changed insignificantly depending on the 3D configurations. For the second group (62% of all participants) significant differences were obtained for those configurations in which the test and background squares were perceived as differently illuminated. The changes in the SLC illusion strength for the second group were consistent with predictions made by the albedo hypothesis. Thus, it seems that the perceived illumination of a surface should be considered the main parameter for lightness estimations in 3D scenes.

Keywords: perception, visual illusions, lightness, perceived illumination, albedo hypothesis, coplanar-ratio hypothesis, virtual-reality technology

The illusion of simultaneous lightness contrast (SLC) has been actively investigated for 180 years. In the illusion (Figure 1) two identical gray squares located on light-gray and dark-gray backgrounds are perceived as dark-gray and light-gray respectively.

The problem of the SLC illusion is tightly connected with the problem of lightness perception. Many authors have considered the SLC illusion as a demonstration of their theoretical assumptions about the process of lightness perception.



Figure 1. The SLC illusion

Let us preliminarily introduce some terms that will be used in this article. All surfaces absorb a certain amount of light and reflect the rest. The intensity of light falling on a surface is called the *illumination*. *Luminance* refers to the intensity of light reflected by a surface and projected onto the retina. The percentage of light reflected by a surface is called *reflectance*. For example, white surfaces reflect about 90% of light, while black surfaces reflect about 3% of it. So the ratio of the intensities of light reflected from white and black surfaces is 30:1. All surfaces are tilted relative to the subject and to the light source. Surfaces that are located in the same plane or in parallel planes are called *coplanar*. The perceived reflectance is referred to as *lightness*. The intensity of light perceived by the subject is called the *perceived illumination*.

Luminance is considered the proximal stimulus for lightness estimations. The problem of lightness perception lies in the fact that luminance depends not only on the surface's reflectance but also on other parameters of the external environment: the illumination of a surface and its slant. The surfaces around us are illuminated differently (some are shadowed, others are strongly illuminated) and are tilted differently in space. In special cases the light intensity coming from shaded white surfaces is less than the light intensity reflected from illuminated black surfaces. So a question arises about the mechanisms that the visual system uses for lightness estimations.

To solve the problem of lightness perception many hypotheses have been suggested. Let us consider some of those that are frequently debated. The first one assumes that the ratio of the luminance of the test surface to the luminance of other surfaces determines this process. Using these ratios it is possible to estimate the relative reflectance of all surfaces that are equally illuminated. Because in natural scenes objects lying in the same surface are as a rule illuminated uniformly, it was assumed (Gilchrist et al., 1999) that the luminance ratio of coplanar surfaces was a basic stimulus for lightness perception. A second hypothesis claims that the perceived illumination of a surface plays an important role in lightness estimations. This hypothesis was formulated by H. von Helmholtz (1867) and then was reformulated as the albedo hypothesis in contemporary theories of lightness constancy (Bergstrom, 1977; Kozaki & Noguchi, 1976; Logvinenko & Menshikova, 1994; Menshikova & Lunyakova, 1994). It supposes that the lightness of the surface and its perceived illumination are coupled in the visual image. In accordance with the rule of their relationship, an increase in perceived illumination should be ac-

accompanied by a decrease in lightness at a constant value of surface luminance. A third hypothesis emphasizes the role of local contrasts for lightness estimation. The idea was proposed by E. Hering (Hering, 1964) and has now been developed in a number of contemporary studies (Blakeslee & McCourt, 1999; Blakeslee, Pasiaka, & McCourt, 2005; Grossberg & Howe, 2003). A fourth approach for lightness perception considers the role of contour junctions—that is, the places where several surfaces having different degrees of luminance are contiguous to each other (Anderson, 1997; Ross & Pessoa, 2000; Todorovic, 1997).

Let us consider the first two hypotheses in detail as they are the most discussed in the modern literature. The first one assumes that surface lightness can be evaluated through the ratio of its luminance to the luminance of other surfaces in the scene (Land & McCann, 1971; Wallach, 1963). This procedure allows the relative reflectance of all surfaces to be computed. To estimate the absolute reflectance the anchoring rule is applied in the visual system. This means that one of the relative reflectance values anchors to some absolute value: for example, the most luminous object is assumed to be white (Gilchrist et al., 1999; Land & McCann, 1971; Wallach, 1976). Thus, the lightness of each object can be determined. However, the described model of lightness estimations works when all surfaces are equally illuminated and there is only one light source in the scene. Otherwise, when there are differently illuminated surfaces, the luminance ratios depend on the intensity relationships of the strongly illuminated and the shadowed surfaces. It is assumed that the lightness estimation in complex scenes is accomplished in two stages: first the groups of coplanar surfaces are picked out, and then lightness is estimated in accordance with the anchoring rule for each group. The anchoring rules “work” in the range of local and global frameworks simultaneously. Local frameworks are used to estimate the luminance ratio of the test patch and adjacent background patches of a surface. Global frameworks are used for estimating the luminance ratio of the test patch and distant patches of a surface. A general lightness estimation is calculated as average lightness through local and global frameworks. This hypothesis was called the coplanar-ratio hypothesis (Gilchrist, 1977), and the visual cues of grouping were called the coplanarity cues. The important role of these cues in lightness perception was shown in a number of studies (Taya, Ehrenstein, & Cavanus, 1995; Wishart, Frisby, & Buckley, 1997).

The alternative hypothesis of lightness perception (the albedo hypothesis) argues for the strong effect of the perceived illumination on lightness estimation. The albedo hypothesis asserts that if the value of perceived illumination increases, lightness is underestimated by the subject, and vice versa: surface lightness is overestimated with a decrease in the value of perceived illumination. For example, the explanation of the SLC illusion (Figure 1) proposed by Helmholtz assumed that the surfaces of the light-gray and dark-gray backgrounds should be perceived as strongly illuminated/shadowed surfaces so this hypothesis would result in underestimation/overestimation of the central squares lightness. The basic problem with this hypothesis lies in the fact that it is necessary to explain the mechanisms for the estimation of perceived illumination. Unfortunately, no neuron mechanisms for illumination estimation were found, so the mechanism for the illumination estimation in the visual system and for the following lightness estimation remains unclear. In spite of these difficulties, results were obtained that confirmed

the influence of the perceived illumination on lightness perception (Knill & Kersten, 1991; Logvinenko & Menshikova, 1994; Menshikova & Lunyakova, 1994; Menshikova & Nechaeva, 2011; Williams, McCoy, & Purves, 1998).

In a number of studies the influence of depth on lightness perception was investigated to test two of the theoretical hypotheses mentioned above. The main idea behind these studies was to change the coplanarity cues by manipulations of 3D positions of the test surfaces relative to the background surfaces. In accordance with the coplanar-ratio hypothesis these manipulations would result in a change in lightness perception. Some works studying the influence of depth on lightness estimations (Kardos, 1934; Wolff, 1933) confirmed these predictions. In one of them (Wolff, 1933) two test surfaces with the same reflectance were arranged against dark and light backgrounds. When test surfaces were coplanar to their backgrounds, the SLC illusion appeared, and the two tests looked different. However, when the test surfaces were moved away from the backgrounds (that is, they were not coplanar), the strength of the SLC illusion decreased. These results showed that the relationship between the test surfaces and the background surfaces occurred only when they were coplanar. Later works also tested the coplanar-ratio hypothesis. The influence of depth cues on lightness perception was investigated using stereo images (Coren, 1969). The observer saw a black cross hanging over a white background. The test gray square was arranged next to the cross and was perceived as being located, in one case, in the plane of the cross, and, in another, in the plane of the background. The observer was asked to estimate the lightness of the test square. Results showed that the test square, perceived in the plane of the black cross, was estimated to be 7% lighter. However, that effect was rather weak. To test the influence of depth cues on lightness perception the study was carried out using the Gelb effect (Gogel & Mershon, 1969). A large, black, strongly illuminated disk hanging over the black unlit background was perceived as white or light gray (the Gelb effect). When a small white disk was attached to the black disk, the Gelb effect decreased—the black disk was perceived as black. However, when the white disk was moved away from the black one (that is, when it was not coplanar), the Gelb effect increased again. Conditions of monocular/binocular viewing were used to investigate the influence of depth cues in lightness perception (Gilchrist, 1977). When the display was viewed monocularly, the test disk was perceived as being coplanar to a dark-gray surface, whereas when the display was viewed binocularly, the test disk seemed coplanar to a light-gray surface. As a result, the shift in lightness estimations in the two conditions was 4.5 Munsell units. The above-mentioned studies were in good agreement with the coplanar-ratio hypothesis. Other studies investigating the role of depth cues did not reveal or determine the very weak influence of coplanar ratios on lightness estimations (Dalby, Saillant, & Wooten, 1995; Epstein, 1961; Flock & Freedberg, 1970; Julesz, 1971; Zaidi, Spehar, & Shy, 1997).

A number of rules were given for applying the coplanar-ratio hypothesis correctly (Gilchrist, 1980). First, the retinal-luminance ratios of the compared surfaces should remain constant. Second, to change coplanar ratios it is necessary to create two different experimental conditions, A and B. Under the A condition the test surface should belong to one background, and under the B condition it should belong to another background. It was shown that when the test surface was not coplanar

to the background surface, the coplanar-ratio hypothesis was not available, and as a result lightness estimations became worse (Gilchrist, 1980). Third, the coplanar ratio hypothesis “works” only when the luminance ratios are more than 30:1. This limitation made it possible to explain why the influence of depth cues on lightness was not revealed in many studies.

These studies provided contradictory results for the role of depth cues on lightness perception. Therefore, the question of choosing one of the alternative hypotheses remained unanswered. One of the problems of choosing an appropriate theoretical approach was connected with the fact that in many studies the experimental conditions were set up in such a way that changes in luminance ratios were accompanied by changes in perceived illumination. An attempt was made to test the two hypotheses under conditions of separate, independent changes in luminance ratios and perceived illumination (Howe, 2006). The results were in better agreement with the albedo hypothesis.

In our study the coplanar-ratio hypothesis and the albedo hypothesis were tested under conditions of independent changes in luminance ratios and perceived illumination by exploring the SLC illusion. The strength of the SLC illusion was investigated as a function of 3D configurations of the test and background squares. In accordance with both hypotheses the changes in depth arrangements of the test and background squares should result in changes in the illusory effect. However, the reasons for and the directions of these changes should be different for each hypothesis. In line with the albedo hypothesis, changes in illusion strength should be connected with the fact that changes in the space arrangement of the test and background squares would result in changes of perceived illumination and, in turn, would result in changes of lightness (Logvinenko & Menshikova, 1994; Menshikova & Lunyakova, 1994). Consequently, by tilting test squares toward/down from the hypothetical overhead light source, it is possible to increase/decrease perceived illumination and therefore to decrease/increase lightness. Changes in the lightness of the test squares should result in illusion strength. If the test squares are tilted differently relative to the hypothetical overhead light source, then perceived illumination should be stronger for one of them and weaker for the other, and as a result the illusion strength should change. But if the test squares are tilted equally relative to the hypothetical light source, the illusion strength should remain constant. In line with the coplanar-ratio hypothesis lightness estimations are determined by the anchoring rule, which depends on coplanarity cues available in the scene. Reducing these cues should result in a decrease in illusion strength. To reduce them the classical 2D illusion was transformed into different 3D configurations. There were two types of transformations. For the first type, the test squares were tilted relative to the background squares (the break of local frameworks); for the second, the background squares were tilted relative to each other (the break of global frameworks). Both types of transformations should result in the reduction of coplanarity cues and then in the reduction of illusion strength for all 3D configurations independently of the spatial arrangement of the test and background squares. However, the reduction should be expressed less for the second transformation type than for the first because the break of local frameworks is more significant than the break of global frameworks for lightness perception.

Method

Participants

Thirty seven observers (12 males and 25 females; age range 17–30) with normal or corrected-to-normal vision were tested. All the observers were unaware of the purpose of the experiment.

Apparatus

Virtual-reality technology was used to present 2D-3D configurations of the SLC illusion. Advantages of and perspectives on this technology in experimental psychology, cognitive psychology, and psychophysiology have been thoroughly described and analyzed in the Russian and international literature (Riva, 2005; Yee, 2007; Zinchenko, Menshikova, Bayakovsky, Chernorizov, & Voiskounsky, 2010; Zinchenko, Menshikova, Chernorizov, & Voiskounsky, 2011). Participants observed 2D-3D images of SLC illusions using the head-mounted-display (HMD) technique eMagin Z800 3D Visor.* The HMD displays were arranged at a distance of 2.5 cm from observers' eyes. The angular sizes of the test and background squares were $2^\circ \times 2^\circ$ and $6^\circ \times 6^\circ$ respectively. Maximum luminance was equal to 333 cd/m^2 . The luminance ratio was 52:1.

Stimuli

The articulated variant of the SLC illusion (Figure 2) was used as the basic pattern because its illusory effect was stronger than that of the original (Adelson, 2000; Gilchrist et al., 1999; Soranzo, Lugin, & Cavazza, 2011).



Figure 2. Articulated variant of the SLC illusion

Different 3D configurations of the SLC illusion were formed by the creation of stereo pairs with the use of Photoshop CS2 9.0. The value of disparity was constant and equal to 10 pxl for all stereo pairs.

Five different types of 2D-3D configurations of the test and background squares were created. They were arranged against the frontal random-point surface. The types were as follows: type 1–2D articulated variant of the SLC illusion (Figure 2);

* The work was done on equipment acquired by the Lomonosov Moscow State University Program of Development.

type 2—the central squares were moved out of the background squares and were parallel to them (Figure 3.2); type 3—the central squares were tilted at the same angles to their backgrounds (Figure 3.3); type 4a and 4b—the central squares were tilted at different angles to their backgrounds: the left one was tilted toward the hypothetical overhead light source, and the right one was tilted downward from it (Figure 3.4a), and vice versa (Figure 3.4b); type 5a and 5b—the background squares were tilted at different angles to the frontal random-point surface in a similar way as for types 4a, 4b.

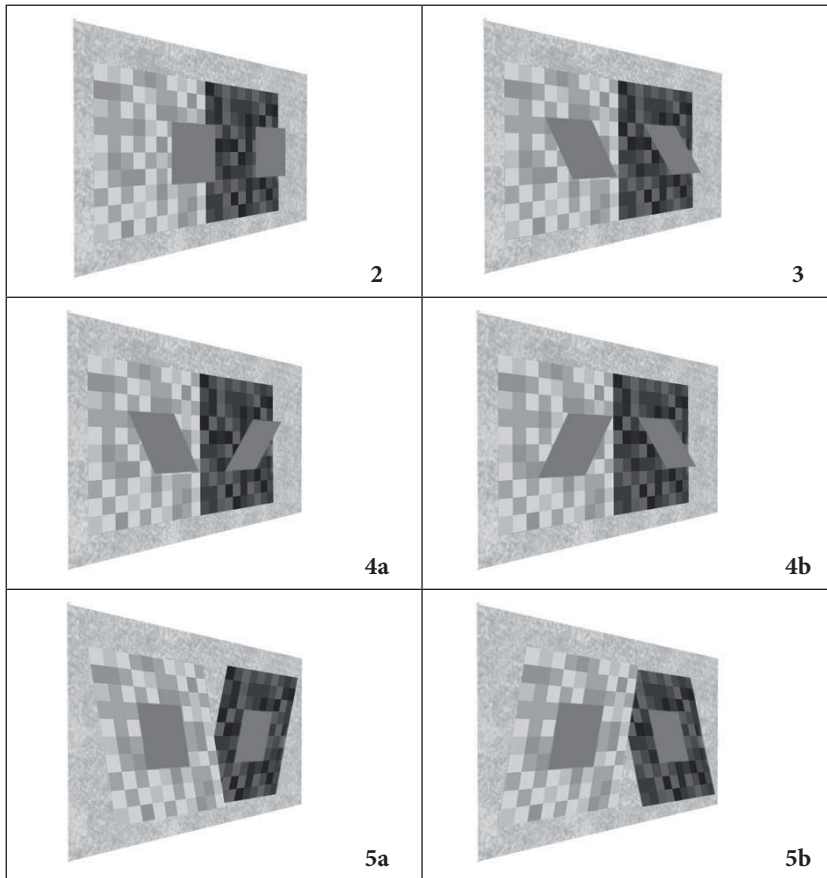


Figure 3. Types of 3D configurations of the SLC illusion

The method of constant stimuli was used to estimate the strength of the SLC illusion. The initial brightness of test squares was equal to 44% of black shade according to the Grayscale. Six variable stimuli were created for every 2D-3D configuration, for which the value of brightness for the test square lying on the light-gray background was constant and the value of brightness for the test square lying on the dark-gray background decreased from 44% to 70% of black shade with a step of 5%. Thus, 42 stereo pairs were created: seven 2D-3D configurations, each having six variable stimuli.

Procedure and Plan

The stimuli sequence was created in MediaLab v2008. 1.33. Each of the 42 stereo pairs was repeated 10 times. The sequence of stimuli presentation was completely randomized. The participant's ability to see 3D configurations was tested at the beginning of the experiment. Then 420 stereo pairs were presented. The time for presentation of each stimulus was 5 s. The screen with possible answers appeared after each presentation. In every trial the participant was asked to choose the lighter of the two central squares.

Results and Discussion

Psychometric functions for 2D and six different 3D configurations were obtained and were used to evaluate the strength of the SLC illusion for each participant and each 3D configuration. The illusion strength (IS) was calculated as $IS = (P_{3D} / P_{2D} - 1) \times 100\%$, where P_{3D} and P_{2D} – 50% probability of answers “lighter” for 3D and 2D configurations respectively. Analysis of individual values of the SLC illusion strength revealed two groups of subjects. The values of the illusion strength were averaged for each group separately. The results are shown in Figure 4.

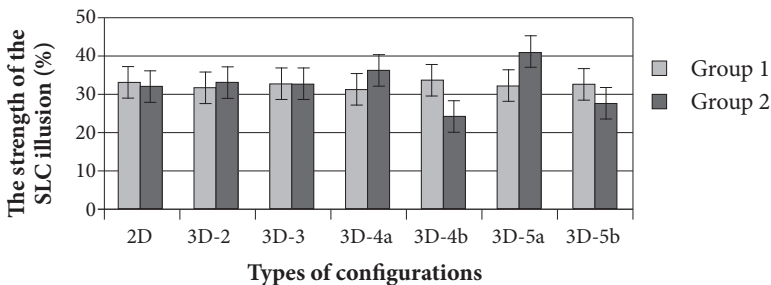


Figure 4. The strength of the SLC illusion as a function of 2D-3D configurations

For the first group (38% of all the participants) the strength changed insignificantly depending on 2D-3D configurations; significant difference $t(72) = 1.86$, $p = 0.05$. For the second group (62% of all the participants) significant differences were revealed for types 4a-4b ($t(72) = 2.77$, $p \leq 0.01$), and also for types 5a-5b ($t(72) = 2.82$, $p \leq 0.01$) of 3D configurations. The results showed an increase of the illusion effect for types 3D-4a and 3D-5a and, on the contrary, a decrease for types 3D-4b and 3D-5b.

The data were analyzed in accordance with the albedo hypothesis and the coplanar-ratio hypothesis. In line with the coplanar-ratio hypothesis the space separation of the test squares relative to the background squares should lead to a reduction of coplanarity cues and, as a result, to a reduction of illusion strength (IS). The value of the reduction should be different for different types of 3D configurations. The break of local frameworks (configurations 3D-2, 3D-3, 3D-4a, and 3D-4b) should result in a stronger decrease of IS than the break of global frameworks (configurations 3D-5a and 3D-5b). As shown in Figure 4, the changes of IS did not confirm these predictions. For the first group there were no significant changes

of IS at all. For the second group the decreases of the illusion effect were found for types 3D-4b and 3D-5b, but they were not consistent with the coplanar-ratio hypothesis. According to the albedo hypothesis, changes in IS should occur only for those 3D configurations in which the test and background squares seemed differently illuminated. In the absence of cast and attached shadows the visual system should make “an unconscious inference” about the overhead light source. For configurations 2D, 3D-2, and 3D-3 the test squares were tilted equally relative to the overhead light source, so IS did not change. For the configuration 3D-4a the test square lying on the light-gray background was tilted toward the hypothetical light source, so it appeared darker in contrast to the test square lying on the dark-gray background, which was tilted downward from the hypothetical light source and so appeared lighter. This configuration resulted in an increase of IS values. Using the same inferences it is possible to explain the decrease of IS values for the 3D-4b configuration. The changes of illusion strength for 3D-5a and 3D-5b may be interpreted similarly.

Conclusion

Two current models of lightness perception—the albedo hypothesis and the coplanar-ratio hypothesis—were tested to explain the results of the study. The changes in the SLC illusion strength for different 2D-3D configurations were consistent with predictions made by the albedo hypothesis. It seems that in 3D scenes the perceived illumination of a surface should be considered as the main parameter for lightness estimations.

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Sense disambiguation in polysemous words: cognitive perspective

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In this paper the authors put polysemy research into the broader context of research into the mental lexicon, cognitive context conceptual priming, and probabilistic conceptual modelling. The article adopts a novel approach to the resolution of polysemy and puts it to an empirical test. The authors argue that priming plays a key role in the activation of an adequate meaning of a polysemous word. Mental structures, represented by a prime lexical unit, contain relevant conceptual information on the target word meaning. The prime triggers a cognitive context that influences the selection process of the target word sense.

Key words: mental lexicon, conceptual modelling, priming, polysemy, mental representations, sense disambiguation, cognitive contexts

1. Introduction

Resolving polysemy has always been and remains one of the key issues in both traditional semantics and cognitive semantics. In cognitive semantics, a polysemous word is interpreted as a mental structure resulting from the complex nature of human experience, and our understanding and interpretation of it. Language crystalizes reality, and shows how it is perceived, categorised and construed by the human mind. Every word is a result of certain cognitive processes (Kubryakova, 1997, p.38).

Polysemous words do not develop their senses at random, but “follow certain cognitive paths or patterns that are natural to human cognition and that structure our acquisition of experience, knowledge of the world and language” (Nerlich et al., 2003, p.7). Language is understood as a cognitive human activity which draws “on patterns that are regulated in accordance with a community’s sociocultural practices” (S.Cowley, 2011). Human knowledge of the world in all its complexity is stored in the mental lexicon.

We can argue that the mental lexicon performs an important role in polysemy resolution, since it is the mental lexicon that concentrates various types of cognitive

processes connected with perception, processing, storage, retrieval, usage and generation of knowledge. There is no unanimously accepted understanding of what the mental lexicon is and what functions it performs. Opinions vary: some consider it to be a mental store of information about words that includes semantic information (words' meaning), syntactic information (how words are combined to form sentences, and the details of word forms.) Some theories present the mental lexicon as an instrument for both language comprehension and production, while other theories distinguish between input and output lexica (M.Gazzaniga et al., 2009, pp.389-390). There are also opinions that the mental lexicon is organized in the form of information-specific networks. It is often understood as a system of concepts and links between them which have been formed as a result of human cognitive activity. However, there is a general understanding that the mental lexicon is an inherent part of human memory; it is directly connected with language and the role it plays in cognition. On the one hand, the mental lexicon is a kind of analogue of a certain natural language. On the other, it is an integral part of the human mind, intellect and human memory (Kubryakova, 2004, p.379).

Given that context is a key factor in resolving polysemy, the central question in the theory of polysemy is still that of what aspects of word meanings are predefined and invariant across multiple contexts, versus what other aspects are indeterminate and only realized in context (Ravin, Leacock, 2002, pp.5-6). The research presented in this article focuses on different types of cognitive contexts stored in the mental lexicon that are activated during the process of word sense disambiguation.

2. Mental lexicon, cognitive contexts and polysemy

The formation of the mental lexicon takes place throughout life. From the age of 16 months, children acquire 10 or more new words daily (Eysenk, Keane, 2010, p.328), and a normal adult speaker has a passive vocabulary of about 50 000 words (M.Gazzaniga et al., 2009, p.389). Bearing in mind that both passive and active vocabulary units are polysemous, polysemy resolution mechanisms never fail to attract attention. Multiple word senses are never a problem for human communication. Speakers unconsciously and quickly select the only polysemous word sense that suits a particular context. However, there is purposeful work of the brain behind every polysemy resolution task.

The method of conceptual modelling allows the authors to reconstruct the process of the formation of certain fragments of the mental lexicon related to perception, processing, storage and retrieval of the information connected with particular senses of a polysemous word.

Since most words in natural languages are polysemous, we may assume that every word has a complex mental representation associated with it. The complex mental representation is a result of the perception, decoding, processing, storage and retrieval of various types of information directly and indirectly, relating to the polysemous word. This complex mental representation is a *combination of cognitive contexts* which store various types of information on all types of situations of their usage, real or potential participants, their actions, the sequence of these actions, etc. Thus, a cognitive context is a mental phenomenon of a complex nature. Each

meaning of a polysemous word has its own cognitive context; a combination of all cognitive contexts associated with all the meanings of a polysemous word creates a complex mental representation of the polysemous word.

Cognitive contexts are not static properties; they reflect the dynamic character of human cognition as such. They do not have a once-and-for-all given content, because their content is constantly adjusted in the process of our perception of reality, gaining new experience and assessing it. The acquisition of the senses of polysemous words progresses with varying intensity depending on the intensity of cognitive activity in general. A child first acquires the words denoting concepts belonging to the basic level of categorization. These words are more frequently used, and as research proves, are acquired more easily; they are also processed and identified faster.

All word senses (irrespective of the concepts they denote) are acquired and learned when used in a specific context. In our study the notion of *cognitive context* is understood broadly, and includes a whole range of cognitive context sublevels — universal, culture-specific, individual, etc. in all the multitude of their parameters. As our empirical research shows, a broad cognitive context may contain ‘universal’ conceptual information which is often perceived and processed *by default*. This information is implicitly present in a given cognitive context, associated with a certain sense of a polysemous word. For instance, spatial relations (up-down, above-under), direction, physical structure of the world (e.g. “the sun rises in the east”), time (e.g. past-present-future), movement and its character, etc. Content-wise, this type of conceptual information is acquired in the course of ontological development, and reflects the ontological characteristics of human experience. This is the kind of conceptual information which is seldom (if ever) updated and will remain physically unchanged irrespective of any pragmatic factors; it is a certain conceptual constant that is always implicitly present. However, without this information, any cognitive context will be incomplete. Cognitive scenarios (or any other knowledge representation forms) represent typical, conventional situations, actions, their sequences, etc. and usually develop *against a certain background*. For instance, if we take the word ‘menu’ (which is polysemous), its cognitive scenario ‘records’ all the actions and their sequence associated with eating out — a waiter brings the menu, customers choose the dishes they want, etc. But the human mind registers not only and exclusively what the menu is and its telic function. It effortlessly perceives, processes and stores all the information associated with the concept *menu* — spatial organization of a restaurant, a café, other customers sitting at their tables, a head waiter meeting customers by the door, etc. This information (which can be initially perceived either consciously or by default) may play an important role and potentially generate new information by means of inference. In the case of polysemy, this type of cognitive context perceived by default may help to identify senses of the polysemous word. The following example shows how strongly this type of cognitive context may influence the word sense selection process, sometimes resulting in mistakes:

The pastor noticed little Alex staring at the large plaque that hung in the foyer of the church.

It was covered with names, and small American flags were mounted on either side of it.

The seven year-old had been staring at the plaque for some time, so the pastor walked up, stood beside the boy, and said quietly, "Good morning, Alex."

"Good morning," replied the young man, still focused on the plaque. "What is this?" Alex asked.

"Well, son, it's a memorial to all the young men and women who died in the service."

Soberly, they stood together, staring at the large plaque. Alex's voice was trembling and barely audible when he asked, "Which service, the 9:45 or the 11:15? (<http://www.emmitsburg.net>)

The physical setting of the conversation (a church), an interlocutor (a pastor) and an activity (attending a morning service) obviously made the boy think of the only meaning of the word *service* — "a religious ceremony that takes place in a church". By the age of seven the boy must have heard the word *service* being used in a variety of meanings and contexts, starting with *service* in the senses "work done by people" and "turn to serve" in sports. However, the physical setting dominated the sense selection process, resulting in the misidentification of the word sense.

The culture-specific cognitive context includes information on the cultural specificities of the situation that the meaning of a polysemous word is associated with. This is the kind of knowledge that is characteristic of a particular community sharing the same physical and social environment. For instance, the meaning of the polysemous word *number*, used in sentences like "Please take a number", may be misinterpreted by people coming from countries where the system of queue numbers in shops or public institutions is not common. In this case an additional explanation is needed: "The ticket hall had one of those systems where you take a *number* from a machine by the door and wait for it to appear above one of the ticket windows" (British National Corpus). In this case the physical setting of the conversation is culture-specific.

Stored in human memory, cognitive contexts associated with particular senses of a polysemous word are the fruits of *individual* perception. Cognitive contexts associated with different senses of a polysemous word are inevitably subjective to a degree, since they are formed on the basis of our previous individual experience. Even when using a word in the same sense, two speakers, without realizing it, operate a different volume of conceptual information fixed by the same word sense. When perceiving, processing and storing a cognitive context associated with a particular polysemous word sense, every person has his/her own conceptual world view depending on his/her previous experience, and his/her subjective idea of the value scale formed during earlier life. This type of cognitive context reflects the epistemic characteristics of cognition.

Hence, each polysemous word is associated with a set of dynamic cognitive contexts forming a complex multi-dimensional mental representation, which could potentially capture and store a significant amount of conceptual information, referring in fact to any number of conceptual domains that are relevant to the identification of a particular sense of the word.

In our opinion the process of word sense acquisition and its storage in the mental lexicon can be formally represented in the following way:

- perception of the word (or a polysemous word sense);

- holistic individual perception of the cognitive context associated with the word; visual and perceptual categorization at the conceptual pre-semantic stage;
- association of the word (or its particular sense) with a particular cognitive context;
- accumulation of cognitive contexts associated with different senses of the polysemous word in the process of the multiple use of the word in a variety of situations;
- formation of a complex mental representation (a set of cognitive contexts) and its storage in the mental lexicon.

Consequently, in the mental lexicon a polysemous word may be represented by a complex mental representation — a set of cognitive contexts associated with different senses of the polysemous word. This mental representation may ‘record’ a large volume of information belonging to different conceptual domains.

We also attempt to analyze the opposite process — the process of word retrieval from the mental lexicon, specifically polysemous word sense disambiguation, with the help of *conceptual priming*.

In a traditional semantic priming task, subjects are presented with pairs of words. The first member of the pair, the prime, is a word; the second member, the target, can be a real word, a non-word, or a pseudo-word. Subjects are faster and more accurate at making lexical decisions when the target word is preceded by a related prime, e.g. the prime ‘car’ for the target ‘truck’ (Gazzaniga et al., 2009, p.390). So conceptual priming is a faster means of identifying a particular word meanly after the presentation of a prime belonging to the same conceptual category.

The results of our research show that a set of cognitive contexts (or a particular cognitive context) may act as a conceptual prime, leading to a faster and more accurate identification of the target word sense. Probabilistic conceptual modelling of word sense disambiguation clearly demonstrates the role of a particular type of cognitive context and conceptual primes in word sense disambiguation.

Conceptual modelling allows us to suggest a cognitive model simulating the process of resolving polysemy:

- perception of a polysemous word in one of its senses;
- activation of the complex mental representation (a *set* of cognitive contexts) associated with the word;
- activation of a *particular* cognitive context acting as a prime;
- word sense selection.

It should be noted that the sequence of conceptual operations presented above is only a hypothesis, and needs experimental evidence. However, it is still possible to illustrate the process of word sense disambiguation using data from the British National Corpus, specifically instances of new senses developing for polysemous English nouns. Let us take the word *bird* as an example, as we used it in our previous works on polysemy development and resolution (Zabolotkina, Boyarskaya 2011, 2012).

The word *bird* has the following meanings recorded in most monolingual English dictionaries:

- n) warm-blooded egg-laying vertebrates characterized by feathers and forelimbs modified as wings
 - S: (n) the flesh of a bird or fowl (wild or domestic) used as food
 - S: (n) informal term for a (young) woman
 - S: (n) a cry or noise made to express displeasure or contempt
 - S: (n) badminton equipment consisting of a ball of cork or rubber with a crown of feathers

(WordNet)

Let us analyse the following sentences retrieved from the British National Corpus. We have chosen four groups of examples showing the use of the polysemous noun *bird* in some of its meanings:

- (1) a. Glancing up, I saw a beautiful yellow bird perched on a telegraph wire, looking like a prize long-tailed canary.
b. The bird shuffled along the perch.
- (2) a. Victoria Wood's quite an attractive bird for a fat lady.
b. Richie left with a bird yesterday.
c. Oh look ain't that, that same bird.
d. He had risen in the City to a financial position which permitted him to park his BMW beside the flash docklands flat, close to his rough but pure roots, in which he kept his nice French bird.
- (3) a. How soon could Kirov get his bird off the ground, do you think?
b. That's a **** there is still no other bird that can take off!
- (4) Ninety seven there it is now showing, Lot ninety seven, singing bird in a cage I have three hundred offered for this, three hundred pounds and twenty, three fifty, three eighty, four hundred and twenty, fifty four eighty five hundred fifty six hundred and fifty, seven hundred fifty eight hundred eight hundred pounds seated now, any more at eight hundred and fifty nine hundred and fifty nine fifty nine fifty, one thousand new bidder thousand one hundred one thousand one hundred pounds, any more?

In examples 1a and 1b the word *bird* is used in its basic primary meaning. In 1a the cognitive context contains conceptual information which serves as a clue for the proper identification of the word sense — spatial position of the object (glancing up), location (perched on a telegraph wire), appearance (beautiful and yellow, looking like a prize long-tailed canary). Even if we had been given a minimum of conceptual information — “glancing up, I saw a beautiful yellow bird...” — it would not have been difficult to identify the meaning of the word since most of us have seen a rather familiar picture many times — birds sitting on telegraph wires. The cognitive context that is activated in 1a (‘birds sitting on telegraph wires’) helps to identify the precise meaning of the word *bird*.

In example 1b the noun *bird* is also used in its basic meaning. However, the character and type of movement of the bird — “shuffled”- activate a cognitive context which is different from the cognitive context in example 1a. This cognitive context is also associatively connected with a bird, but a larger and heavier one, probably

hardly able to fly (one of the prototypical characteristics of birds). The meaning of the word (as it is given in traditional dictionaries) is the same, but the volume of conceptual information and cognitive contexts associated with these senses are different. It makes us think about some domestic birds moving slowly along a perch.

In the second group of examples, cognitive contexts activate another meaning of the polysemous word belonging to the category HUMAN BEING — a female (Victoria Wood, lady), having certain physical (fat) and evaluative (attractive) characteristics. The activation of these conceptual domains helps to identify the metaphorical and pragmatically marked meaning — “an attractive woman”.

In 2b a different cognitive context is activated. It contains information about a rather stereotypical situation — a man leaves a restaurant/bar/party accompanied by a young and attractive girl. This cognitive context is so stereotypical that any part of it can be easily reconstructed. We have seen it happen many times in real life, in movies, etc. We can even reconstruct actions/events preceding the ones described in the sentence. This previously acquired cognitive context helps to identify the metaphorical meaning of the word *bird*.

In example 2c the purely linguistic context is so narrow that it is impossible to identify the meaning of the polysemous word. However, a wider pragmatic context (a young man of 19 talks to his peers) and phonetic peculiarities of his speech make us think of the only target meaning — ‘a young and attractive girl’. Our memory stores the information about young men of a particular age, their behaviour, topics of conversation, etc. We know from our previous experience what young boys are like, what they tend to speak about, etc. Consequently, a particular cognitive context, representing conceptual information and containing a number of pragmatic stratification characteristics, acts as a prime, helping to identify the sense of the target word — “an attractive girl”.

The cognitive context in 2d contains fairly stereotypical information about a well-off clerk, who has a prestigious and well paid job, “had risen in the City to a financial position”, has an expensive apartment — a “flash docklands flat” — and an expensive car — “his BMW”, as well as a pretty girlfriend who is French. This cognitive context is not culture-specific, it is so ubiquitous that it activates the only possible meaning — “a young and beautiful girl”. To some extent, the resolution of polysemy here is very much expectancy-induced. For instance, if we ask anybody to continue the following sentence “He is an oligarch; he has a mansion, a Mercedes and...”, then most people would probably add something like “a yacht, a ..., a wife and a lover”. This stereotype was formed by the mass media. So when we hear a sentence like the one analyzed previously, our minds offer a cognitive context which evokes this stereotype.

In examples 3a and 3b the noun *bird* is used in its metaphorical meaning — ‘a plane’. The complex mental representation in example 3a contains different types of conceptual information — on historical epoch (Kirov), place (Russia), action (get smth. off the ground). Being activated, these cognitive contexts taken together help to identify the metaphorical meaning of the word *bird* which can be found only in some dictionaries — a plane, missile, etc. Our background knowledge about the time of the action and our approximate assessment of the level of technology of that time narrow the volume of conceptual information of the target word to the sense ‘plane’, since missiles had not been designed at that time.

In example 3b a different cognitive context is activated — an airport, the impossibility of taking a flight (take off), irritation and anger (obscene words). A stereotypical situation, familiar to everybody who has had the experience of preparing to take a flight which is then cancelled due to technical problems or adverse weather conditions. Once experienced or perceived, this activated cognitive context may act as a prime, helping to identify the only sense possible — “a plane”.

Example 4 shows another cognitive context — that of an auction. This cognitive context contains conceptual information about all the necessary elements of any auction — a seller (auctioneer), buyers (bidders), money (offered sums) and, finally the lot being sold — ‘a bird in a cage’. The activated cognitive context makes it clear that the lot is not a live bird, since our stereotypical idea of an auction is not primarily associated with selling live birds, but rather works of art. So it is quite clear that “bird in a cage” is either a painting, or a statuette. Since there is no further information it is impossible to identify the sense more precisely, and the sentence remains vague.

3. Conclusion

Thus, we argue that every sense of a polysemous word has a set of cognitive contexts associated with it. The total of cognitive contexts of all word senses forms a complex mental representation. Cognitive contexts as inherent parts of the mental lexicon may perform the function of a prime, resulting in an easier and more precise identification of a polysemous word sense. However, further research is needed regarding the sequence of cognitive processes involved in polysemy resolution.

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The social brain

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This article considers different aspects of the new neuropsychological theory of the social brain and its relationship to Luria's and Vygotsky's understanding of a human as a social and biological unity. The main functions of social cognition are described. Five aspects of these functions and five groups of evidence are analyzed: the negative consequences of brain damage on social behavior and social cognition; the social features of early-childhood development; the double interaction between brain maturation and the formation of mental functions; the negative consequences of social neglect on brain development; and the social and cultural specificity of neuropsychological assessment methods. The proposed new understanding of the social brain is as the social and cultural regulator of brain functioning.

Keywords: neuropsychology, cultural-historical approach, brain functioning, social cognition

The term *social brain* was introduced into neuropsychology by Gazzaniga (1985) in his studies of emotional and social communication disturbances after right-hemisphere damages.

Later this term was used to show how the human brain processes social information and regulates the mind as a whole (Brothers, 1990; Brüne, Ribbert, & Schiefelholz, 2003; Dunbar, Gamble, & Gowlett, 2010; Insel & Fernald, 2004).

Two theories are used to explain the organization of social cognition; the first is *theory of mind* (Weed, McGregor, Nielsen, Roepstorff, & Frith, 2010). In this theory, social cognition is understood as a typical module, separated from any other processes, that operates with specific knowledge. People have a definite theory about inner, nonobservable mental states that generate observable behaviors. Theory of mind is closely related to, or even dependent on, communication

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and language. All acts of communication, such as using metaphors, humor, irony, and sarcastic phrases and having the conversational ability to make issues understandable to others, require constant awareness of the participants' states of mind (their knowledge, intentions, and beliefs). This theory also postulates that activating the theory of mind requires mobilization of some executive subsystems, such as cognitive plasticity, working memory, the inhibition of selected stimuli for the benefit of others, and the ability to use representations and metarepresentations (Aboulafia-Brakha, Christe, Martory, & Annoni, 2011).

Disturbances of social cognition, an inability to understand the feelings of others, which is a manifestation of a lack of theory of mind, is one of the explanations for the behavioral disturbances in autism (Brownell, Griffin, Winner, Friedman, & Happe, 2000; Nikolskaya et al., 2005). Neurovisualization techniques reveal in these patients an aborted development of the dendritic structure of the limbic system and an increase in the number of abnormal cells in the cerebellum (Joseph, 1999).

The second model for the organization of social cognition is *simulation theory* (Adolphs, Damasio, Tranel, Cooper, & Damasio, 2000), which proposes that although mental states of others are not directly observable, it is possible to use our imagination and our mental states as a model for simulating the mental states of others. Simulation theory is connected to the discovery of "mirror neurons," which are localized in the premotor ventral cortex and partly in the parietal lobe (Rizzolatti, Fadiga, Gallese, & Fogassi, 1996); mirror neurons are activated by the subject's own movement but also by observation of another person's movement. Mirror neurons are a kind of "translator" of observable behavior to inner, mental states.

Social cognition has the following main functions:

- integration of a complex situation into a meaningful whole, emotionally and socially
- evaluation of the situation on the basis of moral behavior
- self-regulation

The relationship between social cognition and social behavior is still largely unknown or is very complex and involved in connections with other regulatory processes. It is highly probable that there is no simple translation of social cognition into social behavior. But pathology in those two components leads to the interpersonal maladjustment of patients with brain injury.

Five aspects of the functioning of social cognition and five groups of evidence can be analyzed in studies of social cognition and the social brain:

- 1) the negative consequences of brain damage on social behavior and social cognition
- 2) the social features of early-childhood development
- 3) the double interaction between brain maturation and the formation of mental functions
- 4) the negative consequences of social neglect on brain development
- 5) the social and cultural specificity of neuropsychological assessment methods

Negative Consequences of Brain Damage on Social Behavior and Social Cognition

Neuropsychological studies focusing on the location of brain structures whose failure specifically interferes with social functioning have emphasized the regulative role of the brain's frontal lobes and right hemisphere (Borod, Koff, & Caron, 1983; Eslinger & Geder, 2000; Herzyk, 2000; *Lezak*, 1986; Malloy, Bihle, & Duffy, 1993; Stuss & Benson, 1984; Tompkins, 1997). The functions associated with the right hemisphere have even been described as a “buried treasure” (Perecman, 1983).

Suggested explanations for this role of the right hemisphere have referred to its functional specificity. Also, the right hemisphere has more associative areas than the left. This hemisphere is dominant for the perception of bodily images and for bodily sensations, which are the primary basis for generating affective experience. This claim was on the one hand extensively documented by Devinsky (2000); on the other hand, it points to the role of the so-called neurosomatic concepts, which emphasize the specific contribution of somatic, visceral processes in the brain's organization of cognition and affect. The best-known concept that belongs to the current neurosomatic trend is the somatic-marker hypothesis of Damasio (1999).

As O'Shanick and O'Shanick remark (1994), “personality change” resulting from brain damage and manifested mainly within interpersonal behaviors is considered by family and friends as the most serious problem of a patient with brain damage, even if the change occurs after 1, 5, or 15 years. Such a change also interferes with the efficiency of the neurorehabilitation of brain-damaged patients (Glass, Matchar, Belyea, & Feussner, 1993; *Lezak*, 1986; Pächalska, 2007).

A relatively new theoretical approach is neuropsychanalysis—the study of the relationship between the structure and functions of the right hemisphere and social attachment—namely, coping with stress (Krukow, 2008; Schore, 1994).

To sum up the evidence for the negative consequences of brain damage on social behavior and social cognition one should mention:

- Disturbances in the expression of emotions and in the recognition of the mental state of others after right-hemisphere and frontal damage (the worst results for social behavior are seen in patients with frontal-lobe dysfunctions)
- Behavior disturbances (self-criticism, lack of accuracy in reactions to social stimuli) in the frontal syndrome (Luria, 1973)
- Affective disturbances in people with Parkinson's disease (Glozman, 2004)
- Disorders in the generation, recognition, and experience of fear and the expression of surprise in patients with bilateral amygdala damage (Ammerlaan, Hendriks, Colon, & Kessels, 2008)
- Behavior and social-cognition disturbances after unilateral ischemic stroke in the area of the right middle cerebral artery (Krukow, 2013)
- Social consequences of ADHD (Glozman, 2012)

Social features of early-childhood development

Investigations using functional neuroimaging have contributed a lot of information to the study of the neuronal organization of social cognition. Authors of neuroimaging studies emphasize the role of different frontal areas and of the superior temporal sulcus and temporo-parietal junction. The superior temporal sulcus is activated when a subject perceives biological motion. A newborn infant follows face-like stimuli and has no reactions to inanimate subjects (Goren, Sarty, & Wu, 1975). The same neural structure is considered crucial to anthropomorphizing in adults, in which moving geometric shapes, active for about two minutes, are perceived by healthy people as animate beings that even have intentionality and personality. Studies show that the amygdala also plays an important role in anthropomorphizing (Heberlein & Adolphs, 2004); the amygdala probably initiates the process of social cognition and is its most fundamental source (Grossman et al., 2000; Weed et al., 2010).

Despite the fact that the observed activation may be bilateral in nature, experiments have confirmed a right-hemisphere advantage for identifying biological motion (Saxe, 2006). This advantage may be due to special aspects of neuroanatomical and functional right-hemisphere development. According to Schore (1994) the right hemisphere develops in the first two years primarily as a result of child-mother attachment. This relationship is peculiarly stimulating, and within its framework various abilities of children are developed: in the beginning, perceiving and then distinguishing the mother from other people, especially her face and voice, and, later, recognizing her intentions and other forms of individual intellectual abilities. In this way, attachment is developmentally related to social cognition.

Very early a baby begins to differentiate human voices from other sounds. An interesting study done by Mampe, Friederici, Christophe, and Wermke (2009) showed that the first expressions of infants are socially influenced: newborns' cry melodies are shaped by their native language.

In addition, overloading the visual perception system by watching TV provokes the sensory deprivation of other systems of analysis—above all, motor functions and communication skills. Or a missed phase of crawling, sometimes induced by parents trying to prevent traumas or infections, provokes spatial disturbances (Glozman, 2012).

Double interaction between brain maturation and the formation of mental functions

Thus, we have the double interaction between brain maturation and the formation of mental functions: on the one hand, for the emergence of a function a certain degree of maturity of the nervous system is required; on the other hand, the self-functioning of and the active, developing influence on a psychological function is conducive to the maturation of structural elements of the brain (Halperin, Zaporozhets, & Karpova, 1978). "The effects of childhood environment, favorable or unfavorable, interact with all the processes of neurodevelopment (neurogenesis, migration, differentiation, arborization, synaptogenesis, synaptic sculpting and myelination" (Perry, 2002, p. 79).

The expansion of the ratio of the neocortex to evolutionally older areas is most closely correlated with the size and complexity of the social group in which the human species evolved. In other words, the evolutionary development of the brain is the result of adaptation to social factors.

Negative consequences of social neglect on brain development

Therefore social neglect has very negative consequences on brain development, as was proved in comparative studies of the brains of 3-year-old normal and neglected children by Perry (2002). The size of the brain of a neglected child was significantly smaller than in normal children.

The author revealed also that the early removal of a child from a social situation unfavorable for development favors recovery .

Social and cultural specificity of neuropsychological assessment methods

It has been shown that well-educated but brain-impaired individuals show neuropsychological performance similar to that of non-brain-impaired but illiterate individuals (Puente, 2012).

Thus each neuropsychological test is culturally specific: in one culture it reveals a brain pathology; in another, a low level of education or a lack of skills. The same IQ score will qualify a subject as a genius compared with the middle level of his or her population and as mentally retarded in another culture. Spatial representations of a rural subject are different from those of an urban subject. There are also differences in the lateral organization of verbal functions (Ardila, 1995). Johnson (2006) described 62 culture-specific variables in psychometric tests administration and interpretation.

All norms for neuropsychological tests should be culture-specific to provide their validity. However, most test norms were received through assessment of white subjects from the middle class. The standard procedure of test administration does not provide its relevance to cultural standards. A test translated into another language needs a selection of new material corresponding to linguistic and cultural features.

The language of assessment is of paramount importance for bilingual subjects: often the results are worse if testing is not performed in the native (maternal) language. A comparative study of bilingual and monolingual children with the NEPSY battery revealed that bilingual children in various countries performed better on digital tests and in copying, while monolinguals predominated on verbal and visual attention tests (Garratt & Kelly, 2008).

Cultural specificity is characteristic of both verbal and nonverbal tests. Visual images for naming as well as stories in pictures differ when using the same battery in different countries. The “broken window” story from the Luria battery is inappropriate for subjects who have never seen snow (David & Glozman, 2010).

The procedure of assessment is also important. For instance, in a study by Serpell (1979) African and British children had to reproduce patterns with pen and paper as well as with wire. British children were better with pen and paper, while Africans had better results using wire.

The time allowed for test completion, important for many psychometric tests, also depends on cultural traditions: the quick performance of mental tasks is common for American children from the first classes of school, while in the Russian school system more attention is paid in such activities to selectivity and stability, which interfere with speed. This difference explains why in a comparative assessment of two groups of students Americans did better than Russians in psychometric tests with limited time for completion (Agranovich, 2004).

Cross-cultural studies reveal that some neuropsychological tests are less influenced by cultural differences: for example, verbal-fluency tests, digit-span tests, memory tests, and the test of the “clock without hands” from the Luria battery (Agranovich, 2004).

Thus, the cultural specificity of neuropsychological assessment is both a social and an ethical problem. Cultural equality of tests is as important as their validity for assessment of brain functioning.

Conclusion

As far back as 1922 Luria proposed “a principle of real psychology”: “to deal with the concrete personality, the living human being, as a biological, social and psychological unity” (1922/2003, p. 296). This principle can be considered a foundation of the cultural-historical approach in psychology, which was later developed by Luria together with Vygotsky (1930/1982), and it is, in particular, a foundation of cultural-historical neuropsychology, which studies the interactions of culture and brain functions. A definitive explanation of this approach was given in the last book by Luria; analyzing his own contributions to psychological science, he wrote, “We need to step outside the organism to discover the sources of specifically human forms of psychological activity” (1979, p. 43).

These ideas by Luria were developed in contemporary Western neuropsychology and neurosciences through the concept of the social brain. The social neuropsychological approach is essentially dominant in the newest Western neuroscientific literature. Nevertheless this concept was deeply influenced by narrow localization tendencies in Western neuropsychology, which looked predominantly for cerebral representations of different forms of social cognition and social behavior. Because of this search the participation of different cerebral structures in these processes was proved. Interaction between brain structures can take place at the level of neuroanatomical structures, functional systems, and neurochemical modulation.

The cultural-historical approach in neuropsychology signifies a change in the orientation of studies of the social brain from localization to problems in the social and cultural regulation of cerebral functions.

This is a potentially relevant perspective for further neuropsychological investigation: one should examine not only patients’ cognitive and other regulatory processes but also their relationships with people with whom they interact at different levels of intimacy. This analysis should assess their behavior with a strong emphasis on ecological validity. Nowadays more and more rehabilitation programs use the holistic approach, often taking into account the interpersonal aspect (Jojek, 2008); interdisciplinary cooperation can develop programs combining cognitive therapy with a range of neuropsychanalytic methods (Kaplan-Solms & Solms, 2001).

The correlation of cognition and social behavior assumes that patients who have difficulty in recognizing and understanding intentions and emotions are also judged as emotionally indifferent and as not exhibiting behaviors associated with emotional bonds. Patients who do not perceive the intentional behaviors of others are not able to respond in the manner expected.

To conclude, it is necessary to analyze the possibilities and limitations of the application of the social-brain concept and to answer some important questions:

- Does the assessment of social cognition bring new possibilities for clinical neuropsychological diagnosis?
(Most likely not: social cognition is connected to many structures)
- Are there possibilities for applying the results of social neuroscience in the rehabilitation of neurological and neuropsychiatric patients with disruptions of social behavior?
(Definitely yes)
- Are these results important for regulating a subject's health and quality of life?
(Definitely yes)
- Are they important for developmental neuropsychology?
(Definitely yes)

Thus, diagnosis and therapy should take into account patients' interpersonal relationships and, in particular, the ecological dimensions of neuropsychological assessment as a way to understand "the interdependence of the individual mind and the culture that enabled that mind to grow in a manner that recognizes and copes with the complexities of the world, physical and social alike" (Bruner, 2004, p. xii).

This understanding can permit us to answer the question: What can neuropsychology do for our culture, for social life?

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Psychophysiological mechanisms of mental stress reactions in patients with “hypertension at work” and patients with essential Hypertension: a comparative analysis

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In the study, psychological and physiological features were assessed during an experimentally designed stressful situation in 85 subjects with hypertension (HTN) in the workplace, 85 patients with essential HTN, and 82 healthy individuals.

It was showed, that patients with HTN in the experimental situation were characterized by a complex of physiological and psychological features, which distinguish them from healthy participants. A reliably greater increase in systolic blood pressure (BP) was recorded in these patients in comparison with healthy individuals (on average by 14 and 3 mmHg respectively). The aspiration level (AL) of these patients was characterized by a reliably greater height, inadequacy, and instability; as for nonverbal behavior, it revealed a reliably greater amount of gestures, and frequent changes in voice tone against similar features of healthy individuals.

The group of patients with HTN at work, when compared with essential HTN patients, was characterized by a reliably greater increase of systolic BP (on the average by 16 and 4 mmHg respectively) as a reaction to emotional stress. The systolic BP increase in this group was revealed in combination with an initially reliably lower catecholamines' level (CA), a gradual decrease of CA level in urine, and renin and angiotensin-1 in blood plasma during the experiment. This combination is an indicator of chronic stress and psychophysiological exhaustion. The patients did not manifest any increase of anxiety during the experiment; they were characterized, however, by a greater frequency of AL inadequacy and instability. The behavior of patients with HTN at work during the experiment was marked by a limited repertory of poses and gestures, but more vigorous facial expressions, and frequent pitch jumps. Obtained results lead us to confirm that the repression of emotions comes as a significant pathogenetic factor in the genesis of psychosomatic syndrome among patients with HTN at work, as opposed to patients with essential HTN.

Keywords: hypertension at work, essential hypertension, mental stress, state anxiety, psychophysiological mechanisms, aspiration level, emotion regulation, repression of emotions.

1. Problem statement and motivation

Hypertension (HTN) and related complications remain among the main problems in contemporary medicine and clinical psychology. In recent years a stable tendency of cardiologic disease to grow younger has been noted. The tendency is usually related to the penetrating effect of stress on modern society, while most able and vigorous people fall prey to it. Nowadays an increasing number of patients have been identified whose blood pressure (BP) indices at work are higher than during free time. This HTN form was called "HTN at work" (Stork J., et al., 1992). HTN at work today is found to be one of the most frequent forms of stress-induced HTN (Karasek, 1998; Light, 2000).

The vital importance of early detection, treatment and prevention of the stress-induced HTN is believed to be spurring a revival of interest in psychological models of psychosomatic syndrome genesis in medicine and clinical psychology, as noted recently (Chandola, et al., 2008; Greenberg, 2008; Mann, 2012); this can also be said for new studies on the role of the central nervous system (CNS) in BP regulation (Wyss, Carlson, 2001; Zubcevic, et al., 2011).

The role of stress in BP increase, first established at the beginning of the last century through psychophysiological research conducted by W. Cannon, I.P. Pavlov, H. Selye and G.F. Lang, today is once again being vigorously discussed and investigated with the application of modern diagnostic methods and a new documentary basis provided by contemporary science.

Ample studies show that the sympathetic nervous system (SNS) and the renin-angiotensin-aldosterone system (RAAS) are basic physiological systems which sustain BP regulation. However, in spite of more than 100 years of research, it is still unclear whether recurrent short-term BP increases under emotional stress may lead to a constant BP increase, as is the role of SNS and RAAS in this process. Many specialists find it possible that occasional episodes of BP increase under stress in individuals with genetic and psychological predispositions may cause structural changes in the heart and blood vessels and result in constant HTN.

From the psychological point of view, the question of primary importance is that of which psychological features should distinguish a person who is subjected to enduring aggressive stressful situations. These may suggest a constant demand to comply with high and often excessive requirements every day for many years.

The purpose of this research is to conduct a theoretical analysis and empirical study of specific features of psychophysiological mechanisms of stress reactions in patients with HTN at work, as compared with essential HTN patients.

2. The role of the sympathetic nervous system and rennin-angiotensin-aldosterone system in BP regulation under mental stress: historical and contemporary views

Studies of the role of stress in the etiology and pathogenesis of HTN have a long-standing tradition. In the early works of W. Cannon and H. Selye, the role of SNS in emotion regulation and implementation of stress reaction was tested experimentally. Many inquiries into stress psychophysiology showed that the activation of the autonomic nervous system, in the first place its sympathetic branch, is the factor

which triggers all stress-related physiological changes, including BP increase (Palatini, 1997; Wyss, Carlson, 2001; Kamarck, Lovallo, 2003; Zubcevic, et al., 2011).

In recent years the implication of the peripheral nervous system in long-term BP regulation and development of HTN complications has been revised. The unfavorable role of increased variability in BP, a principal characteristic of stress-induced HTN, was proved. From a contemporary point of view, the medulla oblongata, hypothalamus and cerebral cortex are the main nervous centers contributing to BP regulation (Wyss, Carlson, 2001). New findings in the field of humoral and local BP regulation confirm the thesis that hormonal transmitting components of SNS are the most important homeostasis regulators responsible for stress resistance (Treiber, et al., 2003; Carlson, Wyss, 2011).

However, published data on SNS reaction to intellectual and emotional challenges in patients with HTN is quite ambiguous. In a number of studies, no reliable quantitative difference has been found between healthy individuals and patients with HTN in catecholamines (CA) excretion with urine in response to stress (Men'shikov, Makolkin, Bol'shakova, 1980; Rostrup, Westhein, Kjeldsen, 1993). Some researchers attribute CA increase to the reactive acceleration of its synthesis from dopamine in healthy individuals, and for patients with HTN, to the acceleration of dopamine production (Bell, 1987). Other authors would attribute the relative equality in the increase in concentration of adrenal medulla hormones under different hemodynamic effects to growth of sensitivity and activity of adrenoreceptors of the vascular wall in patients with HTN (Soltis, Field, 1984).

A considerable amount of work would also testify to a different adrenergic reaction in healthy individuals and in patients with HTN. For example, F.Z. Meerson evaluated the CA dynamics while informational tasks were solved by participants in time-limited conditions. He discovered that while initial adrenaline (A) and noradrenaline (NA) indices were relatively equal in both groups, patients with HTN reacted by A increase in blood plasma by 90%, NA – by 107%, while healthy individuals showed A increase by 80%, NA – by 15% from the initial level (Meerson, Gurevich, 1981).

It is important to note that not every form of stress leads to identical hormonal and hemodynamic changes in participants. Many researchers believe that the peak of CA concentration coincides with a climax of graduated emotional strain. At the same time there is a certain contradiction in data provided by different investigations of dynamics of NA/A relation during the test. Most authors point out that healthy individuals, as well as patients with HTN, react with an increase in excretion of both A and NA. With all that, correlation of NA/A during stress tends to go down in the group of healthy participants. That is, stress in healthy individuals is brought about mostly by A; whereas patients with HTN are mostly characterized by NA increase, hence, NA/A correlation in these patients increases under stress (Meerson, Gurevich, 1981; Paran, Neumann, Cristal, 1992; Kurina, Schneider, Waite, 2004). However, some works suggest data of the opposite CA correlations in groups of healthy participants and patients with HTN (Georgiades, A., et al., 1997).

The role of SNS in HTN pathogenesis is estimated ambiguously. There are reports that NA and A excretion with urine recorded for patients with HTN is similar to indices for healthy individuals (Kushakovsky, 1977). Quite different results have been shown through research into CA concentration in blood plasma. An increase

of NA level in blood plasma was detected in 43% of patients with HTN. This data is to some extent confirmed by the results obtained by J.R. Sowers and A. M. Richards, whose study into the daily rhythm of CA secretion and BP in HTN patients revealed a close correlation between NA content in blood plasma and BP indices (Richards, et al., 1986; Sowers, 1981).

The results of SNS activity studies in patients with HTN are equivocal. S.L. Lightman noted that among 22 world centers engaged in the study of CA metabolism under HTN, 7 laboratories obtained data on CA activation increase, while 11 suggest an absence of any significant changes, and another 4 provided data of its decrease (Lightman, et al., 1981). Such a variety of data may be accounted for by a number of reasons, for one thing, by the clinical heterogeneity of studied groups of patients.

The expansion of knowledge in HTN pathogenesis has led to a more scrupulous investigation of RAAS, which together with SNS form a humoral background of cardiovascular reactions. J.H. Laragh introduces a hypothesis of two types of HTN, one of which is characterized by increased renin activity in blood plasma (ARP), another HTN suggests low ARP, while BP remains high due to increased volume of circulating blood (Laragh, et al., 1972). However, the hypothesis was never confirmed, since there were contradictory data for the comparison of central and renal hemodynamics with ARP, especially at the initial stage of the disease, when depressor system is active enough and organic lesions of certain organs and vessels have not yet surfaced.

While RAAS implication in renovascular HTN has been quite well studied, the renin role in pathogenesis of essential HTN is still largely unclear. This becomes clear in counterpleading assessments of clinical data for HTN patients with low and high ARP. Thus, high ARP is accompanied by higher diastolic BP, most frequent and severe progress of hypertensive crises, proteinuria and retinopathy, and heart aches (Shhvacabaya, 1982). Conversely, crises and organic lesions are statistically rare in patients with low ARP (Laragh, et al., 1972). Other authors, contradicting Laragh, would emphasize a correlation with diastolic BP increase and an equal frequency of complications in patients with low ARP in comparison with patients with hyperreninemia.

Thus, analysis of published material leads us to conclude that SNS and RAAS are described as basic physiological systems, providing BP regulation. It is shown that RAAS and SNS are interactive systems with interactions on different levels: central, baroreceptor, adrenal, and level of postsynaptic AT_1 -receptors (Wyss, Carlson, 2001). In healthy people, the short-term effects of the two coordinated systems are directed at activation of powerful compensatory life-sustaining mechanisms. In this case, BP increase, heart rate (HR) growth, angiospasm, blood clotting growth, etc. have an adaptive effect. However, when stress reaction acquires a lingering character, the unfavorable consequences of long-term activation of these mechanisms become obvious.

Recent studies provide ample facts showing that the interaction of nervous (SNS) and humoral (RAAS) mechanisms of BP regulation under stress is one of the central mechanisms of psychophysiological maintenance not only for short-term BP increase under stress, but also for cases of chronic BP increase and the advance of HTN complications (Wyss, Carlson, 2001; Izzo, 2005; Joyner, Charkoudian,

Wallin, 2008). It is necessary to emphasize the importance of purely psychological factors initiating hypertensive reactions as described.

There are several forms of HTN with a predominant increase of systolic BP (systolic BP) and/or SNS activation. Among them, the most interesting for verification of psychosomatic hypothesis is stress-induced HTN, including HTN at work.

3. HTN at work: physiological and psychological aspects

As we mentioned above, HTN at work is now one of the most frequent forms of stress-induced HTN.

The occurrence of HTN at work has been investigated in several projects. Thus, according to data obtained by J. Stork, HTN at work time was detected in 19% of people with normal BP indices, displaying periodical ambulatory changes (Stork, et al., 1992). Recent studies indicate a growth in the frequency of this HTN form in the population (Molinari, Compare, Parati, 2006; Zubcevic, 2011). It most widely concerns people suffering from psychological stress in the workplace. Among the psychological features in patients with HTN at work, the following are emphasized: repressed disposition to anger caused by professional challenges; uncertainty in retaining their jobs; limited opportunities for promotion; high professional requirements with a low level of freedom in decision-making. The group of high-risk includes employees whose position is in the middle of social ladder, so they face pressure both from superiors and subordinates (Cottingham, et al., 1986; Karasek, 1998; O'Donnell, et al., 2008). These patients are characterized by an intensive and enduring experience of negative emotions, which they are prone to conceal in their behavior under apprehensions of being rejected by others. The set of features in general corresponds to emotionality displayed by representatives of the so-called "Type D personality" (distressed personality) (Denollet, 2005).

Research has shown that stress-induced HTN is not a harmless phenomenon. Thus, BP level at work closely correlates with lesion of a target organ (in particular with hypertrophy of left ventricle myocardium), more so than with an ambulatory measured BP level or even night time BP level (Garvas, Garvas, 1999; and others). In the prospective research "Whitehall Study", conducted under the aegis of the WHO, a sample of 10308 managers revealed that restricted freedom in decision-making in professional activity (workers of low- and mid-level) is accompanied by a higher risk of developing ischemic heart disease, both in men and women (Chandola, et al., 2008; Nabi, et al., 2013). Employees suffering high emotional stress were characterized by evident BP increase, progressing with age, while other professional groups showed no such reactions. During prospective research covering 12 years, M. Julius showed that a repressed disposition to irritation in patients with HTN reliably correlates with growth in death rate. Healthy men with normal BP showed no such relationship (Julius, et al. 1986).

A generalized version of pathogenesis of HTN at work may be presented as follows: negatively experienced chronic stress along with genetic and acquired factors contributes in a way to the emergence and/or advance of HTN. In this case the increase of SNS activity serves as a central element of the described interaction. At this point, adrenal medulla releases predominantly A. It stimulates presynaptic β_2 -adrenoreceptors in sympathetic nerve endings, which in turn stimulate NA release.

NA may become active in approaching α_1 -adrenoreceptors and β_1 -adrenoreceptors of a target organ (unstriated muscles of heart and blood vessels) and induce HTN. Frequent and long-term activation of sympathetic element leads to changes in the baroreceptor reflex, 'adjusting' BP to a higher level. Tone of vagus nerve decreases, while BP and HR increase.

The long-term increase of SNS activity may also lead to hyperinsulinemia, with its negative consequences (retention of renal excretion of sodium and water, infringement of cellular electrolyte transportation, development of blood vessels hypertrophy and emergence of metabolic syndrome). Stress reaction is accompanied by the release of adrenocorticotrophic hormone and cortisol. Stress leads to a reduction in renal sodium excretion. Mental stress and saline factor may be mutually increasing.

Apart from the straight hypertensive effect, SNS stimulates RAAS. SNS and RAAS are closely related, since AT_1 -receptors, mediating all the A_{II} effects, are responsible for A and NA release in adrenal medulla. The sympathetic nerve, on the contrary, promotes renin formation in kidneys through A and NA. In consequence, an additive aggravation of pressor effects takes place, which creates further conditions for enduring progressive myocardium hypertrophy.

To summarize all that has been stated above, it should be noted that the most crucial question for understanding the etiology and pathogenesis of HTN at work is the following: what pathophysiological mechanisms stand behind the conversion of BP increase, emerging under mental stress, into a chronic state? Unfortunately, this question has no answer today, as there is no answer to the question about the role of psychological factors in HTN pathogenesis.

4. An empirical study of mental stress reactions in patients with HTN at work and patients with essential HTN

The purpose of this empirical study is to inquire into the specifics of psychophysiological mechanisms of stress reaction in patients with HTN at work, as compared with essential HTN patients, and the revelation of psychological traits connected with particular characteristics of SNS and RAAS.

4.1. Research methods and Participants

The research was carried out with the application of methods of psychological experiment and psychological testing, and methods of physiological data registration.

A stressful situation was created experimentally, employing the procedure of aspiration level (AL) research. A situation was set up that induced a state of mental tension. In the course of the experiment, participants were asked to solve 12 tasks. As stimulating material, Raven's Progressive Matrices, series D and E, were used. The selection of the most difficult, almost unsolvable tasks was stipulated by the purpose of the experiment: to set up a stressful situation. In a preliminary interview, a motivated attitude toward the work was encouraged in the participants, and the experiment was presented as a test of expertise. A time limit was set for task fulfillment. Before and after the experiment participants' level of state anxiety (SA) (the Spielberger SA Inventory), and physiological indices (BP reaction, CA level

in urine, rennin and A_1 level in blood plasma) were assessed. In the course of the experiment features of AL and characteristics of participants' nonverbal behavior were estimated.

Statistical processing of the data was conducted with the application of various methods: calculation of mean values and the standard deviation; calculation of the certainty of distinctions between samples based on indicators of the probability of distinctions between indicators (Student's t-test); detection of correlations among investigated features in groups of participants, employing the method of calculation of Spearman's rank correlation coefficient (r_s), and the Cluster analysis method.

The study involved 170 patients with HTN, stage II, and 82 healthy individuals. Among the HTN patients, 85 participants with HTN at work (mean age was 44.7 ± 4.3 years) were singled out (the first group). This group comprised patients whose BP on working days was statistically higher than their BP on days off (according to results of the ambulatory 48-hours BP monitoring). The second group comprised 85 patients with essential HTN, with a mean age of 47.4 ± 4.5 years. The mean age of healthy participants was 44.9 ± 3.1 years.

4.2. Results

4.2.1. Research in dynamics of physiological indices and anxiety level of patients with HTN and healthy individuals in the course of the experiment

BP data analysis in patients with HTN and healthy individuals shows that average BP indices before the experiment are increased in patients with HTN in comparison with the norm. After the experiment, an increase of BP is detected in both groups, however the increase of systolic BP in patients with HTN is statistically reliable ($p < 0.05$) (Table 1).

Table 1. Average blood pressure indices in HTN patients and in healthy individuals before and after the experiment (mmHg)

Blood pressure indices	Patients with HTN, n=170 (Me \pm SD)	Healthy individuals, n=82 (Me \pm SD)
Systolic BP before the experiment	141.6 \pm 4.1*	127.0 \pm 3.5
Systolic BP after the experiment	155.5 \pm 4.3*	130.0 \pm 1.3
Δ Systolic BP	13.9 \pm 1.3*	3.0 \pm 0.8
Diastolic BP before the experiment	94.6 \pm 3.1*	82.7 \pm 3
Diastolic BP after the experiment	96.1 \pm 2.5*	84.8 \pm 2.9
Δ Diastolic BP	1.5 \pm 0.8	2.1 \pm 0.9

Note. Me — mean; SD — standard deviation. * Differences between the groups are reliable ($p < 0.05$).

BP indices in patients with HTN from the first (HTN at work) and second (essential HTN) groups before and after the experiment are presented in Table 2. No reliable differences in BP indices between the mentioned groups before and after the experiment were recorded. However, after the experiment the growth of systolic BP indices in the first group was reliable higher ($p < 0.05$) than in the second group (16.1 ± 1.9 and 4.1 ± 0.7 mmHg respectively).

Table 2. Average blood pressure indices in the compared groups of HTN patients before and after the experiment (mmHg)

Blood pressure indices	Patients with HTN at work, n=85 (Me±SD)	Patients with essential HTN, n=85 (Me±SD)
Systolic BP before the experiment	141.0±3.5	149.0±3.8
Systolic BP after the experiment	157.1±4.1	153.1±4.0
Δ Systolic BP	16.1±1.9*	4.1±0.7
Diastolic BP before the experiment	92.8±2.0	98.9±2.4
Diastolic BP after the experiment	97.3±2.9	101.3±2.8
Δ Diastolic BP	4.5±0.7	2.4±0.5

Note. Me — mean; SD — standard deviation. * Differences between the groups are reliable ($p < 0.05$).

A comparison of CA levels in urine and renin and A₁ in blood plasma in patients with HTN from the first and second groups, before and after the experiment, showed that patients from the first group have an initially reliably lower level of A and NA in blood than patients from the second group, and that levels of renin and A₁ are comparable. In the course of the experiment, patients from the second group displayed a reliable increase in all four analyzed indices, as the second group showed a reliable decrease. Analysis of the data received during the experiment allows us to note the paradoxicality of reactions to stress in patients with HTN at work (Table 3).

Table 3. Levels of catecholamines in urine, renin, and angiotensin 1 in blood plasma in the compare groups of HTN patients before and after the experiment

Parameters		Patients with HTN at work, n=85 (Me±SD)	Patients with essential HTN, n=85 (Me±SD)
Adrenaline, nmol/s	before the experiment	81.7±0.2	119.8±0.2#
	after the experiment	54.3±0.2*	211.4±0.2*
Noradrenaline, nmol/s	before the experiment	151.6±0.3	182.1±0.3#
	after the experiment	138.6±0.3*	329.2±0.3*
Renin, (ngr/ml)/s	before the experiment	1.04±0.21	0.86±0.21
	after the experiment	0.84±0.01*	0.96±0.01*
Angiotensin 1, (ngr/ml)/s	before the experiment	1.14±0.13	1.26±0.09
	After the experiment	0.96±0.03*	1.35±0.03*

Note. Me — mean; SD — standard deviation. * Differences in the data before and after the experiment are reliable ($p < 0.05$). # Differences between the groups are reliable ($p < 0.05$).

Data analysis of the Spielberger SA Inventory shows an absence of reliable statistical differences both between and inside the groups before and after the experiment. However, the value of the standard deviation in the HTN group indicates a considerable SA data spread both before and after the experiment (Table 4).

Table 4. Average values of state anxiety level in HTN patients and in healthy individuals before and after the experiment (points)

State anxiety level	Patients with HTN, n=170 (Me±SD)	Healthy individuals, n=82 (Me±SD)
SA before the experiment	41.1±3.6	39.6±2.8
SA after the experiment	43.3±4.8	41.8±2.9
Δ SA	2.2±0.3	2.2±0.2

Note. Me — mean; SD — standard deviation. There are no significant differences between the groups in SA.

A comparison of SA level in patients with HTN from the first and second groups showed that qualitative changes of SA level before and after the experiment were comparable in both groups. However, SA level in patients with HTN at work initially was reliably higher, hence the data after the experiment is also reliably higher in comparison with the second group (Table 5).

Table 5. Average indices of state anxiety level in the compare groups of HTN patients before and after the experiment (points)

State anxiety level	Patients with HTN at work, n=85 (Me±SD)	Patients with essential HTN, n=85 (Me±SD)
SA before the experiment	42,8±3,6*	37,0±2,3
SA after the experiment	45,2±2,9*	38,3±2,0
ΔSA	2,4±0,5	1,3±0,2

Note. Me — mean; SD — standard deviation. * Differences between the groups are reliable ($p < 0.05$).

Moreover, we assessed qualitative changes (increase or decrease) in reactive anxiety in the course of experiment. It eventually turned out that the frequency of negative change in SA indices after the experiment is reliably higher ($p < 0.05$) in the group of patients with HTN than in healthy individuals, forming 47.7%. It presumably implies repression of anxiety and other emotions by patients at the moment of stress, as BP increase is reliable ($p < 0.05$).

Table 6. Frequency of positive and negative changes of state anxiety level in the compare groups of HTN patients before and after the experiment (%)

Pattern of SA change after experiment	Patients with HTN at work, n=85		Patients with essential HTN, n=85	
	Absolute value	%	Absolute value	%
Anxiety increases after experiment, $SA_2 > SA_1$	31*	36.5%*	58	68.2%
Anxiety decreases after experiment, $SA_2 < SA_1$	54*	63.5%*	27	31.8%

Note. * Differences between the groups are reliable ($p < 0.05$).

Comparative analysis of the frequency of positive and negative SA changes before and after the experiment in patients with HTN from the first and second groups showed that in the first group, SA decrease after the experiment ($SA_2 < SA_1$) is reliably more frequent ($p < 0.05$), than in the second group (63.5% and 31.8%, respectively). Patients from the second group are characterized by reliably more frequent ($p < 0.05$) increases of SA indices ($SA_2 > SA_1$) after the experiment (Table 6).

Thus, on the basis of data analysis we may conclude that patients with HTN in general differ from healthy individuals by more significant physiological changes arising in the situation of experimental stress modeling. It is shown that patients with stress-induced HTN demonstrate more significant stress reactions, which in certain cases appear paradoxical. It should also be noted that the obtained results testify to the internal heterogeneity of each of the compared groups of HTN patients, which is reflected in the physiological indices.

4.2.2. Study of aspiration level features and nonverbal behavior of patients with HTN and healthy individuals in the course of experiment

Analysis of participants' AL features showed that healthy individuals in our study demonstrate mainly medium AL, rather stable and adequate. In the course of the experiment they show more flexible reactions to success/failure, and introduce corrections into their strategy for picking up the next task with regard to effectiveness of the previous one (Table 7).

Table 7. Frequency of aspiration level characteristics in the compare groups of HTN patients and in healthy individuals (%)

Aspiration level characteristics		Patients with HTN at work, n=85	Patients with essential HTN, n=85	Healthy individuals, n=82
Height	High AL	71.7 *	75.3 *	39.0
	Middle AL	16.5 *	16.5 *	50.0
	Low AL	11.8	8.2	11.0
Stability	Stable AL	43.5 *#	60.0	69.5
	Unstable AL	56.5 *#	40.0	30.5
Adequacy	Adequate AL	30.6 *#	43.5 *	59.8
	Inadequate AL	69.4 *#	56.5 *	40.2

Note. * Differences are reliable in comparison with the group of healthy individuals ($p < 0.05$).

Differences between the first and second groups of patients with HTN are reliable ($p < 0.05$).

The group of patients with HTN had different AL results. Differences were observed for three points: height, stability, and adequacy. In the height profile of AL, HTN patients were superior to healthy subjects. Inadequacy (78.3%) and instability (40.1%) profiles of AL appeared reliably more frequently ($p < 0.05$). As it is shown, patients with HTN at work had a reliably more unstable (56.5%) and inadequate (69.4%) AL compared with the second group ($p < 0.05$). According to the data analysis, patients from the second group in the parameters "stability" and "adequacy" are closer to healthy individuals, than patients with stress-induced HTN (Table 7).

Analysis of participants' nonverbal behavior showed that the group of patients with HTN differed from healthy participants by a greater amount of gestures, more frequent changes in voice, and higher points in the general factor of nonverbal behavior ($p < 0.05$) (Table 8).

Table 8. Average values of nonverbal behaviors in HTN patients and in healthy individuals (points)

Nonverbal behaviors	Patients with HTN, n=170 (Me±SD)	Healthy individuals, n=82 (Me±SD)
Gestures	20.5±1.6*	15.5±1.5
Poses	7.4±1.3	6.0±0.8
Facial expressions	12.1±0.9	13.4±2.2
Tone of voice	9.0±1.2 *	4.4±0.8
General index of nonverbal activity	49.0±1.2 *	39.3±3.1

Note. Me — mean; SD — standard deviation. * Differences between the groups are reliable ($p < 0.05$).

Analysis of nonverbal behavior in the compared groups of patients with HTN showed that patients from the first group employ reliably less gestures and changes of poses ($p < 0.05$), but display more vigorous facial expressions and changes in voice tone ($p < 0.05$), in comparison with the second group (Table 9).

Table 9. Average values of nonverbal behaviors in the compare groups of HTN patients and in healthy individuals (points)

Nonverbal behaviors	Patients with HTN at work, n=85 (Me±SD)	Patients with essential HTN, n=85 (Me±SD)	Healthy individuals, n=82 (Me±SD)
Gestures	18.3±2.8 #	21.6±2.9 *	15.5±1.5
Poses	7.3±2.6 #	10.1±2.6 *	6.0±0.8
Facial expressions	18.3±2.7 *#	9.4±1.1	13.4±2.2
Tone of voice	12.9±1.3 *#	7.2±1.2 *	4.4±0.8
General index of nonverbal activity	56.8±5.2 *	48.3±4.1 *	39.3±3.1

Note. Me — mean; SD — standard deviation. * Differences are reliable in comparison with the group of healthy individuals ($p < 0.05$). # Differences between the first and second groups of patients with HTN are reliable ($p < 0.05$).

Thus, analysis of the results from this stage of research allow us to conclude that patients with HTN differ from healthy individuals by reliably higher but inadequate and unstable aspiration levels, and higher indices in all estimated parameters of nonverbal behavior. This leads us to assume that the group of patients with HTN at work differs in AL indices not only from healthy individuals but also from patients with essential HTN.

4.2.3. Analysis and discussion of results

Analysis of the received results showed that within our research, employing experimental stress modeling, a state of emotional tension was formed in practically all the patients with HTN. This fact is confirmed by BP increase in all the patients with HTN over the course of the experiment, reliably higher than in healthy individuals, and also by significant anxiety in behavior, estimated by a complex of parameters of nonverbal behavior.

However, some patients with HTN were characterized not by an increase (which is regarded as the norm for a stressful reaction), but by a decrease of indices of all measured biochemical parameters, as well as by a decrease of anxiety level (according to data from Spielberger SA Inventory). Besides, patients with a decrease of biochemical indices in the course of stress-modeling were also characterized by initially lower indices of A and NA in urine, and renin and A_1 in blood plasma. This may be explained by the absence of essential biochemical "pre-race readiness", which is extremely important for entering a stressful situation and efficiently coping with it. It may also be an indicator of a long-endured stressful state of the patients. That is, what the patients display is not a "fight or flight readiness" with mobilization of organism resources, but a state of exhaustion of adaptation reserve. It should be noted that few studies have observed a decrease of biochemical parameters under stress in patients with HTN (Lindvall, et al., 1991).

It is necessary to point out that in our research, the presence of reliable ($p < 0.01$) positive correlations was found between the decrease of indices in the Spielberger SA scale and decrease of biochemical indices in the course of the experiment. This phenomenon is reliably more frequent in the group of patients with HTN at work. The group revealed reliable ($p < 0.01$) negative correlations between the high frequency of systolic BP increase and the decrease of biochemical indices (A and NA in urine, renin and A_1 in blood plasma); and also reliable ($p < 0.01$) negative correlations between the high frequency of BP increase and the decrease of anxiety level. In the group of patients with essential HTN, such regularity was not found.

The described facts, we assume, confirm the hypothesis on the state of psychophysiological exhaustion, diagnosed in some patients with HTN through a complex of physiological and psychological characteristics. Besides, this data may be considered as indirect evidence that a stressful state with significant biochemical changes found in some patients with HTN is chronic.

Furthermore, cluster analysis of the data confirmed the hypothesis of the general heterogeneity of patients with HTN, as well as the internal heterogeneity of the compared groups of patients with HTN. Three well-interpreted clusters were statistically marked out; they embrace psychological, physiological and behavioral parameters, which made it possible to describe 3 subgroups inside the groups of patients with HTN:

1. Patients with *openly anxious reaction type* (91 patients, 53.5% of all participants with HTN). Patients from this group are characterized by a significant increase of SA level in the course of experiment, open emotion expression, a rich variety of behavioral exposure accompanied by a slight BP growth and increase of A, NA, renin and A_1 level in the course of experiment.

2. Patients with *excessive emotion repression* (70 people, 41.2 % of participants with HTN). They showed a significant growth of systolic BP level, initially lower A and NA levels, and a decrease in the course of experiment of all measured biochemical parameters; a decrease of SA level, instability and inadequacy of AL. They were characterized by outwardly more quiet behavior and a lower number of poses and gestures, but more varied facial expressions and changes in voice tone.

3. Patients, who differ from the above-mentioned groups by moderate changes in physiological and psychological parameters under stress with optimal indices of emotion control, which brings them closer to the group of healthy individuals (9 patients, 5.3 % of participants with HTN).

Statistical data analysis showed that in the group of patients with HTN at work, a phenomenon of excessive emotional repression was detected in 63% of cases; an openly anxious type of stress reaction was detected in 37%. There were no patients with an adaptive reaction to stress in this group.

Most patients with essential HTN without a BP increase on working days show the openly anxious type of reaction (69% of cases). The repressive type of reaction is present in 20% of cases; and that of adaptive – in 10% of patients.

There is an assumption prevailing in contemporary publications that emotion repression serves as a leading psychological factor of psychosomatic syndrome genesis in patients with HTN. The qualitative data analysis brings us to conclude that this cannot be accounted for pathogenesis of all HTN forms. The emotion repression phenomenon, according to our data, is particularly specific for patients with HTN at work.

For patients with essential HTN, open expression of emotions with a lack of regulation and control of emotions is more typical. However, a low percentage of patients in this group is characterized by normal psychophysiological reactions. Data interpretation suggests that BP increase at least in some of patients with essential HTN without BP increase at work is only marginally mediated by psychological factors. However, verification of this hypothesis requires additional investigation. The group of patients with open anxiety expression and a lack of emotion regulation, in our view, is interesting for psychological study. Our results enable us to assume that these patients are characterized by marginal cognitive mediation of emotional processes. This is the reason for the “explosive character” of their emotional reactions. However, this hypothesis also requires special verification.

The results of this research not only extend the scientific conceptualization of the nature of HTN, but also contribute to the formulation of new questions, which are extremely important for the organization of further studies in clinical psychology (Han, et al., 2009; Veraksa, et al., 2012; Pöppel, Wagner, 2012; Pöppel, et al., 2013; Mezzich, et al., 2013; Zinchenko, Pervichko, Martynov, 2013).

5. Conclusions and implications

1. In patients with HTN in a situation of experimental stress modeling, a complex of physiological and psychological features was defined, which differ them from healthy individuals. During mental stress in the group of patients with HTN, a reliably greater growth of systolic BP is registered in comparison with healthy

individuals (in average by 14 and 3 mmHg respectively). AL of these patients is characterized by reliably greater height, inadequacy and instability; and nonverbal behavior — by a reliably greater amount of gestures and frequent changes of voice tone in comparison with healthy individuals.

2. In the situation of mental stress modeling, the group of patients with HTN is heterogenic in its physiological and psychological features: 53.5% of patients are characterized by open anxiety expression and lack of regulation and control of emotions, 41.2% of patients display dominant signs of emotion repression, and only 5.3% of participants demonstrate optimal stress reactions.
3. The group of patients with HTN at work, in comparison with patients from the second HTN group, is characterized by a reliably greater BP growth (on average by 16 and 4 mmHg respectively) as a response to mental stress. They show initially reliably low A and NA level and decrease of A, NA renin and A₁ levels during the experiment. They are characterized by an absence of SA increase under mental stress, more frequent AL inadequacy (69.4%) and instability (56.5%). Their behavior during the experiment was marked by a limited repertory of gestures and poses, and more vigorous facial expressions and frequent changes in voice tone, as compared with patients with equal or lower BP level on working days than on days off.
4. The received results testify that 63% of patients with HTN at work in our research show a state of chronic stress and psychophysiological exhaustion. All these patients are characterized by the use of the mechanism of emotion repression as a main regulator of emotional state and behavior in stressful situations. With all the facts mentioned above, we may conclude that emotion repression may be considered as an important pathogenesis factor of psychosomatic syndrome genesis in patients with HTN at work, as distinct from patients with essential HTN.
5. These results extend the understanding of the etiology and pathogenesis of HTN, encouraging a more accurate identification of strategies for medical and psychological treatment of patients with HTN, as well as healthy persons who are in stressful situations.

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PSYCHOLOGY OF PERCEPTION

Character and temperamental determinants of prosodic parameters in natural speech

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The study was undertaken to find relationships between personality and temperamental traits (estimated with the help of the Adult Personality Traits Questionnaire by Manolova, Leonhard and the Russian version of the Structure of Temperament Questionnaire (STQ) by Rusalov V. & Trofimova I. (2007)) on the one hand, and parameters of intonation (mean ΔF_0 , tone span, speech rate, duration of speech and mean duration of syllables interval) on the other hand. The parameters of intonation were measured on sample recordings produced by 30 male and female participants. 60 recordings of natural monologues on proposed topics were obtained in situations of the presence and absence of a conversation partner. Demonstrativity (as a personality trait according to Leonhard's typology) was found to significantly affect mean ΔF_0 , tone span and speech rate in the presence of an interlocutor. Social Tempo (as a dimension of temperament according to Rusalov's model) affects the speech rate. In the absence of an interlocutor, only an interaction effect of Demonstrativity and Communication Activity on the same group of vocal parameters was obtained. The presence of an interlocutor proved to be a special condition for the most explicit appearance of Demonstrativity. Temperamental indices that describe the Communication realm seem to moderate the appearance of Demonstrativity in different conditions. Most explicitly, the key feature of people with strong Demonstrativity is a high speech rate.

Keywords: Prosody, voice analysis, speech communication, temperament, personality traits.

Introduction

The investigation of individual differences in natural speech performance is a promising but insufficiently explored area in the psychology of individual difference features (Keller, 2005, Gawda, 2007).

The concept of intonation

The linguistic tradition of studying prosody considers the vocal aspect of human speech as a set of individual characteristics of pronunciation: speech tempo, voice timbre, and intonation itself. By intonation, “pronunciation-hearing expression of different intellectual or emotional-volitional meanings without the use of lexical media (i.e. the verbal structure of a phrase) by creating the acoustic structure of the whole phrase, its specific stressed periods, or a special way of saying particular words (intonation pattern)” (Bernshtein, 1996, p. 124) is meant.

In order to analyze the phenomenon described by the term “intonation”, different concepts, such as “intonation element” (Tseplitis, 1974), “intonation unit” (Sherba, 1958, cit. ex. Svetozarova, 1982), models of Russian intonation (e.g. (Kodzasov, 1999) and the so-called intonation language (Cheremisina, 1982, Blinova, 2001, Grigor’eva, 1999) have been created and developed. These concepts define intonation as a tool used by humans to create or further develop the meaning of a verbal utterance (Tseplitis, 1974, Kazannikova, 2003), which has a certain physiological basis (Cheremisina, 1982) as well as an ancient socio-cultural background (Makarova, 2007, Kushnir, 1990). Thus, it is the tool that, where there is an opportunity for a person to speak, is always used for achieving communication and verbal thinking goals if they are connected with the necessity of oral speech.

In our research, intonation is regarded as a vocal characteristic of speech which is, in its formal and dynamic aspect, used by the individual to achieve a wide variety of communication goals, including making a certain impression on the interlocutor, convincing a person or an audience, etc. Therefore, our approach follows the tradition of research psychologists who study the correlation between speech and character (Belovol, 1999, Manerov, 1997, Ramsay 1968).

Acoustic correlates of intonational features of speech

The vocal aspect of speech that is referred to in various studies as “prosody” or “intonation” includes some characteristics that can change considerably over time, as well as ones that are quite constant. The latter are mainly of interest to research psychologists searching for samples of individual style of oral speech, which can be described by acoustic parameters (Belovol, 1999, Feldstein & Sloan, 1984, Vitt, 1991).

Acoustic parameters can be divided into two major groups. The *first group* comprises parameters describing *tonal characteristics of speech*. By their means, researchers try to describe the melodic, or intonation, aspect of speech, examining the intonation patterns of human speech and the frequency range of the speaker’s voice. The most frequently used tone indices are: average frequency of the main tone — F_0 , in Hz (Mallory and Miller, 1958, cit. ex: Feldstein et al., 1984, Aronovitch, 1976, Keller, 2005, Reissland, Shepherd & Herrera, 2003), average F_0 in semitones (Keller, 2005), minimal and maximal F_0 (Reissland et al., 2003), tone span, i.e. the difference between maximal and minimal F_0 (Tolkmitt & Scherer, 1986, Belovol, 1999), average ΔF_0 , i.e. the difference between two successive measurements of F_0 (Keller, 2005), and particular intonation patterns of speech fragments (Ramsay, 1968, Keller, 2005, Frick, 1985).

The *second group* of acoustic indices comprises the temporal aspect of oral speech, namely: speech tempo measured as the number of syllables uttered per second (Aronovitch, 1976, Steer, 1974, Ramsay, 1968, Gawda, 2007, Markel et. al.,

1972, cit. ex: Feldstein et al., 1984), speech tempo measured as the number of words per minute, words per half minute, and syllables per minute (Goldman-Eisler, 1954, Street & Brady, 1982, — cit. ex: Feldstein et al., 1984], sound/silence ratio (Aronovitch, 1976, Ramsay, 1966, Goldman-Eisler, 1951, cit. ex: Ramsay, 1968, Belovol, 1999), average length of a phrase, average duration of pauses in an utterance, and average duration of a phrase, including each pause after an utterance (Ramsay, 1968).

On the basis of the characteristics mentioned above, we have selected 5 indices that describe tonal variability, in order to achieve the goals of our study. They are: average ΔF_0 and Tone Span, as well as temporal characteristics of speech: average duration of a syllable (indicates the rhythm of speech), overall tempo, and general duration of speech, which show how long a person is ready to discuss a particular theme in the absence of time limitations.

Psychological research of the intonation phenomena of speech

Numerous studies have been conducted *in the psychodiagnostic approach*. After summarizing a number of previous studies, Feldstein S. et al. (1984) set the task of searching for specific vocal parameters that are connected with personality traits, and experimentally confirmed that extraversion/introversion is connected with speech tempo. These authors, as well as previously Steer B. (1974), have also convincingly demonstrated the existence of an individual rhythm of speech that does not depend on the verbal task. While trying to confirm the previous findings, Gawda B. (2007) found a correlation between extroversion and neuroticism, on the one hand, and fluency of speech on the other.

The next landmark in this area of research was the work of Belovol E. (1999), based on today's most modern structure model of formal-dynamical individual characteristics by Rusalov V. et al. (1997, 2007), in which she discovered a number of correlations between acoustic parameters and temperamental characteristics. Thus, it was found that tonal characteristics of speech in different oral tasks are connected with all dimensions of the temperament (tempo, plasticity, ergonicity, emotionality) that appears in all types of activities (social, intellectual and motor).

Studies into the effects of subclinical depression on oral speech characteristics, in the case of achieving a communication goal in parent-child interaction in which mothers had to speak or read aloud, can also be of interest when related to the same group (Bettes, 1988, Reissland et al., 2003). It turned out that mothers suffering from depression lose the ability to adjust their verbal behaviour (whole intonation patterns, pausing features and duration of utterances were studied) to the needs of a current situation: they make incongruously long pauses, and demonstrate abnormality of conscious emotional expression in speech (they are either unable to express a particular emotion or express an unsuitable one despite having the right intention). These findings can be useful for understanding the effects of personality traits that are in some way similar to certain symptoms of depression, such as reduced activity and sluggishness, reduced vitality, a pessimistic approach to life (i.e. Distimity, as understood by Leonhard K. (2001), Manolova O. (2005)) on speech.

We suppose that intonation parameters of speech can be regarded as a set of individual and sociocultural means that help to achieve different communication goals. Presumably, this instrument is most essential to a person whose personality

structure requires a large number of social contacts. Therefore, we have carried out research into the relationship between acoustic parameters of human speech and two aspects of personality: the specifics of the communication sphere as a part of temperament (Rusalov, 1997), and Demonstrativity (Manolova, 2005, Leonhard, 2001, Rusalov, 1997) as a personality trait.

In view of the issues mentioned above, the aims of this quasi-experimental research were 1) to establish how character and temperamental traits affect the intonation parameters of natural speech, 2) to find out which of the changes in subjects' intonation patterns occur due to changes in communication context, 3) to examine whether these context changes moderate the influence of personal traits on speech.

Method

Participants. 30 people aged between 21 and 40, 15 women and 15 men, took part in this study. All sessions took place in a laboratory in presence of the experimenter.

Research procedure. The experimenter and participant were sitting at a table, facing each other. There was a personal computer in front of the experimenter. The participant was asked to take a microphone and give detailed answers to two questions, one for each trial. The question for the first trial was: "What do you think about the Unified State Exam (EGE in Russian)?" The question for the second was: "What do you think about modern Russian TV?"

During the participant's answer in the *first trial* the experimenter was sitting in front of him, keeping eye contact and using other techniques of active listening (nodding, demonstrating through gestures that he understood what had been said, etc.) Thus, the experimenter played the part of the participant's silent conversation partner. During the *second trial* the experimenter, having informed the participant in advance about his behavior, stood up, turned his back on the participant, and started looking through his papers. Thus, in the second trial the participant had no interlocutor, not even a silent one.

On finishing these two trials, the participant had to fill in two questionnaires: "Structure of Temperament Questionnaire" by Rusalov V. et al. (2007) and "A test of character traits" by Manolova O. et al. (2005).

Equipment. All the answers were registered in a MacBookPro7.1 computer using a Sennheiser e855 microphone and an ART Tube MP OPL single-channel microphone preamplifier.

Speech processing. In order to derive the acoustic parameters, we conducted a qualitative-quantitative acoustic analysis of each phonogram, 60 in total, i.e. two phonograms per participant. The duration of the registered phonograms varied from 1 to 5 minutes.

The qualitative part of the acoustic analysis included manual splitting of the phonogram into separate syllables using Sony Soundforge 10 software. This procedure helps us to obtain measurements of the fundamental frequency of all vowels pronounced by the participant, with the index on the time axis corresponding to each sound. Thus, we transformed the phonogram into rows of numerical pairs: "main tone frequency — corresponding time", in which each pair n_i is related to the syllable n_i . Then we calculated the average consequential change of the fundamental frequency F_0 by the formula:

$$\overline{\Delta F_0} = , \text{ where } F_{0i} \text{ и } F_{0(i-1)} \text{ are two sequentially measured } F_0.$$

We will call this *Pitch Variability*.

The range of variance of F_0 , normalized according to the pitch of the individual's voice, was then calculated by the following formula:

$$\frac{F_{\max} - F_{\min}}{F_{\max} + F_{\min}}$$

This value is called *Tone Span*.

Three temporal indices of speech were calculated:

1. *Overall duration of speech* — the total time of sounding, which reflects how long the participant was speaking to express his opinion on the given topic.
2. *Average duration of a syllable* was calculated as the average time interval $\overline{\Delta t}$ between two consecutive measurements of F_0 , i.e. between the vowels of two consecutive syllables.
3. *Speech Rate* was calculated by the formula N/T , where N is the total number of syllables, corresponding to the number of F_0 measurements, and T is the total duration of speech (ms).

Processing the psychodiagnostic data. The questionnaire of Rusalov V. was used for calculating the Index of Communication Activity of a personality and the Social Tempo, and the questionnaire of Manolova O. was used to measure Demonstrativity.

In order to carry out statistical analysis of the data in SPSS 14.0, we used one- and two-way analysis of variance (ANOVA), correlation analysis with the use of Pearson's coefficient, and the non-parametric Mann-Whitney test.

Results

1. The first trial: face-to-face with a silent interlocutor.

A comparison of the differences between groups of participants with varying levels of Demonstrativity showed the effects of statistical significance, including its influence on vocal parameters: Pitch Variability ($U_{\text{emp}} = 48$, $n_1 = 17$, $n_2 = 13$, $p = 0.009$), Tone Span ($F(1, 28) = 6.242$; $p = 0.019$), and Speech Rate ($F(1, 27) = 8.705$; $p = 0.006$). Thus, the higher the degree of Demonstrativity, the narrower the Tone Span, and the lower the Speech Rate and Pitch Variability (fig. 1, 2, 3).

Table 1. A comparison of means: Speech Rate and Pitch Variability in the first trial, in groups with high and low Social Tempo.

Social Tempo	N	Mean of Speech Rate	N	Mean of Pitch Variability
"quick" participants	14	4.05	14	0.13
"slow" participants	15	3.18	16	0.17

Also, a between-groups comparison of participants with different levels of Social Tempo showed the statistically significant effect of this factor on Pitch Vari-

ability ($F(1, 28) = 6.088$; $p = 0.02$) and Speech Rate ($F(1, 27) = 7.430$; $p = 0.011$). The higher the Social Tempo, the lower the Pitch Variability and the higher the Speech Rate (table 1).

The results of the two-way ANOVA did not show any statistically significant interaction effect of Demonstrativity and Communication Activity on the following parameters: *Pitch Variability* ($F(1, 26) = 1.25$, $p = 0.27$, no main effect by the index of Communication Activity was found: $F(1, 26) = 0.001$, $p = 0.98$); *Tone Span* ($F(1, 26) = 0.019$, $p = 0.89$, no main effect by the index of Communication Activity was found: $F(1, 26) = 0.16$, $p = 0.69$) and *Speech Rate* ($F(1, 25) = 1$, $p = 0.33$, no main effect by the index of Communication Activity: $F(1, 25) = 0.7$, $p = 0.78$) (Fig. 1, 2, 3).

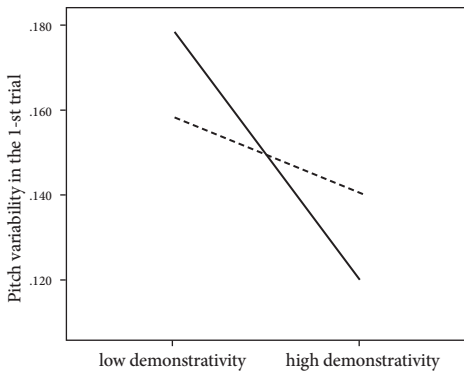


Figure 1. The interaction effect of Demonstrativity and Communication Activity on Pitch Variability in the first trial. A solid line denotes *high Index of Communication Activity*, and a dashed line denotes *low Index of Communication Activity*.

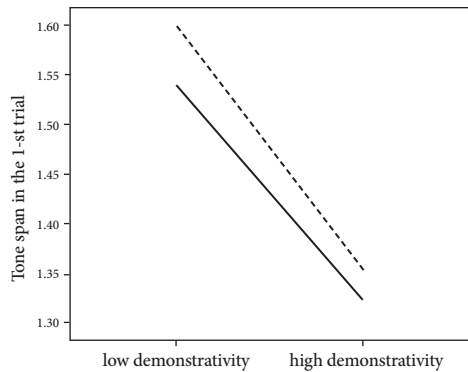


Figure 2. The interaction effect of Demonstrativity and Communication Activity on Tone Span in the first trial. A solid line denotes *high Index of Communication Activity*, and a dashed line denotes *low Index of Communication Activity*.

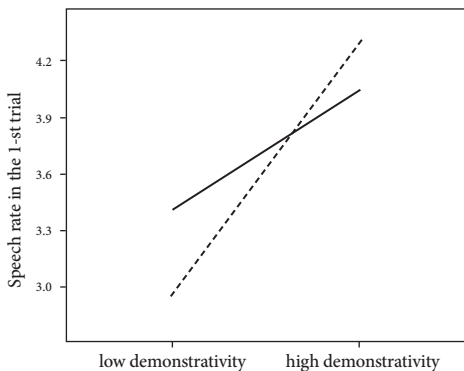


Figure 3. The interaction effect of Demonstrativity and Communication Activity on Speech Rate in the first trial. A solid line denotes *high Index of Communication Activity*, and a dashed line denotes *low Index of Communication Activity*.

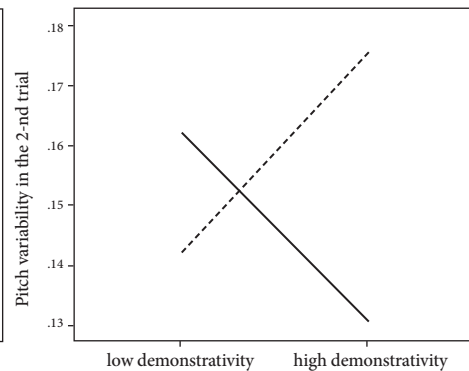


Figure 4. The interaction effect of Demonstrativity and Communication Activity on Pitch Variability in the second trial. A solid line denotes *high Index of Communication Activity*, and a dashed line denotes *low Index of Communication Activity*.

2. The second trial: absence of an interlocutor.

A between-groups comparison of participants with varying levels of Demonstrativity did not show any statistically significant effect on Pitch Variability ($F(1, 28) = 0.42$, $p = 0.52$), Tone Span ($F(1, 28) = 0.2$, $p = 0.9$), or Speech Rate ($F(1, 27) = 2.48$, $p = 0.13$).

A between-groups comparison of participants with varying Social Tempo showed the effect of this factor on Pitch Variability on a quasi-significant level ($F(1, 28) = 2.942$; $p = 0.097$). The higher the Social Tempo, the lower the Pitch Variability ($M_1 = 0.16$, $M_2 = 0.13$, $n_1 = 16$, $n_2 = 14$, 1st group — “slow” participants, 2nd group — “quick” participants).

The two-way ANOVA showed an interaction effect between Demonstrativity and Communication Activity on a number of vocal parameters: *Pitch Variability*, ($F(1, 26) = 3.345$; $p = 0.079$, no major effects of Demonstrativity and Communication Activity were found ($F(1, 26) = 0.003$, $p = 0.96$; $F(1, 26) = 0.491$, $p = 0.49$)), *Tone Span* ($F(1, 26) = 5.189$; $p = 0.031$, no major effects of either of these factors were found ($F(1, 26) = 0.145$, $p = 0.707$; $F(1, 26) = 0.018$, $p = 0.894$)), *Speech Rate* ($F(1, 25) = 4.418$; $p = 0.046$; a major effect of Demonstrativity was found ($F(1, 25) = 5.728$, $p = 0.025$), no effect of Communication Activity was found ($F(1, 25) = 1.510$, $p = 0.231$).

When the Communication Activity indices have high values, Demonstrativity is higher and Pitch Variability and Tone Span are narrower; Speech Rate is not affected by Demonstrativity in this situation. When the indices of Communication Activity have low values, Demonstrativity is higher, Pitch Variability is greater, Tone Span is wider, and Speech Rate is higher (Fig. 4, 5, 6).

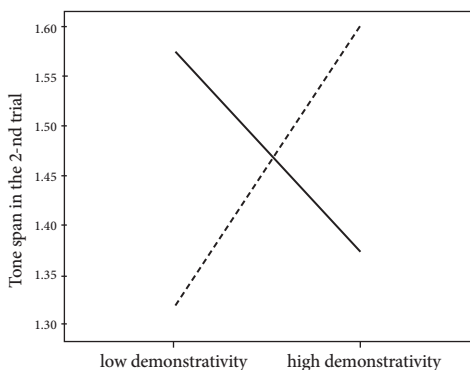


Figure 5. The interaction effect of Demonstrativity and Communication Activity on Tone Span in the second trial. A solid line denotes high Index of Communication Activity, and a dashed line denotes low Index of Communication Activity.

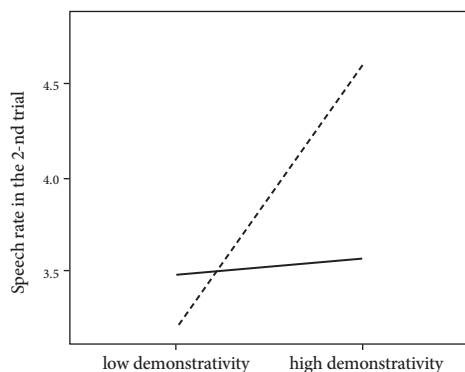


Figure 6. The interaction effect of Demonstrativity and Communication Activity on Speech Rate in the second trial. A solid line denotes high Index of Communication Activity, and a dashed line denotes low Index of Communication Activity.

3. The correlations between vocal speech parameters in the first trial.

The results of correlation analysis between vocal parameters showed a number of statistically significant correlations: Pitch Variability has a negative correlation with Speech Rate ($r = 0.629$, $p = 0.01$) and a positive correlation with Tone Span

($r=0.672$, $p<0.01$) and Average duration of a syllable ($r=0.727$, $p<0.01$); Tone Span has a positive correlation with Duration of speech ($r=0.567$, $p<0.01$) and a negative correlation with Speech Rate ($r=-0.542$, $p<0.001$).

4. The correlations between vocal parameters in the second trial.

The use of the correlation analysis procedure for finding correlations between the vocal parameters in the second trial made it possible to trace one statistically significant positive correlation — between Pitch Variability and Tone Span ($r=0.512$, $p<0.01$), and a negative one — between Average duration of syllable and Speech Rate ($r=-0.929$, $p<0.01$).

Discussion

1. Correlations between vocal parameters in the first and second trials.

The parameters that describe the tonal characteristics of speech (Pitch Variability and Tone Span) are closely connected in both trials: the more changeable the voice pitch, the wider the Tone Span becomes. This result can be explained by the fact that both parameters describe the characteristics of pitch variance of the whole speech sample, and their calculation is based on the measurements of ΔF_0 and F_0 .

The connection between Average Duration of Syllable and Speech Rate was also expected, because both of these parameters represent speech tempo — the longer the Average Duration of Syllable, the lower the Speech Rate.

It is interesting to note the negative correlation between Pitch Variability and Speech Rate in the first trial — the more changeable the pitch of voice (i.e. the more modulations that can be traced in the speaker's voice), the lower the Speech Rate will be, and vice versa. It is noteworthy that in the second trial there was no similar correlation. In the context of "intonation means" this fact can be explained as follows: if a man can see his conversation partner and notice his partner's reactions of active listening and interest, he will select such methods as either variance of tone, i.e. intonation, or speech tempo (he can probably focus on the volume of verbal output or its content).

The striving to say a lot within a given time (even though it was not limited on purpose) might indicate a detailed and reasoned viewpoint on a given topic, but also the absence of any viewpoint accompanied by a wish to make an impression of a person with his own views and capable of reasoning.

The absence of a correlation between the parameters of intonation and tempo in the second trial can be interpreted as a greater variety in the use of vocal means during the creation of oral speech in the absence of a conversation partner — an individual might "add" to his vocal methods, as well as exclude a greater variance of tone, simultaneously changing the parameters of speech tempo. One of the reasons for this might be that the speaker cannot be sure of the impression he is making on the listener (because the latter is still present in the room, and after all gets the phonogram when the experiment is over), so if the speaker is trying to make an impression, he will presumably use all available vocal means in the non-feedback situation during his monologue. Another reason, might on the contrary be a lack of interest in making an impression on the listener who has distanced himself.

2. Demonstrativity and Communication Activity.

In the first trial, which takes place in the presence of an interlocutor, Demonstrativity affects three interconnected vocal parameters. However, in the first trial the Index of Communication Activity has no influence of its own on the vocal parameters. Only one of the constituents, Social Tempo, affects two out of three interconnected vocal parameters (Pitch Variability and Speech Rate), while the other two (Social Plasticity and Social Ergonicity) have no effect on the vocal parameters in the first trial. These results partially match the previous findings (Belovol, 1999): the researcher found that Social Tempo has a negative correlation with the so-called “voicing coefficient”, measured as a percentage of the time of pronouncing vowel sounds within the overall speaking time (i.e. the quicker the speech, the shorter the time spent pronouncing the vowels).

As for Demonstrativity, we follow Leonhard K. (2001), Lichko A. (2010) and Manolova O. (2005) here, and consider it as a special skill to achieve one's goals through communication with others by means of social competence and role-play, the ability to adjust one's behaviour to the conversation partner. Therefore, the more an individual tends to regard his social links, communication, and ability to interact with people as a means of achieving his goals, the less changeable is his tone (Pitch Variability), the narrower his Tone Span, and the higher his Speech Rate. The key feature of these people appears to be high Speech Rate. A person with a high index on the scale of Demonstrativity, regardless of having an opinion on the given topic or not, will try to say as much as possible in order to show his interlocutor that he *has got something to say*.

In the *second trial*, neither Demonstrativity nor Communication Activity as separate variables had any statistically significant effect on the vocal parameters. However, they did have an interaction effect on the group of vocal parameters (Pitch Variability, Tone Span and Speech Rate) influenced by Demonstrativity during the first trial. This interaction effect can be interpreted as the necessity of a special condition that triggers the effect of Demonstrativity in a situation where the speaker has no attentive conversation partner. It depends on whether an area of communication is predominant for the speaker, and whether he is confident in communication or not. If the individual has a low Index of Communication Activity, then the higher his index of Demonstrativity, the greater the Pitch Variability, the wider Tone Span, and the higher the Speech Rate. Thus, having any weaknesses in the communication area, an individual with higher Demonstrativity will use all his vocal means to impress his potential listener: voice modulations, a wide tone span, and high speech tempo. So to speak, he will be doing his best to “play to the gallery”.

At the same time, people who are strong at communication (i.e. have a high Index of Communication Activity, which in our study means having high scores on each of the following parameters: Social Plasticity, Social Tempo, and Social Ergonicity) have a different effect of Demonstrativity: the higher the Demonstrativity, the lower the Pitch Variability, and the narrower the Tone Span, while there is no difference in the Speech Rate. It is noteworthy that the last aspect of the interaction effect of Demonstrativity and dependent variables is similar to its main effect in the first trial.

When interpreting the data in terms of intonation means, we should note that, on condition of a high Index of Communication Activity, an individual with high Demonstrativity will not use the opportunity to enrich his intonation and increase his Speech Rate. Perhaps, the effect of the listener's presence is not so vivid here as in the first trial, and therefore there is no orientation on the listener, which is typical for those who have Demonstrativity.

It is therefore clear that the effect of Demonstrativity on speech characteristics is the opposite for people with different levels of Communication Activity. Supposedly, people with lower levels of Communication Activity are using a compensatory mechanism in their behavior, and therefore pay more attention to situational social interactions, trying to impress their partner every time, while people with higher levels of Communication Activity and Demonstrativity focus on the quantity, not quality of social interaction, and therefore the absence of an interlocutor could lead to a great decrease of interest in self-demonstration.

It is worth noting that the last combination of characteristics — the low index of Communication Activity and the high index of Demonstrativity — is quite rare, according to Manolova O. (2005), because Demonstrativity usually has a positive correlation with Communication Activity. However, a case is possible in which one aspect of the communication sphere, or all of its aspects simultaneously, are not very strong (e.g. because of physiological problems), which enables us to exclude this individual from the group of people confident in communication. However, we can still regard this individual as a personality with a strong level of Demonstrativity (Leonhard, 2001).

Conclusion

In conclusion we can summarize that changes in the context of speech communication seem to fundamentally affect correlations between intonation parameters: there were more correlations and of a larger variety in the presence of an interlocutor. In our opinion this may indicate a reorganization of the ways people use intonation while speaking. We suppose that communicative context is the condition of Demonstrativity to appear as a factor that determines intonation performance style. Conversely, a non-communication context induces more complex determination, i.e. an aggregate effect of Demonstrativity and Social Activity.

A practical application of the results of the present research can be linked with the development of psychodiagnostic means that would make it possible to assess individual features of a speaking person based on measurement of speech features. It also may prove very useful for psychodiagnostics to choose an appropriate condition that would provoke the very appearance of the personality traits' influence on speech. In view of the above, we consider the development of special speech tasks, as well as determining conditions and contexts that would trigger the demonstration of different types of intonation, to be a subject for further research. Moreover, the obtained results may be useful for the development of software able to simulate the speech patterns of a person with certain personality traits.

To develop this subject, the authors would like a) to clarify in a controlled experiment whether a test subject can perceive the situation of talking in the absence of an interlocutor as a communication act depending on his character and tempera-

mental traits; b) to conduct an experiment with a wider variation of communication aspects of experimental speech tasks and c) a wider variation of other conditions of performance of experimental speech tasks that may trigger the effect on intonation of character traits that have not shown any influence on intonation in the present research, and that appeared not to correlate with the social aspects of temperament.

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Proprioception as a basis for individual differences

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In this chapter the author summarises the descriptions of proprioceptive sense from different perspectives. The importance of proprioceptive sense has been shown in developmental psychology, in both the earlier and later stages of individuum formation. The author emphasises in this chapter the role of proprioception as a basis of personality and the individual differences construct. The importance of assessing behaviour at multiple levels has been pointed out by experiments of classic and modern researchers that should include not only verbal tests that would be more important for conscious mental description, but also techniques that could assess other behavioural characteristics, including automatic unconscious and pre-reflexive behaviour. The author also describes the effects of altered proprioception in humans, such as the Pinocchio effect, and other spatial perception distortions. In this chapter the importance of proprioception in acquiring new skills (embodied knowledge) as automatic and conditioned reflexive behaviour has also been highlighted. Finally, the complete picture of the individuum has been presented as a multi-layered level of a body-mind union approach.

Key words: proprioception, individual differences, multi-layered personality, embodied knowledge, automatic movements.

*The aspects of things that are most
important for us are hidden because
of their simplicity and familiarity.*
Wittgenstein (cited in Sacks, 1985)

*In the cognitive sciences, the most challenging phenomena
are often the ones we take for granted in our everyday lives.*
Botvinick (2004)

Definition of proprioception

The term “proprioception” was introduced by Sherrington (1906), although this basic feeling of ourselves had always been present. Proprioception, or the perception of body awareness, is a sense that people are frequently not aware of, but greatly rely upon. More easily demonstrated than explained, proprioception is the “unconscious” awareness of where the various regions of the body are located at any given time. For example, with closed eyes, we can say where our hands or legs

are at this moment. Without proprioception we could not bring a spoon bearing soup into the mouth, ride a bicycle, or change the gears of a car without looking at our hands or feet.

Proprioception as described by Sechenov

In his 1863 work “Refleksi golovnogo mozga” [*Reflexes of brain*], the renowned Russian physiologist Sechenov called proprioception a “dark muscle sense” (Sechenov, 2013, originally published 1863), and described the role of that muscle sense in the training of vision, hearing and other senses, especially in his work “Elements of Thoughts” (Sechenov, 2013). He demonstrated that spatial vision is formed first of all with the help of proprioceptors of the eye muscles, and secondly, due to multiple evaluation and combination of distance by eyes or legs. As for distance measurements, we still conserve in some countries “proprioceptive” (related to the length of body parts) units like “feet”, “inch”, or old ones such as ell (originally a cubit, i.e., approximating to the length of a man’s arm from the elbow to the tip of the middle finger, or about 18 inches), dactilus or digit, and palm in ancient Greece.

As Sechenov thought, the muscle is not only analysing components of space, but also of time: “Near, far, height of subjects, their traces and velocities — all are the products of the muscle sense... The same muscle sense, being partial (fractioned) in periodical movements, becomes a partial measurement instrument of space and time” (Sechenov, 2013).

Proprioception is tested by Russian neurologists when they ask patients to touch their nose with their finger or walk with their eyes closed along a straight line drawn on the floor. It is also checked by American police officers by having a suspect touch their nose with their finger, with eyes closed, to gauge alcohol intoxication: people with normal proprioception make an error of no more than twenty millimetres.

Effects of alterations in proprioception

When proprioception is altered, sensitive ataxia can take place, as in the clinical case described by Wingshtein (Schmidt, 1984), when a patient after an operation had lost her proprioception and gradually forgot how to move or eat, and even stopped breathing. To remain functional, she would compensate for proprioceptive loss by other senses, principally by vision, as in the Ian Waterman case (BBC movie, 1998, *The man who lost his body*). If proprioceptive impairment takes place due to some body part being missing from one’s mental self-image, we need to check it visually (to look down at our limbs, for example) or by touch (to pinch ourselves to feel this part); however, under a complete loss of proprioception in all or a part of body, we simply cannot feel it and may guide ourselves only visually, as in the Ian Waterman case. In order to learn to walk again, he used his eyes and needed to always look at his feet while moving (BBC documentary, 1998, *The man who lost his body*).

Small proprioceptive alterations are felt when one catches cold or is simply tired. Under vibration or other external/internal stimuli (real and virtual) proprioceptive changes can appear, such as the “Pinocchio effect” (Kilteni, Normand, Sanchez-

Vives, & Slater, 2012; Lackner, 1988) when body size perception is altered (perceived as too large or too small). To experience the “Pinocchio Illusion”, you need to apply a vibrator to the biceps tendon while one holding your nose with the ipsilateral hand. Muscle stretching occurs due to stimulation of the muscle spindles by the vibrator, creating a kinesthetic illusion of the arm moving away from the face. Since the fingers are still holding the nose, this results in a perception that the nose is moving away from the face also, and thus enlarging. Similar effects (changes of body part sizes) happen during epilepsy or migraine auras, or during changes in gravity when astronauts are passing the frontier of Earth’s gravity, or in reactive airplane tests that take the ballistic curve of Kepler (when weightlessness lasts between 20 to 60 seconds), as per Lebedev’s self-observation (Leonov & Lebedev, 1965):

Due to motor noise and vibration, I guessed that the airplane was accelerating. After several seconds the overload had occurred... I felt like I was falling down an abyss. This feeling, I estimated as lasting 1-2 seconds... Knowing very well theoretically about difficulties of weightlessness, I expected to spend it badly; however it was a contrary reaction. I felt delight that transformed later into euphoria... Then the overload started again. The state of weightlessness came suddenly and I flew up and then off in an indefinite direction. It was a moment of full disorientation in space. Later I came to recognize the situation. I saw the floor and walls of the room. The latter seemed to be enlarging. The illusion was like looking through inverted binoculars. When I looked at the floor, it was enlarging and shrinking as if escaping and moving from me. At that moment I tried to grab for something. Though the objects seemed to me to be close, I could not reach them and that fact provoked the sharpest emotional excitation.”

EGG results proved that weightlessness worked as a powerful excitatory stimulus; for this reason, people who had weak nervous systems had greater space disorientation and felt the “world crush” symptom, while people with strong nervous systems merely felt positive (sthenic) emotions. Moreover, the reactions that appeared during weightlessness flights correlated to reactions in other stressful situations (such as during parachute jumping, etc.). However, even in people with strong nervous systems, these flights through vestibular-proprioceptive stimuli had become habitual, and people could experience emotional-neurotic breakdowns (reactive neurosis) in cases of astenisation and chronic fatigue (Leonov & Lebedev, 1965).

If proprioception on the first level involves afferent signals to the Central Nervous System (CNS), at the second level it comprises the feeling of body parts as their projection in the cortex. The above-mentioned somatosensory homunculus is also believed to be related to Phantom Limb Syndrome: when a person continues to feel a limb or other amputated part of body (appendix, tooth, etc.) (Ramachandran & Hirstein, 1998; *Phantom limb*, 2009). Phantom sensations can occur as passive proprioceptive sensations of the limb’s presence, or more active sensations such as perceived movement, pressure, pain, itching or temperature. The missing limb often feels shorter and may feel as if it is in a distorted and painful position. Occasionally, the pain can be made worse by stress, anxiety, and weather changes (Arena, Sherman, Bruno & Smith, 1990; *Phantom limb*, 2009), and the intensity and continuity of the illusory perception can depend on individual differences. Thus, positive significant correlations were found between neuroticism and evocation latencies;

while the intensity and continuity of the illusory sensations were significantly described with more amplitude by extroverts in comparison to introverts (Juhel & Neiger, 1993).

Awareness of proprioceptive sense and other definitions of proprioception

Since the proprioceptive sense often goes unnoticed because humans adapt to it (this is an effect of habituation or desensitization to a continuously present stimulus), we can become aware of it when we lose it. Particular cases of induced proprioceptive loss are local anaesthesia before operations: teeth or some part of the body before a surgical intervention. Temporary loss or impairment of proprioception can apparently happen periodically during growth, mostly during adolescence, or may be altered when large increases or decreases in bodyweight/size occur due to fluctuations of fat (liposuction, rapid fat loss, rapid fat gain) and muscle content (bodybuilding, anabolic steroids, catabolises/starvation) or in those who gain new levels of flexibility, stretching, and contortion. Moreover, proprioceptive sense and body size performance related to it can be altered by vibration (Longo, Kammers, Gomi, Tsakiris, & Haggand, 2009).

At present there is in fact no clear definition of proprioception: apart from being narrowly connected to equilibrioception (balance), proprioception is sometimes interchangeable with kinaesthesia, although the latter specifically excludes the sense of equilibrium or balance, and can be counted as a subset of proprioception (Proprioception^a, 2007). Although we have always had the basic sense of proprioception, and even though scientists started to pay attention to it at the end of the 19th century, almost hundred years later questions related to proprioception in the article “Where does Sherrington’s ‘muscular sense’ originate?” were still unclear (Matthews, 1982).

Other definitions of proprioception appeared later on. One of them included a broader context of proprioception that was based not only on pure physiological sense, but was also expanded to the “self-perception of thought” in which thought is aware of its movements (Bohm, 2007).

Proprioception as a basis of personality in Allport’s theory

Previously, proprioception was one of the components of “self” (“I”) or “ego” that was expanded in the theory of psychology by Gordon Allport (*Gordon Allport*, 2006), who operated using the term “proprium” (“my own” from Latin) instead. Following his ideas, the development of “proprium” has eight stages to reach maturity, the first of which comprises a proprioceptive awareness that together with interoceptive and touch sense were a basis of the whole “self” or “proprium” construction and development, or “propriate” functions:

1. **The Sense of Body or Bodily Self** (develops in the first two years of life) is a sense, or awareness, of one’s own body and its sensations; it is a basic axis of personality development and an anchor for self-awareness. In this, all bodily organic feelings are included even though we had not been aware of them until some painful or unpleasant sensation appeared. We perceive everything related to our body as something warm, close and pleasant; and everything alien to it as something cold,

distant and unpleasant. Allport's favourite demonstration of this aspect: Imagine splitting saliva into a cup — and then drinking it down. What is the problem? It's the same stuff that you swallow all day long; however, it has left your bodily self and thereby become foreign to you.

2. The Sense of Self-Identity (develops in the first two years) — is a sense which grows gradually and is most evident when the child, through acquiring language, recognizes himself as a distinct and constant point of reference. First children recognize their name among a flood of sounds, and later they understand that they are the same person despite external (due to growth) and internal (thought) changes.

3. The Sense of Self-Esteem or Pride, which is an individual's evaluation of himself and the urge to want to do everything for oneself and take all the credit. It is an exaltation of the ego; an ego that is inherent to man by nature, and needed for survival. Everyone tends to self-assertion, and must have a sense of pride in themselves, and be self-satisfied. It is a time when we recognise that we have value to others and to ourselves. This is especially tied to the continuing development of our competencies.

4. The Sense of Self-Extension (occurs during the third year of life), which states that even though some things are not inside my physical body they are still very much a part of my life. Certain things, people, and events around us also come to be thought of as central and warm, and essential to existence. Some people define themselves in terms of their parents, spouse, children, clan, gang, community, college or nation. Some find their identity in activities: I am a psychologist, a student, a bricklayer. Some find identity in a place: my house, my home town. When their child does something wrong, parents can feel guilty about it. If someone scratches our car, we can feel like they hit us. While at an early age, the child identifies himself with his parents or joys that "pertain" to him, later this feeling is extended to other social groups (classmates, neighbours, nation). At a mature age this process can be expanded to the processes of development of abstract ideas and moral values.

5. Self-Image (develops between four and six), or how others view "me", is another aspect of selfhood that emerges during childhood. This is the "looking-glass self," as others see me. This is the impression I make on others, my appearance, or my social esteem or status, including my sexual identity. It is the beginning of consciousness, ideal self, and persona.

6. Sense of Self as a Rational Coping being (occurs between the ages of six and twelve), when the rational capacity to find solutions to life's problems appears. This sense is related to abstract thinking and planning, and allows people to cope effectively with the demands of reality.

7. Propriate Striving or Motivation (the core problem for the adolescent according to Allport; normally develops after twelve). It is the selection of occupation or other life goal, when adolescents know that their future must follow a plan, and in this sense it makes them lose their childhood. It is related to forming an ideal view of our self, and direction for future development (where an intentional drive takes over from natural desires and impulses) and is more closely related to reflecting interest, tendency, disposition, anticipation, planning, problem solving, focus and intention. This is our self as goals, ideals, plans, vocations, callings, a sense of direction, and a sense of purpose.

8. Self as Knower or as Subject of Knowledge — a feature that, according to Allport, rises above the other propriate functions and synthesises them. It lies in the fact that man knows not only the objects of matter, but also himself, resulting in the development of man's capacity for self-knowledge and self-awareness. The knower (thinking agent) “rides” on top of them. The thinker is different from his or her thoughts.

The first three functions — senses of body, of self-identity and self-esteem — are developed in early childhood. The other functions are enlarged over time, and depend on individual features of men, own life paths, or experience. Gordon Allport emphasized that at any stage of personality development, not just one propriative function is developed but a fusion of several. For example, in the situation of maturation of self-understanding, the rational subject of proprium, personal motivation (striving), an extension of “ego”, and self-image are activated. According to Allport, proprium is a positive quality of human nature, related to creative personality development. He was simultaneously a believer in the uniqueness of the individual and the wholeness of personality.

Multi-layered model of personality

Corr and Matthews (cited in Corr, 2010) noted in their Introduction to the *Cambridge Handbook of Personality Psychology*:

A persistent theme... has been the multi-layered nature of personality, expressed in individual differences in neural functioning, in cognition and information-processing, and in social relationships. Abnormal personality too is expressed at multiple levels. Despite the inevitable difficulties, a major task for future research is to develop models of personality that integrate these different processes.

The multilayered presentation of the human being is represented by the collective unconscious depicted in traditional souvenirs, such as the “Matryoshka” doll that was popular not only in Russia, but also in Japan and other Eastern European countries (Fig. 1).

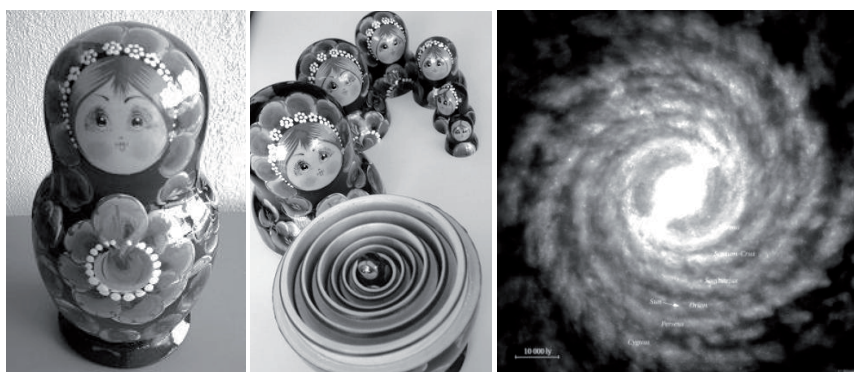


Figure 1. “Matryoshka”, a traditional Eastern souvenir, represents a multilevel personality model (bio-psi-social-historical). Its interior is reminiscent of a Universe model (photo and picture adapted by author).

Despite some common personality traits in persons and their similarity in body composition, the most integrative picture is obtained at the level of individual description, performed by singular case studies, such as was described by the neuropsychologist Luria (1968, 1972) and by Sacks (1985). Each person is a microcosm, a mini-Universe that reflects the external world with individual features. The exteroceptive senses “adjust” our perception and reduce the individual internal variability which is more fully expressed by the proprioceptive sense, and is independent of external influence (Enoka, 2002).

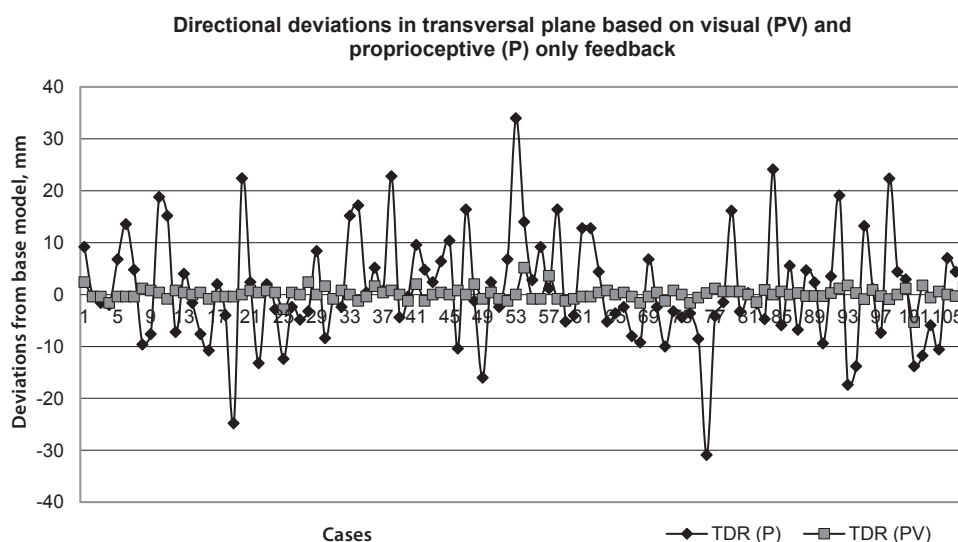


Figure 2. Comparative graphic of the subject’s performances (X-axis) in different sensory conditions: PV — proprioceptive-visual and P — proprioceptive only.

As an example of the range of individual variability between fine graphomotor performance of individuals in condition with vision (PV) and in proprioceptive (P) only, when the participant did not see either the graphical feedback of his drawings nor his own hand position is represented in Figure 2 (Tous-Ral & Liutsko, 2012; Liutsko & Tous-Ral, 2012). MANOVA analysis has shown the significant differences between fine graphomotor performances when comparing both sensory conditions (PV vs. P) (Tous-Ral, Muiños, Liutsko, & Forero, 2012). For this reason, also continuing the Mira y Lopez tradition, the proprioceptive sense was used by Prof Tous (2008) to create the Proprioceptive Diagnosis of Temperament and Character (Tous Ral, Muiños, Tous López, & Tous Roviroso, 2012) which can complement verbal techniques in personality assessment thus providing, in a sum, a global picture of a person.

Learning with the help of proprioception and automatic behaviour

Proprioception plays an important role in our daily lives (Goble, Noble, & Brown, 2010). Its automatic performance is done mainly on the unconscious level: visceral organ regulation (respiration, heart function, etc.), locomotive synchronization for

balance, and optimal kinematics in humans (we have an autopropulsive mechanism that consists of about 600 muscles, 200 bones and several hundred tendons) or in animals (how a centipede coordinates all its legs) (Fig. 3).

Proprioception is a basis for acquiring automatic knowledge, sometimes called know-how or “embodied” knowledge (Barsalou, 2008; Sebanz, Knoblich & Humphreys, 2008) of the kind based on practical experience, daily routine activity, or professional skills. When we start to learn a new skill, such as cycling or driving, we need to see our feet pedalling or our hand changing the gear; however, with time and repeated practice we do it on the proprioceptive level and without visual guidance, apparently working on autopilot (Lee, Swinnen, & Serrien, 1994). Without proprioception we would have no professional pianists, painters, ballet dancers, circus acrobats, or sportsmen.

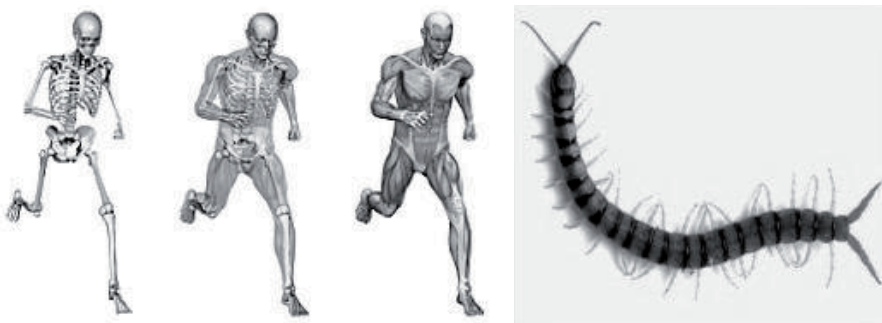


Figure 3. Muscular-joint-skeletal human presentation and centipede (picture adapted by author).

Practical knowledge, due to proprioceptive sense, becomes “embodied” knowledge, allowing us to be less stressed during multiple and/or prolonged activities. Such habits and skills start to work automatically and without our brain control, as reflexions. In order to appreciate this, we could mention the examples of automatized movements from the experiments of the renowned Russian physiologist Sechenov, carried out more than 100 years ago (Sechenov, 2013):

- 1) When a *decapitated* frog’s leg was pinched, the frog tried to remove the leg from the stimulus; however, when the leg was daubed with an acid, the frog scrubbed the leg with another part of the body.
- 2) When a frog *without a brain* was pinched on the table, it started to crawl in order to escape from the stimuli; however, when it was pinched in water, the frog started to swim.

These examples were of “rational” behaviour that worked as an automatic reflex.

Corr (2010) pointed out, in consideration of importance, multiple levels of behavioural control that require recognition of both (a) the relationship between automatic (reflexive or pre/non-conscious) and controlled (reflective, often with conscious representation) processes and (b) their time pattern (or lateness of controlled processes and their awareness). Modern researchers have shown that we become aware of our actions, or that controlled processing comes, with a lag

time of 300–500 msec after the action had been started, i.e. mind followed by brain events (Corr, 2010). In Libet's experiments (cited in Corr, 2010), the removal of the hand from a hot stove occurred before awareness of the hand touching the stove. According to Gray's theory (2004), the control of action consisted of late error detection and correction; i.e. it was related to cognitive processes that interrupt undesirable automatic brain-behaviour routines and correct for more adaptive ones.

Mechanisms of behavioural control (e.g. automatic vs. controlled processing) are fundamental in psychological explanation; and individual differences in these mechanisms may be assumed to play an equally important role in personality psychology. (Corr, 2010).

Corr (2010) stresses the importance of distinguishing between information obtained by different types of psychometric. While lexical tests (Big Five or others) can preferentially reflect controlled processing and conscious awareness that codifies important features of society (e.g. appreciation of artistic beauty; Openness), the importance of social interactions (Agreeableness), and following the norms and ethics established by society (Conscientiousness), then temperamental and biological measures (BIS/BAS and DP-TC), on the other hand, would reflect more dispositional, emotionally-based responses. This information can be more closely related to emotional control (Neuroticism) and Extroversion (it belongs to more automatically-elicited preference, since the preference to go to a lively party or to stay at home is not based on rational judgment, but more emotionally: likes and dislikes). We act as we feel and wish at a given moment, but when we reply to questionnaires we can fake an answer that can be more "rational" for our observers (especially in cases of special goals and interests, like applying for an attractive job). In this case the replies correspond more to our socially "desirable" behaviour than to our real selves. In this case we "supplement" or "modify" our behaviour to fit that accepted by the "norms" and "values" of the specific socio-historical culture of time.

To see how these values and qualities really are formed in children's behaviour, I would like to return to Sechenov's renowned work "*Reflexi golovnogo mozga*" (Sechenov, 2013). He explained that during development, children first like the "images" of their toys, and wish to be like their "heroes". Later, they transfer the qualities of these heroes to their own qualities as a model to follow: to be strong and without fear, to be generous and sympathetic, kind and honest, etc. The child, fusing with the image of his favourite hero, identifies with its qualities and transfers them to his own identity. Playing with his hero (it can be a reproduction of the live examples that surround him as well: parents, close friends or significant teacher figures, imaginary heroes from books, movies or videogames), the child repeats many times the actions of his "model", and words and attitudes toward to others, i.e. visual, auditory and action behaviour. Prof Ivannikov (2010) also mentioned in his lecture dedicated to achieving a socio-historical experience the importance of sense in the main activity of children: "Game (playing) is that type of activity of a child, in which the norms of human relationships are discovered and supported."

Embodied cognition

The issue of embodiment and situated cognition has arisen again recently as a core idea that perception, action, and cognition are shaped by the social context in which we engage with others, suggesting that cognition should be investigated at the group level rather than at the individual level (Knoblich, 2008; Sebanz, Knoblich, & Humphreys, 2008). Returning to the developmental growth of children, Sechenov (2013, originally published 1863) described how the “passion” of toys and play passes with time, although deep convictions relating to this behaviour remain and can acquire other forms. The boy who played a lot with knights, fighting for high moral values, will conserve his deep conviction to fight for justice: as a soldier, general or advocate, for example, or simply as a noble person. The Russian pedagogue Sukhomlinskij, in his work “I give my heart to children” (1985), said of education:

Children should live in the world of beauty, fairy tales, music, painting, fantasy, creativity (translated by author, Liutsko, 2013).

And the following passage from Leo Tolstoy has become an aphorism in the field of education (*Aphorism*, 2007):

All moral education of children comes down to good example. If you live well or intend to live well, and in so far as you succeed in your “goodness” in life, children will have a good education (translated by author).

A modern proof of one aspect of such a “visual” fusion is the activation of somatosensory parts of the brain, relating to an action a person simply watches in a video game, on the TV, or in a video recording (Lee, Swinnen, & Serrien, 1994; Repp & Knoblich, 2004; Scholz, 2010); this activation is more pronounced when the person is practising this type of activity, as compared to reading novels (Repp & Knoblich, 2004). Moreover, the so-called “mirror system” (formed by mirror neurons) matches observation and execution in goal-related actions, and appears to be to some degree a “functional” equivalent, somewhere between simulating, observing and performing an action (Sebanz, Knoblich, Stumpf, & Prinz, 2005). People tend to reproduce automatically by internal or imagined replication of the posture they observe, mimicking facial expressions and gestures; this covert imitation requires the use of implicit knowledge of one’s own body (Bosbach, Knoblich, Reed, Cole, & Prinz, 2006). In addition, the use of expert models also has considerable pedagogical support by means of a *perceptual blueprint*, a precise representation of the perceptual demands of the task. The suggestion that viewing repetitious performances of skills would “imprint into” the behaviour of observers was checked by Lee, Swinnen, & Serrien (1994). They found that the performance of persons who observed the skill prior to their own reproduction of it were better than novices who had not seen it before (Lee, Swinnen, & Serrien, 1994).

To sum up, as has been shown here, proprioceptive sense plays a crucial role in education and formation, and is a basis of individual differences and personality construct. Due to the scarcity of investigations relating to proprioception in psychology, this article can help to connect different, interrelated areas (generally body-mind paradigm) and show the importance of studying this little-known sense more in the future.

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The role of time perspective in coping behavior

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This article describes research on the role of time perspective in a person's choice of coping strategies in interpersonal conflicts. The interrelationship between different types of coping strategies (cognitive, emotional, and behavioral) and the orientation of time perspective are considered. P. G. Zimbardo's technique, which defines the orientation of time perspective, and E. Heim's technique, which is directed at exploring coping strategies, are used in our research. The sample consisted of 295 participants: 156 women and 139 men, with an average age of 32 years. The research shows that a future orientation is directly connected with the choice of cognitive and behavioral coping strategies in interpersonal conflicts, while an orientation to the negative past results in emotional coping strategies. A person's orientation to the fatalistic present engenders retreat and avoidance of conflict resolution, which are nonadaptive behavioral strategies that include few coping techniques.

Keywords: time, time perspective, coping strategies, interpersonal conflict

An extremely important component of a person's mental health and psychological well-being is the ability to independently define the purposes of one's life, and also to have available in one's image of the world an extended and substantial time perspective, oriented to the future. Time is one of the important but extremely little used resources of a person's mental organization and self-realization in society. As a consequence, in intricate social conflicts or difficult life situations, the loss of time perspective means the loss of one's life purposes, and is one of the symptoms of an approaching life crisis. In human formation and development, time determinants become an integral element of personality structure, consciousness, and the "developing-person" criterion (Zinchenko & Morgunov, 1994). Therefore, a person's time perspective can be considered as an indication of an ability to handle difficult situations and to choose strategies for coping with them. As Zinchenko and Morgunov (1994) note, people can develop their personalities only when they are time-conscious: when they master time and create their own time.

Another Russian psychologist, L. S. Vygotsky, points out that "human formation into an individual and personality assumes a specific combination or time coincidence of internal development processes with external conditions, which is typical for each age-stage of ontogenesis" (1982, p. 108). Hence, the formation of

time perspective becomes a means of self-control, and of developing coping strategies in difficult situations. Today, studying the development of time perspectives, not only in the context of personality formation but also in the context of the development of coping strategies in conflict situations, has become a matter of primary importance. The theoretical-methodological basis of research in Russian psychology is presented by Vygotsky in his cultural-historical approach to understanding a person and her/his formation. The implementation of this approach has found its continuation and further development in the works of such prominent psychologists as L. I. Bozhovich, A. N. Leontiev, A. V. Zaporozhets, and D. B. Elconin, and also in the works of S. L. Rubinshtein and K. A. Abulhanova-Slavskaya on the problems connected with the course of life and personal time, and also on the concept of personality chronotope highlighted by A. A. Uhtomsky, M. M. Bakhtin, and V. P. Zinchenko.

Time perspective

In Russia, psychological problems related to a person's time perspective have been discussed by K. A. Abulhanova-Slavskaya, T. N. Berezina, A. K. Bolotova, E. I. Golovaha, A. K. Kronik, I. S. Kon, N. N. Tolstyh, E. N. Osin, A. Sircova, and others.

With regard to the experience of time, Rubinshtein (1977) has put forward the idea of a person's course of life, a subjective picture of his/her life. Rubinshtein stresses the necessity of taking into account a person's ability to change his or her life. Another of Rubinshtein's concepts covers the subject of life and the principle of personality analysis through life activity.

In foreign psychology the notion of time perspective has been introduced by Kurt Levin (2001), who views it as a person's vision of his or her future and past in the present. In addition, the cognitive choice and emotional experiences connected with past or future events can have an impact on the person's activity here and now, and can motivate future actions. B. V. Zeigarnik, Levin's pupil and a well-known Russian psychologist, believes that past experience, being an essential characteristic of a person's dynamics, can play an important role in determining life perspectives, setting time milestones, and reaching objectives. Zeigarnik points out that the ability to give a more or less objective assessment of a situation from the point view of its present and future development, and to find a way to set feasible goals, is a necessary and important condition for the formation of human personality (Zeigarnik, 1971).

In his works, Frank (1939) defined the concept of *time perspective* as the influence of past experience and future plans on the process of decision-making and behavioral patterns in the present. In 1985 Joseph Nutten, in accordance with Levin's idea of the fullness of life space in time, put forward a thesis that the concept of time perspective appears under the influence of a person's cognitive evaluation of his/her needs and intentions. Having agreed with Levin on the question of the impact of past and future experiences on behavior in the present, Nutten (2004) emphasized the specific influence of the future. He stressed that the formation of time perspective is determined not merely by a person's past experience, but also by cognitive analysis of his/her plans for life, and thus the formation of time perspective provides a basis for individual motivation.

The latest works in the area of time-perspective research have been presented by Brissette, Scheier, and Carver (2002), D'Alessio, Guarino, Pascalis, and Zimbardo (2003), and Zimbardo and Boniwell (2004).

Time perspective is one of the overall characteristics of a personality. It plays an important role in life processes and events, affects many spheres of human activity, and is connected with different personality features. The importance of studying time perspective is explained, above all, by the influence that the person's thoughts on his/her past and present may have on the efficiency of his/her activity in the present.

Time perspective as an integral construct is connected with many personal features; it is capable of influencing different aspects of a person's behavior, including behavior in difficult situations, which are more widespread nowadays due to the instability and unpredictability of the social situation and the growth of social-psychological intensity. A belief in the occurrence of only negative events in the near future is often observed in conflict situations. It can be considered one of the factors in stress. The expectation of an unpleasant event is generally harder to endure than the event itself (Bolotova, 2007, 2012).

Coping behavior

A person's coping behavior plays an important role in resolving difficult conflict situations that may arise in various spheres of life. In Heim's (1988) opinion, coping behavior shows itself in the cognitive and emotional actions that a person takes to overcome difficult situations and to adapt to existing circumstances.

This concept was first used by L. Merfi in 1962 to research behavioral patterns that children employed to cope with problems in personality formation and developmental crises (Karvasarskii, 2000). The coping problem was thoroughly studied in the context of psychological stress by Lazarus (1993), who regarded coping as the behavioral and cognitive efforts undertaken by a person to decrease the influence of stressful circumstances. Now, the idea of coping is used in studies of behavior in every difficult life situation.

There are various classifications of coping strategies in psychological research. For example, Heim (1988) has suggested considering emotional, cognitive, and behavioral strategies. These three types of coping behavior vary in accordance with degree of adaptiveness: adaptive, relatively adaptive, and nonadaptive.

The problem of coping with difficult conflict situations is now treated by many Russian and foreign psychologists through the "resource approach." This theory assumes that there are certain specific personality features that help to overcome difficulties (Bodrov, 2006; Folkman & Lazarus, 1998; Hobfoll & Lerman, 1988; Holahan & Moos, 1987; Taylor, 1995; Vodopianova, 2009; and others). Time perspective in this context is one of these significant features.

As Zimbardo and Boyd (1999) claimed, time perspective can be regarded as a person's constant feature. However, time perspective has its own situational characteristics due to being affected by the person's cultural, social, and age characteristics, economic and marital status, educational background, or religious beliefs.

Thus, it would appear that during a person's life, time perspective can vary under the influence of his/her career achievements; significant events; changes in economic, social, and political environment; and successes and failures (Sircova & Mitina, 2008).

Connections between time perspective and coping behavior

In foreign psychology a number of researchers have studied the connection between choice of coping strategies and personality characteristics—in particular, time perspective. Among them are Epel, Bandura, and Zimbardo (1999), Folkman and Lazarus (1998), Wills, Sandy, and Yaeger (2001), Worrell and Mello, (2007).

In Boniwell and Zimbardo's research (2004), time perspective was used as a predictor of various actions taken by a person. Respondents in these experiments were put in conditions similar to a "prisoner's dilemma." The researchers discovered that in such situations, future-oriented and past-oriented people were more inclined than present-oriented people to cooperate, as they realized that cooperation could lead them to the desirable goal more quickly than other strategies. Present-oriented people behaved in an irrational way; they worked at random, without any planned tactics, and they seldom used cooperation. Thus, Boniwell and Zimbardo stress the importance of time perspective in the choice of coping strategies in difficult and conflict situations. A balanced time perspective can help a person to cope with difficulties and complicated situations because of its influence on coping behavior.

Brissette and colleagues (2002) found that a person oriented to the future is inclined to think about and control all aspects of a difficult situation. At the same time, he/she is optimistic and believes that self-efficacy will help resolve the conflict.

In Russian psychology, the problems connected with the interrelationship between time perspective and the choice of coping strategies in difficult situations in general, and in conflict situations in particular, have been examined in the works of Abulhanova-Slavskaya (1991), Alekseeva (2002), Arestova (2000), Ryabinkina (2007), Sircova (2008), Sircova and Mitina (2008), Tolstyh (2010), and others.

Research conducted by Alekseeva (2002) shows that the degree of personal involvement in the process of coping with difficult life situations increases with age. It is expressed, first of all, in one's taking responsibility for existing conflicts, and this in itself has a great impact on the choice of specific coping behavior.

Sircova and Mitina (2008) have proven the existence of a correlation between a balanced time perspective and such indicators as intelligence, endurance, satisfaction, and adaptive coping strategies.

The results obtained by Ryabinkina (2007), Belinskaya (2009), along with other researchers, show that in a conflict situation, future-oriented people choose such coping strategies as self-control, searching for ways to solve the problem, and distancing. This behavior can be characterized as being based in a desire to dismiss the problem for a certain period of time in order to consider ways of solving it rationally. A person with a time perspective focused on the past can positively re-evaluate the situation and accept responsibility for an existing conflict. At the same time, the person can try to find positive aspects in the conflict that will enable him/her to avoid similar errors in the future. The research shows that coping strategies

connected with the search for social support can be chosen by both past-oriented people and those focused on the future. This finding proves the universality of this strategy because communication with significant people can be regarded both as a resource from past experience, on which the person falls back during difficult times, and as part of the future.

Working on the construct of time perspective, Boniwell and Zimbardo (2004) described a “balanced time orientation,” which combines five factors: when high points prevail in the person’s positive past and future orientations, when middle points are at the scale of the hedonistic present, and at the same time, when low points are at the scale of the negative past and fatalistic present. A well-balanced time perspective provides flexibility, which allows a person to shift among the events of the past, present, and future in response to life circumstances and situations. The behavior of a person whose construct shows high indicators is determined by a balance between the influence of past experience, the purposes of the present, and appropriate thoughts about the future. According to Sircova and Mitina (2008), this combination of time orientations is optimal for the psychological and physical health of a person, and also for his/her adaptation to and effectiveness in society.

Despite the importance that time perspective can have in choosing coping strategies in conflict situations, the topic has not been thoroughly researched in modern Russian psychology.

Research project

Methodology

Modern research on time perspective basically uses the methodology of the Zimbardo Time Perspective Inventory (ZTPI) (Zimbardo & Boyd, 1999), which was developed by P. Zimbardo in cooperation with A. Gonzalez and allows simultaneous work with all three aspects of time—the past, the present, and the future. The ZTPI method consists of five factors, or scales: the negative past, the hedonistic present, the positive past, the fatalistic present, and the future. In our work we have researched the connection between time perspective and choice of behavioral coping strategies in an interpersonal conflict by applying Zimbardo’s technique (in Sircova’s (2008) adaptation) and also Heim’s inventory (1988), which explores various types of behavioral coping strategies.

Participants

The sample included 295 participants; 139 of them were male, and 156 were female. The average age was 32 years.

Results and discussion

The Statistical Package for the Social Sciences (SPSS) 14.0 was used for statistical data processing (descriptive statistical data, differential criteria, correlation analysis). The data was verified against the normality of distribution by applying Kolmogorov-Smirnov’s test, asymmetry, and excess indicators. The obtained distribution of the variables relevant to personality characteristics investigated in the

research did not differ from the normal distribution. This result allowed us to use the parametrical technique.

Table 1 describes the time-perspective orientation of the sample as a whole.

Table 1. Description of Time Perspective for the Entire Sample

Scale	Mean	Standard deviation	Asymmetry	Excess
Negative Past	2.47	0.74	0.35	-0.73
Hedonistic Present	3.42	0.54	-0.25	-0.24
Future	3.71	0.55	-0.35	0.01
Positive Past	3.74	0.59	-0.35	0.74
Fatalistic Present	2.51	0.65	0.32	-0.24

Table 2. Spearman Correlations Between Time Perspective and Choice of Coping Strategies

Coping strategies	Negative past	Hedonistic present	Future	Positive past	Fatalistic present
Analysis of problem	0.011	0.026	0.172*	-0.029	0.127
Self-possession	-0.232*	-0.126*	0.356**	-0.086	-0.043
Awareness of own importance	-0.117	-0.277**	0.318**	-0.134*	-0.099
Relativity	0.038	0.059	0.057	0.039	0.052
Religiousness	-0.062	-0.044	0.189**	-0.098	-0.051
Searching for sense	0.089	0.021	0.029	0.015	0.099
Ignoring the problem	0.034	0.034	-0.309**	-0.045	0.093
Humility	0.152	0.089	-0.312**	-0.072	0.099
Dissimulation	0.317*	0.044	-0.226*	-0.017	-0.026
Confusion	0.255**	-0.017	-0.053	-0.059	0.017
Protest	-0.075	0.046	0.273**	0.126	-0.334**
Optimism	-0.043	0.214*	0.282**	0.321*	-0.069
Emotional relief	0.079	0.042	0.021	0.266**	0.045
Passive cooperation	0.117*	0.114*	-0.062	0.085	0.078
Suppression of emotions	0.424**	-0.022	-0.057	-0.044	0.313**
Obedience	0.351**	0.056	-0.258*	0.061	0.418**
Self-accusation	0.093	0.039	-0.019	-0.059	0.274**
Aggression	0.092	0.268**	-0.265**	-0.021	0.173**
Cooperation	-0.313**	0.043	0.127*	0.268**	-0.076
Altruism	-0.292**	-0.065	0.026	0.326*	-0.093
Communication	-0.465**	-0.081	0.275**	0.225*	-0.191**
Distraction	0.058	0.052	-0.017	-0.141*	0.069
Indemnity	0.041	0.321*	0.059	0.032	0.026
Constructive activity	-0.037	-0.199*	0.134*	-0.031	-0.043
Active avoidance	0.051	0.232*	-0.355**	0.019	0.361**
Retreat	0.388**	0.271*	-0.091	0.042	0.225**

Note. * $p \leq 0.05$ ** $p \leq 0.01$

High indicators on the scales of the future and the positive past, a moderate value on the hedonistic present scale, and low points on the factors of the negative past and fatalistic present, show that a person possesses a balanced time perspective. Of the respondents taking part in the research, 41% possessed such a perspective.

As an outcome of the research, we found a correlation between the choice of coping strategies and a person's time perspective. Table 2 shows statistically significant correlations. As the correlation coefficient does not allow us to determine the direction of the connection, it is necessary also to consider Figures 1 and 2, which present the percentage parity of the choice of types and variants of coping strategies against the orientation of time perspective.

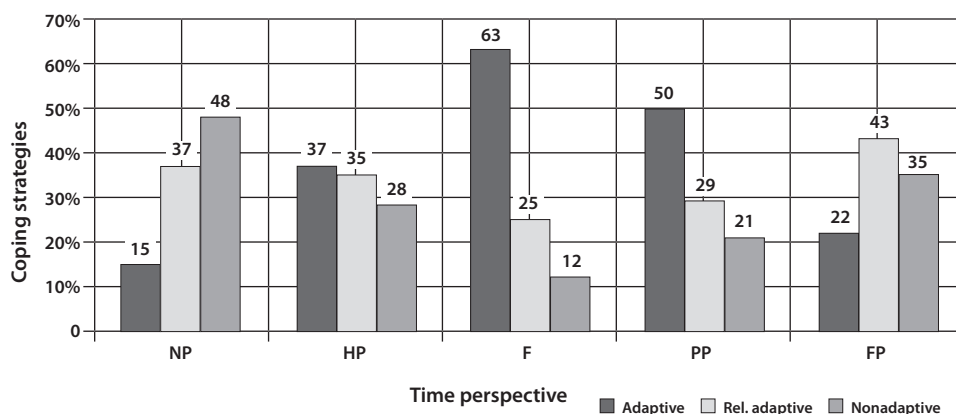


Figure 1. The choice of types of coping strategies depending on orientation of time perspective.

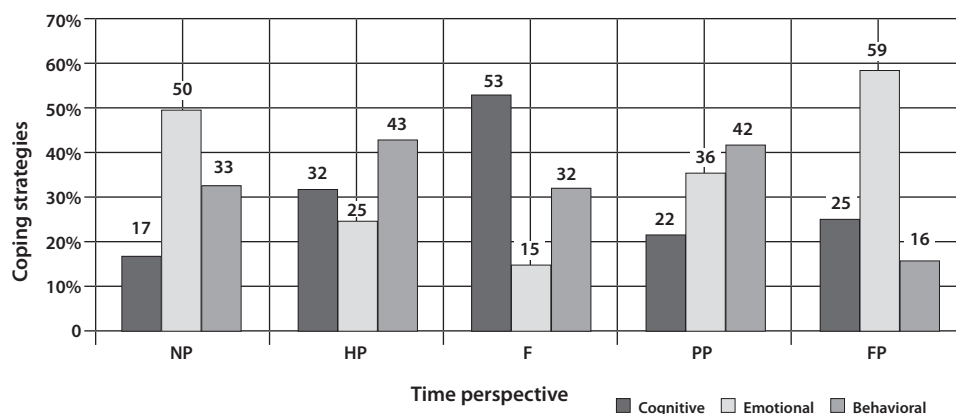


Figure 2. The choice of variants of coping strategies depending on orientation of time perspective.

Statistical analysis proves that the *future*-oriented person is inclined to choose adaptive cognitive strategies in a conflict situation. Such people are self-controlled, and try to analyze the existing conflict and find possible ways to resolve it. Also, time-perspective orientation to the future significantly correlates

with the choice of cognitive adaptive strategies. In conflicts, such people often turn to others, cooperate with them, and make a joint effort to overcome the difficult situation. The future-oriented person understands that in some cases, in order to save the relationship with his opponent or to avoid future negative consequences, it is better to use a cooperation strategy than confrontation and animosity. At the same time such people try to be optimistic and believe in their own ability to cope with the conflict. The aspiration to set goals and efforts made to achieve them, along with active participation in the events of their own lives, allow them to turn to strategies that avoid conflicts and help them to retreat from the existing difficulties.

The research suggests that a person's time orientation to the *fatalistic present* notably correlates with the choice of relatively adaptive and nonadaptive emotional strategies in conflicts: suppression of feelings, self-blame, obedience, and aggressiveness. It is also connected with the choice of nonadaptive behavioral strategies of active retreat and avoidance. At the same time, this time perspective negatively correlates with the choice of adaptive emotional and behavioral strategies of protest and cooperation. In a conflict situation such people try to suppress their emotions, considering themselves to have been offenders, or on the contrary they can become aggressive and release their emotions onto others.

In this way such people try to avoid the problems emerging in a conflict situation. Fatalistic-oriented people regard their future to be predetermined and simply accept life as it is, without seeing the necessity of taking action in order to affect the situation. For them it is simpler to avoid the conflict and to concentrate on the emotional side of the problem.

Orientation to the fatalistic present is not notably connected with any one of the cognitive strategies. People who do not trust their self-efficacy in coping with a conflict situation and who believe that the future has already been predetermined are not inclined to analyze the problem, think of ways of solving it, and make their own decision; instead they rely either on other people or on the circumstances.

The *negative past* is the only time orientation that reveals a substantial connection with the choice of all types of nonadaptive coping strategies. It notably correlates with the strategies of dissimulation, confusion, suppression of emotions, obedience, and retreat. It has a negative correlation with the choice of adaptive types of cognitive and behavioral strategies, such as self-possession, altruism, and cooperation.

The prevalence of this time orientation can be explained by the fact that a person's past contains injurious and unpleasant experiences that have had an impact on his/her personality formation. Therefore, when the person faces a conflict, a new unpleasant situation, he or she tries to avoid the problem, retreat, and suppress negative emotions. Cognitive analysis of the reasons that may have led to the conflict, and a search for ways out of it, are not the main strategies for such a person. The combination of nonadaptive emotional and behavioral coping strategies proves to be unproductive; such strategies cannot teach the person to cope with difficulties effectively.

The orientation to the *positive past* has a negative correlation with the choice of cognitive strategies and, at the same time, positively correlates with the choice of

adaptive emotional and behavioral strategies such as optimism, cooperation, altruism, and communication. As we have already pointed out, a person thinking about the past has many nostalgic moments and strong positive emotional experiences. Therefore, when such a person faces a conflict situation, he/she tries to remain optimistic and believes that his/her self-efficacy will help to handle the conflict. Such people try to acquire useful experience from conflict situations. Besides, they often consider cooperation and communication with other people to be an important resource when coping with difficulties.

It would appear that coping strategies connected with the search for social support can be chosen by both people oriented to the positive past, and those focused on the future. As we have already mentioned, this feature proves the universality of this strategy, because communication with significant people can be regarded both as a resource from past experience which the person uses at difficult moments, and as part of personal future plans. We can find evidence of the universality of this concept in other research (Belinskaya, 2009).

A person's orientation to the *hedonistic present* is connected with the choice of optimism as an emotional strategy, and also with nonadaptive emotional and behavioral strategies such as aggression, retreat, and active avoidance. However, this time orientation has a negative correlation with the choice of adaptive cognitive strategies of self-possession and awareness of one's own importance. A person oriented to the hedonistic present has a desire to live a full life and enjoy it here and now, instead of thinking about the future. Consequently, in a conflict situation such people try to be optimistic and to retain confidence in a positive outcome despite temporary difficulties. They retreat and try to avoid the arising problem because it may interfere with the usual comforts of their lives. But in case of failure, they can resort to the strategy of emotional outbreak and aggressive behavior.

In addition, in the orientation of time perspective among the respondents of our research, some significant differences were found with regard to the degree of variability of coping behavior. We understand *variability of coping behavior* as the respondents' choice of seven or more coping strategies in a conflict situation. Statistically significant differences were noticed in the orientation of time perspective to the fatalistic present and to the future (Mann-Whitney U-criterion $p = 0.04$ and $p = 0.03$, respectively).

The majority of future-focused respondents (56%) demonstrated variability of coping behavior. They realized that strategies leading to success in different situations of interpersonal interactions vary. At the same time, as has already been mentioned, people focused on the fatalistic present do not see any benefit in their actions, and therefore their coping behavior in conflict situations is rigid. Thus, 61% of these respondents chose only two or three strategies in conflict situations. Therefore, a time-perspective orientation to the negative past assumes the choice of the least adaptive coping strategies, and orientation to the fatalistic present leads to the choice of rigid strategies and to the relative absence of behavioral variants in conflict situations.

The research allows us to draw the following conclusions:

1. Time perspective is a person's view of the future or the past in the present. The events of the future or past develop in reality, and influence the activity of the person here and now. It is important to see these events as they interact and to assess their influence on the events in the present.
2. Time perspective can influence different aspects of a person's behavior, including behavior in conflict situations.
3. In a conflict situation, a time perspective oriented to the future leads to the choice of cognitive and behavioral coping strategies, while orientation to the negative past is connected with the choice of emotional coping strategies.
4. The orientation of time perspective to the fatalistic present predicts the choice of nonadaptive behavioral strategies such as retreat and avoidance to resolve a conflict. Time perspective focused on the positive past is connected with the choice of adaptive behavioral and emotional coping strategies.
5. Time perspective focused on the hedonistic present is connected with emotional coping behavior in conflicts, and both adaptive and nonadaptive coping strategies.
6. The orientation of time perspective to the negative past leads to the choice of the least adaptive coping strategies, and orientation to the fatalistic present results in the relative absence of different coping strategies.

Conclusion

The findings of our research can be put to use in social-psychological training in developing time representations, and they can also be used in the process of psychological counseling on resolving conflicts in interpersonal relationships.

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WORK AND ORGANIZATIONAL PSYCHOLOGY

The determinants of the development of professional distortions in medical personnel, teachers, and psychologists working in an industrial-disaster zone

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This article presents research results regarding the determinants and individual predictors of professional distortions in the medical personnel, teachers, and psychologists who were involved in long-term programs of human relief assistance after a catastrophic accident at the Sayano-Shushenskaya hydroelectric power station. The research aim was to analyze the factors influencing the increase in and the accumulation of occupational stress in the groups investigated. The stress studied was caused by strong emotional tension in 3 months of intensive work after the accident. The extraordinary situation served as a challenge, a kind of “strength test” for individual adaptation, which led to the manifestation of extreme adaptation options (destructive and constructive forms) and allowed us to clarify the factors that contributed to their development. The research showed that, in this situation, psychological (in particular, emotional) resources and individual coping characteristics played a determinative role in professional adaptation.

Keywords: occupational stress, coping behavior, emotional intelligence, individual predictors, professional distortions, stress management

Studies of personal adaptation to dynamic work conditions and job content form one of the most important domains in work and organizational psychology. Contemporary base-line research is targeted to reveal the factors that contribute to effective work, unimpaired health, and well-being. In this domain the studies of various professional disadaptations and the elaboration of psychological support programs are growing rapidly (Bodrov, 2006; Cooper, Dewe, & O'Driscoll, 2001; Kasl, 1978; Leonova, 1996, 2003).

Many of the studies are devoted to manifestations of stress and the development of professional distortions in socio-economic occupations (Leonova & Bagryi, 2009; Leonova & Kachina, 2006; Mitina, 1998; Velichkovskaya, 2004; Vodopianova & Starchenkova, 2009; Yasko, 2005). The identifying features of such occupations

are the following: the peculiarities of the job context require not only a high level of mastery and work quality but also special personality traits: eagerness to maintain excellent psychological stability, to prevent chronic stress, and to minimize the risks of distortions (such as burnout syndrome), including chronic fatigue, neuroses, and stress-related diseases.

In the socionomic domain disadaptation predictors can be subdivided into two types: external (job content and work, organizational and socioeconomic conditions) and internal (individual characteristics, work motivation and values, job satisfaction, work experience, and competence level) (Velichkovskaya, 2004; Yasko, 2005). A number of studies focus on coping behavior—namely, the types of coping strategies (Vodopianova & Starchenkova, 2003). Some researchers investigate components of emotional intelligence as one of the coping resources on the personality level (Khazova & Vershinina, 2010; Lusin, 2004; Ryajeva, 2010). Emotional intelligence, defined as the ability to understand, to differentiate, and to control self-emotions and the emotions of others (Mayer & Salovey, 1993), is a work-specific characteristic that is required in socionomic occupations.

In spite of a broad range of investigations targeted at revealing the psychological resources needed for successful professional development, the problem of adaptation to the demands of extreme/difficult work situations is on the agenda. Work efficiency and the internal costs of task execution are the main indicators of the potential for adequate professional actualization. Efficient work ensures a high level of functioning and health maintenance in the nurturing professions in critical environments.

Description of the research project

This article presents the results of research focused on discovering the determinants and individual predictors of professional distortions in medical personnel, teachers, and psychologists working under tense conditions. Participants in the study were involved in long-term programs of human relief assistance after a catastrophic accident at the Sayano-Shushenskaya hydroelectric power station. The large-scale accident took place on August, 17, 2009; 75 employees died. At the time of the study the specialists had worked in conditions of emotional tension and high workload for over 2.5 months.

First stage

The investigation consisted of two stages. In the first stage a diagnostic and training program was held for the group of psychologists. The psychologists were engaged in long-term programs of psychological assistance to the victims. There were 15 psychologists, 14 women and 1 man; the average age was 35; average work experience was 10 years. Two months after the accident the psychologists' workload rapidly increased because of the high number of calls for psychological help. At the time of the research the psychologists were working in nearly extreme conditions. It became obvious that the accumulation of fatigue and emotional tension increased the risk of developing chronic fatigue, which is a predictor of possible professional distortions. At the same time, thanks to the high rate of work engage-

ment and the positive emotions related to work results, the psychologists did not consider the high workload a serious hazard.

The implementation of psychological procedures targeted to recovery of the human functional state (HFS) became urgent as a kind of “psychological assistance” to the psychologists themselves. This work was done within a training course designed to provide the psychologists with the means for acquiring psychological self-regulation (Leonova, Kuznetsova, Kachina, & Zlokazova, 2012).

The aims of the training course were (1) to elicit psychological means for effective, goal-oriented self-regulation that met the standards for efficient work, and (2) to train psychologists in the sufficient use of these means.

In group discussion the typical indicators of HFS dynamics in highly tense work were elicited. The internal parameters of nonoptimal (destructive) HFS were clarified, and seven criteria for a goal-oriented HFS (a state meeting the requirements of the work conditions and tasks) were accepted as the inner markers for self-regulation (see Figure 1). As the list of markers was fixed and accepted, every training participant created his/her own set of self-regulation formulas for adequate HFS when working under tense conditions.

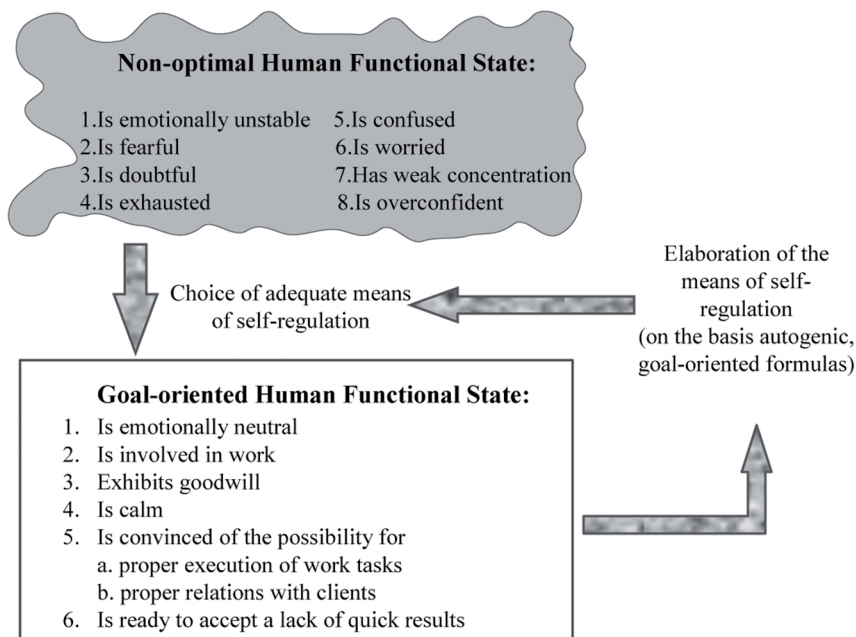


Figure 1. Elaboration of goal-oriented HFS optimal for psychological work with the victims.

Previously published empirical data highlighted the strong, multilevel effects of the positive HFS dynamics that resulted from the training course (Leonova, Kuznetsova, Kachina, & Zlokazova, 2012). The self-reports showed that new means for the internal recovery of self-regulation were successfully acquired by the psychologists.

At the end of the training course a final discussion was held. The psychologists accepted the fact that they scheduled insufficient time for rest and recreation. They considered it obvious that the high work intensity and the lack of rest led to fatigue and emotional tension. The worthwhile, intensive work, carried out upon “first request,” step by step adversely affected the adaptation potential of the psychologists. The participants stressed that reflexive analysis of their fatigue level was helpful in understanding that a strong motivation for success at work cannot fully compensate for the consumption of inner resources. They accepted the necessity for recreation and thought it should be viewed as the first stage of self-care, targeted to preserve health, to increase professional success, and to decrease the risk of professional deformations.

Second stage

The second stage of the research included diagnostics in the groups of medical personnel and teachers. For both groups, the deaths of so many people and the loss of feelings of safety and stability made work highly difficult. Consequently, the probability of new and/or escalating maladaptive forms of response increased.

The extraordinary situation appeared as a challenge, a kind of “strength test” for individual adaptation. This challenge led to the manifestation of extreme adaptation options (destructive or constructive forms) and allowed us to clarify the factors that contributed to their development. The variety of adaptation options was reflected in different degrees and kinds of occupational-stress syndromes (Leonova, 1996, 2007). It can be assumed that psychological resources (in particular, emotional intelligence) and individual peculiarities of coping played a determinative role in providing professional adaptation.

The investigated groups (both medical personnel and teachers) had no proper knowledge for providing sufficient psychological help to the victims, and, as well, they didn't possess any special self-regulation skills for working under tense conditions. For this reason, we suggest that some psychological characteristics (above all, emotional-personality characteristics) and typical coping behavior played a key role in successful adaption to extraordinary situations.

Goal

The research aim was to analyze the factors that led to the increase in and accumulation of occupational stress in the groups of medical personnel and teachers. These factors caused strong emotional tension in the 2.5 months of intensive work after the accident.

Tasks

The research tasks were formulated as follows:

1. To evaluate the dominant components in the occupational-stress syndrome and to reveal the high-risk zones for a loss of health and well-being and a decrease in work efficiency in the investigated occupational groups
2. To determine the specific coping strategies of professionals with different levels of occupational stress

3. To determine the role of emotional intelligence and different coping strategies in predicting health disorders and decreases in work efficiency (risk of chronic stress, burnout syndrome, and other distortions) in the investigated occupational groups

Sample

The sample of medical personnel and teachers consisted of 117 people:

- 40 doctors and nurses working with victims and their family members in the ambulatory-care clinic, as well as with employees engaged in the reconstruction work at the power station (38 women, 2 men; average age, 46; average work experience, 25 years)
- 77 school and preschool teachers (75 women, 2 men; average age, 43.5; average work experience, 23.7 years).

Methods

The diagnostic set of assessment methods had the following components (see Table 1):

Table 1. Diagnostic Indicators

IDIKS scales	Strategic Approach to Coping Scales (SACS) questionnaire
TV1. Risk factors and objective job constraints (4 subscales) TV2. Subjective appraisal of job difficulties (4 subscales) TV3. Job rewards and administration (4 subscales) TV4. Acute-stress manifestations (6 subscales) TV5. Chronic-stress manifestations (6 subscales) TV6. Personality and behavioral deteriorations TV0. General stress index (summarizing score of indexes of main scales calculated by regression model) Lie scale	1. Assertive actions 2. Social joining 3. Seeking social support 4. Cautious actions 5. Instinctive actions 6. Avoidance 7. Manipulative actions 8. Asocial actions 9. Aggressive actions
Emotional Intelligence Questionnaire	
1. Self-awareness 2. Self-management 3. Social awareness 4. Relationship management General indicator of EI	

- The Managerial Stress Survey (IDIKS) (Leonova, 2006) was the main instrument for detailed evaluation and analysis of manifestations of occupational stress.

- The Strategic Approach to Coping Scales (SACS) questionnaire by S. Hobfoll, adapted version (Vodopianova & Starchenkova, 2003), was used for assessing typical coping strategies and coping-behavior models.
- The Emotional Intelligence Questionnaire (Manoilova, 2007) was used for evaluating the ability to identify, assess, and control the emotions of oneself and others.

Results

1. Stress syndrome in medical personnel and teachers

IDIKS data showed a high level of perceived stress for both groups of participants (see Table 2). In addition correlation of the data revealed significant similarities in their IDIKS profiles. The value of the lie scale index is in the range of norms, which testifies to the reliability of the collected results.

Table 2. IDIKS Descriptive Statistics for Medical Personnel (n=40) and Teachers (n =77)

Indices	Medical personnel		Teachers	
	Mean (σ^2)	Stress level	Mean (σ^2)	Stress level
TV1. Risk factors and objective job constraints	44.14 (9.39)	Moderate	46.30 (11.83)	Moderate/Expressed
TV2. Subjective appraisal of job difficulties	60.6 (7.86)	High	56.96 (6.85)	High
TV3. Job rewards and administration	50.62 (6.20)	Expressed	51.61 (7.13)	Expressed
TV4. Acute-stress manifestations	55.90 (9.33)	High	56.20 (10.27)	High
TV5. Chronic-stress manifestations	59.70 (9.20)	High	60.36 (9.77)	High
TV6. Personality and behavioral deteriorations	52.79 (8.01)	Expressed	53.63 (8.13)	Expressed
TV0. General stress index	56.30 (7.78)	High	56.63 (8.26)	High

The main stressors for both groups of participants were as follows:

- *Low autonomy* (TV2.4. — high/extremely high stress level): (a) in the medical personnel: the strict control and regulation of treatment, conflict between the regulations and the real performance conditions; (b) in the teachers: impossibility of being spontaneous and taking initiative at work, need to strictly follow the prescribed rules and regulations
- *Low task variety* (TV2.1. — high stress level): (a) in the medical personnel: monotony, prevalence of single-type tasks, impossibility of applying new treatment tools and methods; (b) in the teachers: daily routine and frequent repetitions of the same tasks
- *Low task identity* (TV2.2. — high stress level): in both groups: prevalence of simple and familiar tasks, lack of demand for innovation

- *Low job rewards* (TV3.2. — high stress level): in both groups: low rewards, lack of approval and encouragement for achieving success, no prospects for further development and career growth
- *Poor feedback* (TV3.3. — high stress level): in both groups: shortage of information about performance quality, lack of capacity to monitor work results

The pattern of stress factors displays strong dissatisfaction with the content of professional activities. Current tasks were perceived as simple and stereotypical, and the work was perceived as tightly regulated. Both the medical staff and the teachers felt a lack of support from organizational leadership. This negative evaluation of their own work, as well as the limited prospects for further development, could have been exacerbated given the background of the strong negative emotional experience in the preceding months. It might also have been caused by a feeling of “self-incompetence,” arising from lack of the ability to provide psychological assistance to the victims and their relatives. As a result, the range of stress factors provoked a variety of negative, acute, and chronic manifestations of stress and of the personality and behavioral deteriorations that are the long-term effects of stress.

The actual state of the participants was characterized by manifestations of strong, acute stress:

- actual well-being (TV4.6 — extremely high stress level)
- disturbances in behavior (TV4.5 — high stress level)

The most frequently reported negative symptoms are typical signs of psychological exhaustion: low spirits, asthenia, cognitive tension, and a lack of desire to do anything. These symptoms indicate not only reduced efficiency but also the steady depletion of adaptation resources, which is perhaps the reason for the development of the chronic form of stress. Chronic-stress manifestations in teachers and medical personnel included:

- *anxiety* (TV5.1 — high stress level): constant agitation, worrying about the future, lack of self-confidence
- *depression* (TV5.3 — high stress level): feeling hopeless, loss of meaning and sense of prospective in life, fatalism, constant depressed mood and anguish
- *chronic fatigue* (TV5.4 — high stress level): rapid fatiguability, feeling jaded and worn-out, having difficulty completing simple work tasks
- *psychosomatic reactions* (TV5.5 — high stress level): frequent severe headaches, waves of nausea and giddiness, difficulty breathing, spasms in the stomach
- *sleep disturbances* (TV5.6 — high stress level): insomnia, fragile or troubled sleep, excessive daytime sleepiness

Permanent destructive stress effects were manifested in personality and behavioral deteriorations connected, mainly, with the development of the following:

- burnout syndrome (TV6.2 — high stress level)
- neurotic reactions (TV6.3. — high stress level)

Table 3. Groups at High Risk for Intense Stress Development

Stress level	Interpretation	% (number)
Expressed	The stress level is beyond allowable. It represents a potential threat for functioning and psychological well-being. Should be engaged in psychological support programs.	Medical personnel: 37.5% (15 people) Teachers: 39% (30 people)
High	Activity and health risk. Psychological help required to reduce the stress.	Medical personnel: 50% (20 people) Teachers: 48% (37 people)
Extremely high	High probability of failure and mental breakdown. Need a rehabilitation course.	Medical personnel: 12.5% (5 people) Teachers: 13% (10 people)

In this case a “classic” way of developing burnout syndrome is clearly established—from the loss of important components in the structure of professional-personal competence to the final, persistent neurosis (M. Burish, cited by Velichkovskaya, 2004).

According to these results, we can conclude that there are two groups of symptoms that require psychological correction: (1) intense psychophysiological exhaustion, which significantly restricts the ability to maintain efficiency and adequate functioning; (2) a complex of disturbing-depressive feelings that distort self-perception and a person’s attitude toward the world.

2. Changes in the structure of occupational-stress syndrome and of coping behavior in proportion to the increase in the general stress level

To analyze the basic patterns in stress-syndrome development and its negative outcomes, subgroups at different stress levels were assigned (in compliance with TV0 index norms).

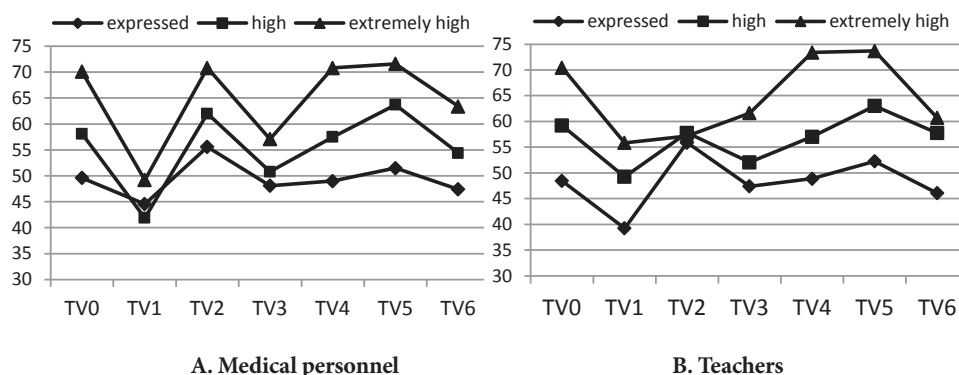


Figure 2. Stress profiles for risk groups. Indices: TV0 — general stress index; TV1 — risk factors and objective job constraints; TV2 — subjective appraisal of job difficulties; TV3 — job rewards and administration; TV4 — acute stress; TV5 — chronic stress; TV6 — personality and behavioral deteriorations.

As can be seen, about two-thirds of each of the subgroups (62.5% of the medical personnel and 61% of the teachers) had high and extremely high stress levels. They were not just in the risk zone; they faced a real threat of activity disruptions and health breaches (see Figure 2 and Tables 4 and 5).

In the group of medical staff the stress profile did not undergo significant changes as the general stress index increased. There was a homogeneous intensification of all negative stress outcomes (all the main scale indices rose; see Figure 2A and Table 4). This pattern testifies to the intensification of negative emotional experience as well as to the manifestation of more expressive destructive stress: symptoms of acute stress reliably increased ($p < 0.001$); long-lasting fixing of the indications of chronic stress existed ($p < 0.001$); manifestations of general neurosis and burnout increased ($p < 0.01$).

Table 4. Significant Differences in the IDIKS Indices of the High-Risk Subgroups of Medical Personnel

Indices	Group 1 Expressed Mean (σ^2)	Group 2 High Mean (σ^2)	Group 3 Extremely high Mean (σ^2)	χ^2 Mean (σ^2)
TV0. General stress index	49.60 (3.26)	58.11 (2.77)	70.11 (4.53)	32.93 (0.00)
TV 1. Risk factors and objective job constraints	42.12 (9.04)	44.50 (8.59)	48.76 (13.42)	17.59 (0.00)
TV2. Subjective appraisal of job difficulties	55.58 (5.64)	62.00 (5.43)	70.84 (8.17)	16.18 (0.00)
TV3. Job rewards and administration	48.14 (5.00)	50.79 (4.42)	57.15 (9.19)	5.93 (0.05)
TV4. Acute-stress manifestations	48.98 (3.91)	57.52 (5.95)	70.88 (8.61)	26.14 (0.00)
TV5. Chronic-stress manifestations	51.50 (4.24)	63.69 (5.66)	71.57 (6.93)	27.88 (0.00)
TV6. Personality and behavioral deteriorations	47.37 (5.98)	53.44 (5.08)	63.42 (7.65)	17.47 (0.00)

In the teachers the pattern of stress manifestation was different (see Figure 2B and Table 5). The central factor of the stress syndrome (with the same high magnitude in all three subgroups) was the subjective appraisal of job difficulties. However, this initial negative mental representation of the work was not necessarily related to the high level of stress in all subgroups. Thus in the “expressed” subgroup all other indicators were in the moderate range; these individuals were adapting to professional problems.

In the subgroups with high and extremely high stress levels there was a stable increase of negative symptoms, especially in manifestations of acute and chronic stress ($p < 0.001$), and, consequently, personality and behavioral deteriorations strengthened ($p < 0.01$).

Table 5. Significant Differences in the IDIKS Indices of the High-Risk Subgroups of Teachers

Indices	Group 1 Expressed Mean (σ^2)	Group 2 High Mean (σ^2)	Group 3 Extremely high Mean (σ^2)	χ^2 Mean (σ^2)
TV0. General stress index	48.45 (3.33)	59.36 (3.16)	71.01 (4.08)	62.93 (0.00)
TV 1. Risk factors and objective job constraints	39.24 (8.63)	49.77 (11.78)	54.62 (9.67)	18.65 (0.00)
TV2. Subjective appraisal of job difficulties	55.87 (6.81)	57.54 (7.17)	58.06 (5.84)	1.55 (0.46)
TV3. Job rewards and administration	47.39 (4.05)	52.33 (5.93)	61.56 (8.01)	24.46 (0.00)
TV4. Acute-stress manifestations	48.87 (3.75)	57.01 (6.36)	75.13 (10.17)	45.66 (0.00)
TV5. Chronic-stress manifestations	52.36 (6.24)	63.11 (6.77)	74.46 (5.09)	44.40 (0.00)
TV6. Personality and behavioral deteriorations	46.07 (4.63)	57.95 (5.67)	60.28 (6.61)	44.88 (0.00)

The high-risk subgroups in both contingents differed not only in the scale of the negative stress experience and its destructive effects but also in the patterns of coping strategies (Figure 3). The predominance of prosocial and direct coping models is typical for medical personnel in general. The medical personnel in the study mostly used social joining (mean = 24.38, $\sigma^2 = 2.94$), social support seeking (mean = 24.23, $\sigma^2 = 3.83$), and instinctive actions (mean = 19.97, $\sigma^2 = 2.92$) to cope with stress. The magnitudes of these indicators were at the border of the medium and high ranges, and their levels should draw attention to the relatively low level of assertive actions (mean = 18.15, $\sigma^2 = 2.20$).

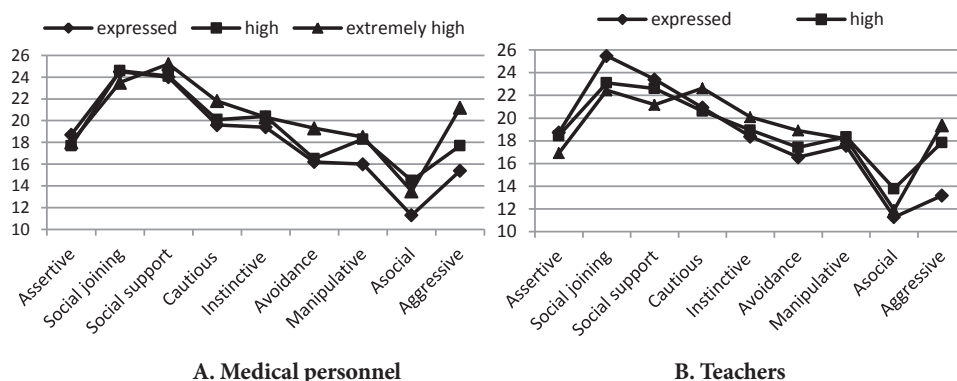


Figure 3. Coping strategies in high-risk groups.

However the repertoire of coping strategies was transformed when the general stress index increased (see Figure 3A). Significant differences were identified among the subgroups in the frequency of asocial ($\chi^2 = 6.59$, $p < 0.05$) and aggressive ($\chi^2 = 7.11$, $p < 0.02$) actions. Frequent asocial coping behavior decreases the

adequacy of professional behavior, in which positive forms of social interactions with patients and colleagues are expected.

A rather wide range of coping strategies characterized the group of teachers. Most often they used instinctive actions ($\text{mean} = 18.89$, $\sigma^2 = 3.10$) and avoidance ($\text{mean} = 17.31$, $\sigma^2 = 3.83$) to cope with stress, and they also regularly used social joining ($\text{mean} = 23.93$, $\sigma^2 = 7.54$) and social support seeking ($\text{mean} = 22.72$, $\sigma^2 = 4.71$).

As in the case of the medical personnel, as the stress level increased, teachers more often used asocial and passive coping models (see Figure 3B). The higher the stress level, the more the teachers tended to use socially nonsanctioned coping strategies: aggressive ($\chi^2 = 17.31$, $p < 0.001$) and asocial ($\chi^2 = 5.68$, $p = 0.05$) actions. In addition they started actively resorting to passive coping strategies: cautious ($\chi^2 = 5.12$, $p < 0.08$) and avoidance ($\chi^2 = 4.74$, $p < 0.09$) actions.

Teachers with high and extremely high stress levels (as well as medical staff) began to use coping strategies aimed mainly as fast affective discharge (aggressive actions) and a kind of “devaluation” of the interests of others in order to use them as a means to achieve goals (asocial actions). Apparently, this trend was caused by the insufficient development of interpersonal communication and conflict-management skills. In addition we can assume that the coping strategy of getting out of a difficult situation became one of the typical forms of behavior in the teachers when they were unable to cope with increasing stress.

3. Characteristics of emotional intelligence (EI) in professionals with different stress levels

The type of coping strategies used in the subgroups with a high level of stress shows the deficiency of those resources that ensure emotional and personal regulation of job activity. That fact indicates the need for a detailed analysis of relevant integrative personality qualities, including emotional intelligence (EI).

Table 6. Descriptive Statistics on EI Indicators for Medical Personnel and Teachers

Indicators	Medical personnel	Teachers
	Mean (σ^2)	Mean (σ^2)
General indicator of EI level	6.22 (2.09)	6.35 (1.70)
Self-awareness	4.51 (2.41)	4.32 (1.92)
Self-management	8.24 (1.51)	8.08 (1.42)
Social awareness	4.51 (2.40)	4.53 (2.04)
Relationship management	5.51 (1.90)	5.77 (1.49)

The characteristics of EI for each of the professional groups were analyzed (see Table 6). The degree of EI in both the medical personnel and the teachers was rather high. No statistically significant differences between the groups on the separate components of EI were revealed. High scores on the self-management scale and lower scores on the relationship-management scale characterized each of the groups. But the awareness skill, on both the self-awareness and the social-awareness scales, was developed considerably worse: the scores were on the border between the low and medium ranges.

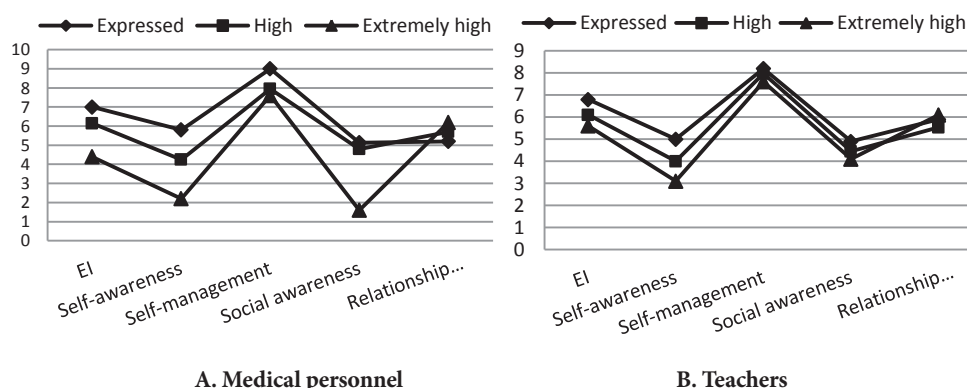


Figure 4. EI indicators in high-risk groups.

In the medical personnel, statistically significant differences among scores on both the general indicator of EI and the components of EI were revealed by comparing subgroups with different levels of stress (see Figure 4A and Table 7). The scores of EI gradually decreased in the groups with high and extremely high stress levels. This tendency can be seen clearly in the scores on the general indicator of EI ($p < 0.05$) and on the awareness scales ($p < 0.01$). In addition, there were contradictory dynamics in EI indicators in the subgroup with an extremely high stress level. They had very low scores on both of the awareness scales and very high scores on both of the management scales at the same time.

Table 7. Significance of Differences on EI Indicators in the High-Risk Subgroups of Medical Personnel ($n = 40$)

Indicators	Group 1 Expressed Mean (σ^2)	Group 2 High Mean (σ^2)	Group 3 Extremely high Mean (σ^2)	χ^2 Mean (σ^2)
General indicator of EI level	7.06 (1.90)	6.15 (2.08)	4.40 (1.51)	6.46 (0.04)
Self-awareness	5.80 (2.33)	4.25 (2.09)	2.20 (1.78)	8.95 (0.01)
Self-management	9.00 (1.06)	7.95 (1.57)	7.60 (1.67)	5.27 (0.07)
Social awareness	5.13 (2.38)	4.80 (2.26)	1.60 (0.89)	9.47 (0.01)
Relationship management	5.20 (1.61)	5.70 (2.07)	6.20 (1.92)	1.08 (0.58)

For the teachers the difference between the EI scores of the high-risk subgroups was not that huge (see Figure 4B and Table 8). Significant differences were revealed only on the self-awareness scale ($\chi^2 = 7.25$, $p < 0.03$). This result reflects a special feature of the teachers' group in general—a not very clear awareness of feelings and emotions on both the self-awareness and the social-awareness scales. But at the same time they had quite high scores on relationship management and self-management, which is probably a sign of a special professional deformation (the so-called authoritarian-indicative type).

Obtained data about the existence of valid differences among subgroups with different stress levels, as well as about alterations of the leading models of coping behavior, raise the question of the exact reason for such differentiation. Consid-

ering the fact that individual peculiarities are relatively constant personal formations that develop in the process of gaining professional and life experience (Mayer & Salovey, 1993; Mitina, 1998; Zeer, 2006), a supposition can be made that they can actually play the role of initiators or predictors of destructive forms of stress. The testing of this supposition was carried out during the final stage of data analysis.

Table 8. Significance of Differences on EI Indicators in the High-Risk Subgroups of Teachers (n = 77)

Indicators	Group 1 Expressed Mean (σ^2)	Group 2 High Mean (σ^2)	Group 3 Extremely high Mean (σ^2)	χ^2 Mean (σ^2)
General indicator of EI level	6.76 (1.79)	6.14 (1.61)	5.66 (1.73)	3.13 (0.21)
1. Self-awareness	4.96 (1.90)	4.00 (1.85)	3.11 (1.27)	7.25 (0.03)
2. Self-management	8.26 (1.31)	7.97 (1.52)	7.66 (1.50)	1.33 (0.52)
3. Social awareness	4.90 (2.06)	4.45 (2.03)	4.11 (2.09)	0.87 (0.65)
4. Relationship management	5.90 (1.56)	5.54 (1.27)	6.11 (2.20)	0.74 (0.69)

4. Analysis of individual predictors of chronic stress and for the development of professional distortions

To define individual characteristics that may be regarded as predictors of intensive chronic stress and the development of professional distortions, a regression analysis was used (step-by-step regression method):

- *independent variables*: (a) the components of emotional intelligence and (b) the indicators of coping strategies where significant differences among the subgroups were found
- *dependent variables*: indices of chronic stress and personal and behavioral deterioration

The regression analysis was run for each of the dependent variables, separately for the groups of medical personnel and teachers (see Tables 9 and 10). The intensity of the accumulation of chronic-stress symptoms reliably depended on the “self-oriented” components of emotional intelligence and maladaptive coping strategies (see Table 9). In both occupational groups the main factor that determined the development of chronic stress was a reduced capacity for reflection and awareness of self-emotions and feelings. To a rather great extent the development of chronic stress was also determined by focusing on self-management and self-control, which, however, had a different impact in the two occupational groups. The significant influence of direct and asocial coping was evident in each of the examined contingents.

Thus, the main predictors of chronic stress in the medical personnel were impulsive coping strategies and reduced control over their emotions and feelings. In teachers the key determinants of the accumulation of negative stress symptoms were aggressive actions and the reduction of assertive actions. The trend to self-management and self-control enhanced manifestations of chronic stress in the teachers, perhaps because of the teachers’ typical orientation to hyper-self-control, which can lead to aggressive outbreaks in difficult situations.

Table 9. Predictors of the Manifestation of Chronic Stress (Regression Analysis Results)

Indicators	R^2	Level of significance (t -criterion)
<i>Medical personnel (n = 40)</i>		
1. Self-awareness	0.27	$t = -3.69, p < 0.01$
1. Self-awareness 2. <i>Instinctive actions</i>	0.41	$t = -4.25, p < 0.01$ $t = 2.92, p < 0.01$
1. Self-awareness 2. <i>Instinctive actions</i> 3. Self-management	0.51	$t = -1.81, p < 0.1$ $t = 3.80, p < 0.01$ $t = -2.73, p < 0.01$
<i>Teachers (n = 77)</i>		
1. Self-awareness	0.31	$t = -5.30, p < 0.01$
1. Self-awareness 2. <i>Aggressive actions</i>	0.38	$t = -3.41, p < 0.01$ $t = 2.79, p < 0.01$
1. Self-awareness 2. <i>Aggressive actions</i> 3. Self-management	0.44	$t = -3.96, p < 0.1$ $t = 3.18, p < 0.01$ $t = -2.48, p < 0.05$
1. Self-awareness 2. <i>Aggressive actions</i> 3. Self-management 4. <i>Assertive actions</i>	0.48	$t = -3.20, p < 0.01$ $t = 2.81, p < 0.01$ $t = 2.32, p < 0.01$ $t = -2.17, p < 0.01$

Table 10. Predictors of Personality and Behavioral Deteriorations (Regression Analysis Results)

Indicators	R ²	Level of significance (t-criterion)
Medical personnel (n = 40)		
1. Aggressive actions	0.44	t = 5.34, p < 0.01
1. Aggressive actions	0.49	t = 5.75, p < 0.01
2. Instinctive actions		t = 2.04, p < 0.05
1. Aggressive actions	0.57	t = 5.20, p < 0.1
2. Instinctive actions		t = 2.75, p < 0.01
3. Social awareness		t = -2.55, p < 0.05
1. Aggressive actions	0.65	t = 5.70, p < 0.01
2. Instinctive actions		t = 2.99, p < 0.01
3. Social awareness		t = -3.44, p < 0.01
4. Relationship management		t = 2.73, p < 0.01
1. Aggressive actions	0.69	t = 5.24, p < 0.01
2. Instinctive actions		t = 3.61, p < 0.01
3. Social awareness		t = -3.71, p < 0.01
4. Relationship management		t = 3.23, p < 0.01
5. Age		t = -2.08, p < 0.05
Teachers (n = 77)		
1. Aggressive actions	0.20	t = 3.93, p < 0.01

The impact of individual characteristics on the development of personality and behavioral deteriorations was pronounced only in the medical personnel (see Table 10). The most significant contributors to psychological disadaptation were frequent use of instinctive and aggressive coping strategies as well as low social awareness and a tendency to control the emotions and feelings of others.

In teachers the only significant contributor to the development of personality and behavior deteriorations was aggressive coping actions ($R^2=0.20$; $t=3.93$, $p<0.01$). A quick temper and a confrontational position in professional interactions (with colleagues and pupils) can be viewed as predictors of the burnout syndrome. We can assume that a reduced number of such predictors for personality and behavioral deteriorations were found in teachers because of the length of their teaching experience (more than 20 years on average). It is well known that the critical period for the development of burnout is 5 to 12 years, and after that the effects of negative stress are mainly an increase in psychosomatic disorders and the development of asthenic syndrome (Velichkovskaya, 2004).

Discussion and conclusions

The elicited factors of high tension and psychological adaptation disturbances in the medical specialists and the teachers are in agreement with those found using the contemporary systems methodology for occupational-stress research (Cooper et al., 2001; Leonova, 2007). The demands of professional activity determined the general trend of the described stress syndromes and the stress-pattern manifestations even in the extreme situation of the study. This statement is substantiated by the following results:

1. The general tendencies in the development of destructive forms of stress in the two occupational groups were defined. In both the medical personnel and the teachers the dominant components of the integrated occupational-stress syndrome were the excessive degree of manifestations of acute and chronic stress as well as the fixed symptoms of burnout and increasing neurotic reactions. Accumulated during a whole working life, the stable manifestations of distress were aggravated by the accident situation. The main trends of the disturbances not only limited the possibilities for an adequate response to the demands of a highly tense situation but made more difficult the performance of even habitual tasks and, moreover, deformed self-attitude and attitude toward work.

2. Analysis of the data from the three stress-level groups revealed the dynamics of occupational stress and elicited several factors as individual providers of that stress; these findings are helpful to people coping with similarly tense work conditions. The stress syndrome expanded according to the generalized accumulation of negative symptoms. At the same time the specifics of the stress-development process were different for the two occupational groups. In the medical staff the degree of stress rose when general work tension increased. In the teachers the key factor in intense stress was the sustained negative attitude toward work, which was interpreted as "pedagogical routine." Such distortion of the job image leads to a loss of a sense of meaning in one's work, a decrease in motivation, and a devaluation of work results.

3. Qualitative analysis of coping behavior showed the prevalence of prosocial (social joining, seeking social support), direct and asocial (instinctive and aggres-

sive actions), and passive (cautious actions) behavior models. The low index of assertive actions can be interpreted as an indicator of an insufficiency of coping resources. Feelings of helplessness and inadequacy determine the explicit need for social support, the desire to avoid additional troubles, and the intention to eliminate tensions and anxiety by any means.

4. The data revealed developed emotional intelligence in the participants and, at the same time, some imbalance among the components of emotional intelligence: the highest extent of self-control and the lowest level of understanding self-emotions and identifying the emotions of others. Insufficient psychological stress-management skills make employees prone to stress. Special training in the means of self-regulation could compensate for the lack of adaptive psychological resources.

5. Regression analysis helped to confirm the influence of some individual characteristics on the intensity of the manifestation of stress. Low self-emotion reflexive capacity, as well as instinctive and aggressive coping behavior, can be viewed as the predictors of chronic fatigue and the accumulation of professional distortions. The results showed that the development of these stable maladaptive forms is closely connected with the lack of some particular components of emotional intelligence and the use of nonadaptive coping-behavior models. The general (limited reflexive abilities) and the specific predictors of the consequences of destructive stress were singled out. In the medical personnel the main predictors were the preferred use of instinctive coping strategies and the low level of control over self-emotions; in the teachers, the predictors were aggressive coping actions combined with the enhanced control of self-emotions. These differences reflect specific inadequate emotional-behavioral patterns in the abreaction of work problems.

6. Predictors of chronic stress and predictors of professional distortion turned out to be different from each other. For chronic stress a tight predictor set was found; it consists of emotional-intelligence characteristics and the dominance of disadaptive coping behavior. The development of professional distortions is to a great extent elicited by frequent use of aggressive and instinctive actions. Most likely the accumulation of symptoms of chronic stress leads not only to a decrease in adaptative potential but also to the somatization of the effects of long-term tension.

7. Habitual means of stress management and a restricted range of coping-behavior models are not enough for the effective elimination of the long-term consequences of tension. For this reason the elaboration and implementation of psychological support programs for medical staff, teachers, and psychologists are on the agenda. These programs should be targeted to the development of emotional competence, the acquisition of self-regulation skills, and the framing of constructive coping strategies. The implementation of the training program designed for psychologists showed a strong multilevel optimization effect, which was obtained by using means of self-regulation based on reflexive analysis.

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Gender stereotypes among road users

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This article analyzes the mechanism of stereotyping as exemplified by gender stereotypes of road users. Gender stereotypes are not only viewed as an a priori image of a percept, but also examined 'in action' — at the very moment of their actualization with road users. In the paper we have identified the content of road users' gender stereotypes; analyzed the behaviour of male and female drivers, pinpointing a number of gender-specific behavioural features; demonstrated that male and female driving differ from each other in terms of speed, intensity and roughness; and identified the conditions and mechanisms underlying the actualization of gender stereotypes. Based on video and audio materials, we have found that drivers' gender-specific behavioural features are perceivable to road users: such features trigger the actualization of gender stereotypes as attributive schemes, which determine the interaction between road users, while also laying the foundation for gender stereotypes.

Key words: Gender stereotype, stereotyping, gender behaviour, road behaviour.

In modern social psychology, the study of determinants of social cognition suggests research into the social psychological mechanisms affecting the way an actor builds a consistent orderly image of the world. Researchers examine the mechanisms involved in the cognition and conception of social reality by an individual, and in reality's representation as his/her internal picture of the world, which necessitates the study of the social context making for the supra-individual character of social cognition and its attributes. The related problem of social stereotypes and stereotyping is core to the study of how the image of the interaction partner is formed.

Traditionally, social stereotypes, including gender ones, are approached as a priori images the individual creates in the process of his/her socialization, and invokes when evaluating people (Dontsov, Stefanenko, 2008). Social stereotypes result from the categorization of social experience conditioned by culture and upbringing. Social stereotypes reflect the typification of habitual estimates, expectations, viewpoints and prejudices. Such concepts of social bonds and relations are formed within a single culture and are stably shared by its members. They help maintain socially acceptable models of behaviour and the system's overall function-

ning. Stereotypes also satisfy individuals' intersubjective need for 'rock-solid values' and for standards of 'proper' social behaviour. As a factor in social relations, they provide consolidation not only of groups (gender or other), but of society in general (Dontsov, Emelyanova, 1987).

On the other hand, the mechanism of stereotyping manifests itself as part of the social perception process in human interaction (Kabalevskaya, 2012). The need for 'social knowledge' contained in stereotypes is conditioned by the need to promptly and socially accurately perceive and conceive reality. The schematic image of the percept acquires an applied aspect: it serves as a supply of 'ready-made knowledge' sparing the individual's efforts. Such knowledge covers acceptable behaviour, as well as motivational and role expectancies. It underlies the subject's interpretation of reality: the individual attributes his or her own expectations to the other, and sees the other's behaviour against this framework. Also, the individual seeks to pattern his/her behaviour following culturally determined expectations reflected in the stereotype. All this suggests that stereotypes should, first and foremost, be studied *a priori* with respect to the subject. In the current tradition of their empirical study, stereotypes are largely viewed as a result of stereotyping, i.e. retrospectively, and analyzed as socially typing categorical schemes. Analyzing such stereotyped knowledge, researchers tend to focus on its development process and content as reflecting the existing social discourse. But stereotyping would be also interesting to investigate from another angle, i.e. the application of stereotyped knowledge and its use in evaluating people. In other words, since individuals' interaction and mutual perception are mediated and regulated by internal constructs ('social stereotypes'), we need look at how these constructs are actualized, and at the causes and conditions of stereotype formation by an individual. However, the problem of stereotype actualization in people's behaviour and activity has only recently entered the scientific agenda and so far not been given proper consideration, although it is clearly a promising area for social psychology.

Traditional studies of social stereotypes (including gender) as historically evolved patterns of collective consciousness do not reveal the actual mechanisms of perception triggering the stereotyping process which is objectively (and perceptibly) caused by subjects' activity. To reveal these mechanisms, we need to explore the actual interaction between subjects and objects, particularly aspects of interaction providing for the appearance and actualization of gender stereotypes. This problem has been approached through the study of road users' gender stereotypes.

The research we are going to describe, on the one hand, follows the tradition studying gender stereotypes as categorical schemes within the subject's social conceptual system and, on the other hand, attempts to correlate gender stereotypes with the behavioural features invoking gender images in drivers' minds. The research had three key objectives. Firstly, we intended to identify and analyze the content of male and female drivers' gender images as formed within the cultural discourse and fixed in the individual consciousness, while also maintain and self-replicated in drivers' road behaviour. The second objective was to examine driving activity and single out its gender-specific characteristics. Finally, we intended to investigate how road users perceive drivers' actual behaviour, and to identify the determinants responsible for the categorization of an observed driver and his/her activity as representing the respective gender group. What is intended, in fact, is to

identify the moment of a gender stereotype manifestation during the interaction between road users.

The empirical research comprised two steps. The first, traditional part of the research addressed the content of road users' gender stereotypes. We studied websites, conducted survey polls on various automobile forums, organized focus groups, and made a series of interviews, applying content analysis to the data received. Overall, the research covered 142 road users. Respondents in the first part fell into the following categories: motor car drivers — 20 men and 20 women, aged from 19 to 56, with various levels of driving experience including six professional drivers (two men and four women); and indirect road users: 18 traffic police officers (men) with over 5 years of work experience, and 7 pedestrians (three men and four women), aged from 35 to 50, with no driving skills. Professional, social and economic or ethnic characteristics were not taken into account. The research also used forum replies by male and female drivers in the specifically provoked discussions of male/female drivers' typical characteristics, their behaviour in various traffic situations, and their self-image as drivers. The sampling covered ten automobile forums, about 30 messages from each, posted by men and women over a certain time period. In total, we analyzed 185 messages by male drivers and 185 messages by female drivers, discussing their ideas about other male and female drivers, as well as about themselves. We calculated the average frequency with which characteristics were mentioned among men and women. A characteristic was added to the stereotype list if it was mentioned by no less than 25% of respondents.

The survey research also included a series of 40 semi-structured, in-depth interviews with male and female drivers, both amateur and professional. Drivers were equated in terms of experience and age and sorted into three small groups. The interview guide included questions relating to drivers' characteristic behaviour and interaction, and analysis of accident situations involving respondents, along with a number of projective questions on the characteristic of a 'natural-born driver', wishes concerning drivers, and evaluation of various traffic situations. Interview results were interpreted qualitatively.

The results of the first part were supplemented with the data received from two focus groups with a specifically designed topic guide. The participants were traffic police officers and pedestrians, asked about their views on road users, their characteristic behaviour and interaction in cases of offence, traffic accidents, and traffic safety from the gender viewpoint. The results were processed using content analysis.

The stereotypical image of a female driver includes a number of features named by drivers as well by traffic police officers and pedestrians. They perceive the female driver as incompetent in driving, lacking self-confidence, hesitant, unpredictable, egocentric and unsuccessful. Men intensify the negative aspect of the image, adding such negative features as inaptitude for driving, low intellectual level, and patterned mindset. Overall, respondents point to the secondary role of female drivers as road users and to their insufficient driving skills compared to male drivers. The stereotypical image of a male driver, on the contrary, is a model driver serving as a benchmark in any traffic situation. It includes such features as self-confidence and pragmatic character. But it is also characterized by impulsivity, nervousness, non-observance of traffic rules, etc. Many of its features are negative and could hardly be deemed normative from the viewpoint of safety, which is the key traffic criterion. The stereotypical image of a male driver is also shared by various categories of road

user and underlies the drivers' self-stereotyping — both, male and female, as follows from Charts 1 and 2.

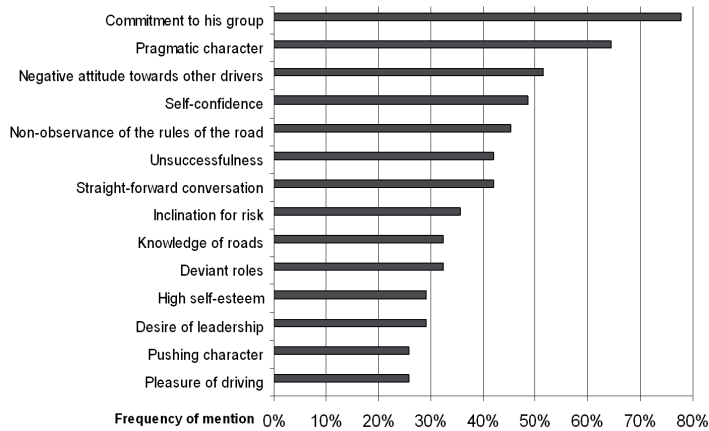


Chart 1. Self-Stereotype of Male Drivers

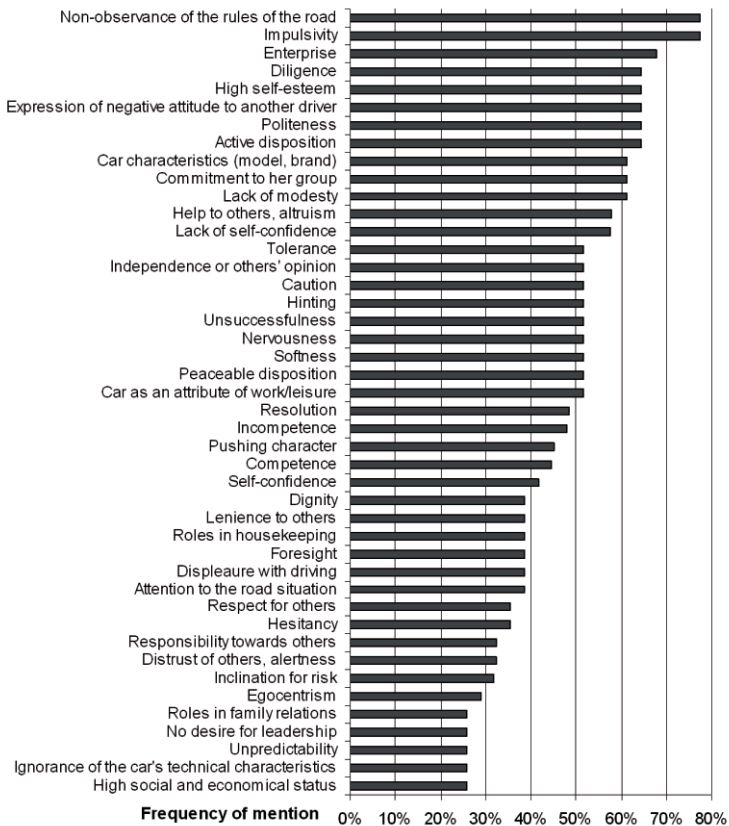


Chart 2. Self-Stereotype of Female Drivers

Characteristics found in the self-stereotype of male drivers largely conform with their stereotype. In addition, male drivers emphasize their pleasure from driving and often appeal to deviant roles, thus signaling that such behaviour is acceptable in a traffic situation. The female drivers' self-stereotype also correlates closely with the male drivers' image but has certain specifics in its formation (Table 1): thus, features named by women themselves are partly adopted from the male image, either directly (for instance, nervousness, impulsivity, non-observance of rules) or with the opposite sign (for example, women tag themselves as polite and tolerant in contrast to the alleged impoliteness and intolerance of men). Interestingly, female drivers fully share the idea of their own incompetence. Their self-stereotype includes hesitance, incompetence, and lack of self-confidence. Given such a combination of two self-images of female drivers, we might speak of a dual, positive-negative character of their self-stereotype. As the analysis of the interviews has shown, in case of success the positive features of the self-stereotype are actualized. Unlucky situations are explained by appealing to negative features. In-depth interviews with four professional female drivers also reveal the duality of their self-stereotype. Besides, female taxi drivers,

Table 1. Structure Specifics of Female Drivers' Self-Stereotype

Structure specifics of female drivers' self-stereotype	Sample features
Contrasting the male driver stereotype	Respect for others Leniency to others Tolerance Politeness, softness Hinting No desire for leadership Displeasure from driving
Resembling the male driver stereotype	Non-observance of the rules of the road Pushing character Nervousness Impulsivity Self-confidence Active disposition Foresight Enterprise Lack of modesty Competence Resolution
Resembling the female driver stereotype	Unpredictability Roles in family relations Egocentrism Hesitancy Incompetence Lack of self-confidence Ignorance of the car's technical characteristics Roles in housekeeping

just like non-professional female drivers, compared themselves to male drivers. However, they denied the gender specificity of this image: the meaning-making foundation of their activity was seen in the professional role of the driver. Female drivers' self-stereotype allows them to maintain a positive self-image and high self-esteem, to approvingly evaluate their behaviour and, on the whole, to raise the status of their group representatives.

In-depth interviews with male and female drivers with various driving experience also reveal the dynamics of motivational grounds in driving (Table 2). As driving experience grows, the dominant motives of road behaviour change: with female drivers, the motives of gaining self-confidence and of their own safety give way to the safety of others, while male drivers become less preoccupied with personal achievements (success and status), also for the sake of others — starting to view safe and accident-free driving also as an achievement.

Table 2. Dynamics of Driving's Motivational Grounds




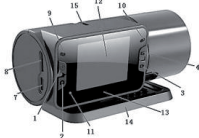
Driving experience, age	Dominant motives of road behaviour	
	Male drivers	Female drivers
Beginners Driving experience: 0–2 years Age: 19–23 years	<ul style="list-style-type: none"> • Self-fulfillment (self-efficacy) and attainment of material welfare; 	<ul style="list-style-type: none"> • Safety (their own); • Overcoming a lack of self-confidence
Middle category Driving experience: 3–10 years Age: 23–29 years	<ul style="list-style-type: none"> • Acknowledgement of professional success as a driver 	
Experienced drivers Driving experience: over 10 years Age: 35–56 years	<ul style="list-style-type: none"> • Care for personal accomplishments (success, status) gives place to care for others: safe, accident-free driving as an accomplishment 	<ul style="list-style-type: none"> • Motive of personal safety comes to be scaled against the safety of others

And yet, summing up the results of the first part of the research, we may conclude that the Russian driving community is dominated by traditional patriarchal gender stereotypes. Such concepts reflect the gender asymmetry in this social sphere: they assign a normative benchmark to the male driver's image, whereas women act as secondary and incompetent road users.

The second part of the research examined gender stereotypes in correlation with the behaviour specifics of road users, and addressed the mechanism of their actualization in the real activity of representatives of the gender subgroups. The study of stereotyping as a mechanism of gender stereotype actualization at the moment of observing real gender-specific behaviour required a respective organization of the research scheme. First, we had to analyze men's and women's objective driving activity. Second, we needed to examine how road users perceive drivers' behaviour, i.e. to compare the perceived activity and its evaluation by observers. For this purpose, we made a video recording of the real behaviour of six male and six female drivers, including both beginners and experienced ones. The participants were four men and women, aged 21–26, with driving experience

of less than two years, and eight men and women, aged 30-45, with driving experience of over 10 years. Each driver took the same car and made the same route containing areas of different characters and difficulty. The traffic was uniform because of the timing: the experiment was carried out between noon and 1:00 P.M. on working days. The drivers' activity during the trip was registered by three cameras (Table 3).

Table 3. Study of Drivers' Gender Behaviour

	Camera	Fixation Parameters
	Camera 1: «Subjective Camera»*	<ul style="list-style-type: none">• Duration of the driver's fixation on moving and motionless objects;
	* <i>SubCam method</i> (S. Lulu, V.N. Nosulenko, E.S. Samoilenko)	<ul style="list-style-type: none">• Number of moving and motionless objects within the driver's attention focus;• Description of the objects of attention.
	Camera 2: aimed at the driver	<ul style="list-style-type: none">• Number of eye and head movements by the driver.
	Camera 3: panorama	<ul style="list-style-type: none">• Overall number of objects within the driver's attention field at every stage of the manoeuvre.

The first camera, nicknamed «subjective» in a number of publications, was located in the frame of a pair of glasses put on by the driver himself/herself, as a sort of a 'third eye'. It constantly recorded the driver's stare direction and attention focus. Two others were standard dashboard cameras. One was fixed on the windscreen of the car, directed at the driver and capturing his head and eye movements. Another, an all-sky camera, captured the overall quantity of objects within the driver's attention field. All drivers wore thick gloves, thus making their gender non-conspicuous on the recording.

The recordings showed that male and female driving styles were indeed different from each other. This is especially the case in complicated manoeuvres. A recording fragment with an uncontrolled T intersection became a matter of detailed analysis. Structural analysis of the driving activity (Kabalevskaya, 2012) was based on the data from all three cameras, and suggested a step-by-step analysis of the driver's actions during the manoeuvre, also taking the context into account. We analyzed objects within drivers' attention field, and calculated the average time of fixation upon them, which allowed us, in addition to the quantitative analysis, to reveal a number of qualitative gender-specific characteristics.

As a result of the analysis, we have identified a variety of gender-specific features related to driving activity and distribution of attention.

Table 4. Manoeuvre Duration for Men and Women by Stages

Group / sex	Overall duration of the manoeuvre by stages		
	Preparatory stage	Main stage	Completion stage
Male drivers	15.03	3.7	4.8
Female drivers	49.5	3.8	2.5

Note. * average duration of manoeuvre stages by subgroups.

Table 5. Description of the Objects of Attention of Male/Female Drivers by Stages

Group / sex	Male drivers — (number of people)	Female drivers — (number of people)
Preparatory stage I	<ul style="list-style-type: none"> • vehicles moving in own and opposite lanes — 6 • traffic lights — 5 • vehicles waiting to make a turn — 4 • control of side mirrors — 4 • control of own and opposite lanes — 3 • control of rear-view mirror — 2 • attention towards the road (straight) — 2 • car dashboard — 1 	<ul style="list-style-type: none"> • traffic lights — 6 • control of own and opposite lanes — 4 • vehicles moving in own and opposite lanes — 4 • vehicles waiting to make a turn — 4 • pedestrian — 4 • control of side mirrors — 3 • a bus on the right — 1 • car dashboard — 1
Preparatory stage II	Not detected.	<ul style="list-style-type: none"> • repeated control of traffic lights- 5 • vehicles moving in own and opposite lanes — 3 • control of rear-view and side mirrors — 2 • control of own and opposite lanes — 1 • attention towards route map — 1
Main stage	<ul style="list-style-type: none"> • control of left side mirrors — 2 • vehicles moving in own and opposite lanes — 1 • attention towards the road (straight) — 1 • vehicles in opposite lane — 1 • control of opposite lane — 1 	<ul style="list-style-type: none"> • control of traffic in own lane (turning head to the right)-3 • control of traffic in the opposite lane at the moment of the manoeuvre performance (including a vehicle moving in the opposite direction) — 3
Completion stage	<ul style="list-style-type: none"> • control of side mirrors — 5 • attention towards the road (straight) — 2 • control of rear-view mirror — 2 • one's own lane — 2 • glance 'elsewhere' (beyond the road) — 2 • control of opposite lane — 1 • vehicles moving in front of the driver — 1 • traffic lights — 1 • control of vehicles in opposite lane — 1 • attention towards route map — 1 	<ul style="list-style-type: none"> • vehicle moving in front of the driver — 4 • vehicles moving in opposite lane — 3 • control of left side mirror — 2 • glance at the traffic lights — 1 • attention towards the route map and towards the car's interior ('elsewhere') — 1

Thus, female drivers spend almost three times as much time as men on a manoeuvre (Table 4). The average manoeuvre duration reached 57.5 seconds with women, while this figure was only 24.2 seconds for men. This fact is due to differences in distribution of attention (Table 5). Before the manoeuvre, at the preparatory stage consisting of observation and analysis of the road situation in order to

decide on the action, female drivers consider both, main and secondary variables. The women's attention is divided between the traffic lights, their own and opposite lanes, and vehicles — moving and waiting to make a turn. In addition, four women out of six also monitored pedestrians and other objects beyond the relevant road situation. They give almost 1.5 times more attention to motionless objects than male drivers (Table 6). This ultimately produces an additional preparatory stage with female drivers, where they focus attention on the key objects — approaching obstacles. Male drivers have only one preparatory stage, as they initially focus on the main item. Men's attention is basically focused on vehicles in their own and opposite lanes, moving or waiting to make a turn, which are objectively the most significant obstacles to the intended manoeuvre.

Table 6. Time of Male/Female Drivers' Attention Fixation by Stages

Stage	Driver's sex	Ratio of fixation on moving objects to the number of moving objects within the attention focus	Ratio of fixation on motionless objects to the number of motionless objects within the attention focus
Preparatory stage (I)	Male drivers	1.34	0.93
	Female drivers	1.29	1.39
Performance stage (II)	Male drivers	1.7	–
	Female drivers	0.5	–
Completion stage (III)	Male drivers	1	2.75 (data for two drivers)
	Female drivers	0.67	–

During the manoeuvre itself, men and women did not display considerable differences. At this stage the driver checks his/her anticipations concerning the road situation dynamics against its real progress. The manoeuvre took 3.7 and 3.8 seconds with male and female drivers, respectively.

The stage of the manoeuvre's completion revealed certain qualitative differences. Women checked the success and safety of the completed manoeuvre twice as fast as men — 2.5 seconds against 4.8 seconds, respectively. However, control of the rear-view and side mirrors helps male drivers orient themselves and, accordingly, spend less time afterwards in the preparatory stage of a new manoeuvre. Female drivers' attention (drawn by the route map, for example, and by the car's interior) is distributed not in accordance with the objectives of either control or adaptation. As a result, female drivers have to spend more time preparing for the next manoeuvre and to extend its preparatory stage.

Thus, the analysis has demonstrated that driving activity is indeed gender-specific and revealed a number of characteristic male/female driver features. These features are also found in the content of the gender stereotypes identified above: hesitancy and unpredictability in the female drivers' image vs. a pushy character and impulsivity in the male drivers' stereotype. These results have enabled a supposition that the stereotypes we have identified reflect drivers' actual gender-specific features. Proceeding from this, we have formulated the *main hypothesis* of

the present research: the mechanism of gender stereotyping is based on road users' perception of objective gender-specific features of drivers' behaviour, as reflected in verbal gender-related evaluations, which results in a categorization of the percept as a representative of the respective gender subgroup, with the subsequent attribution of the gender stereotype content to the percept.

In order to verify these suppositions, we needed to detect, firstly, whether drivers' gender-specific behavioural features were perceivable to other road users and, secondly, to what extent perception of these features actualized the gender stereotypes.

For this purpose, we selected five recordings with most conspicuous samples of gender-specific behaviour. Recordings featuring two female and three male drivers with the driving experience from less than two years to over ten years, were randomly shown to various road users: 34 male drivers and 31 female drivers with various driving experience who had not been involved in the first part of the research, as well as to 10 traffic police officers and 7 pedestrians. The respondents were asked to characterize the driver they observed on the recording. The interviews did not specifically draw respondents' attention to gender issues. As we have mentioned above, the driver's sex was not obvious due to the gloves.

The results are as follows.

Table 7. Analysis of Respondents' Comments (based on 325 interviews)

Characteristics of drivers' activity	Attributed to a Male Driver (sample comments)	Attributed to a Female Driver (sample comments)
<i>Driving speed</i>	«very fast, at full throttle, high speed»	«goes quietly, without haste»
<i>Driving roughness</i>	«smoothly, without accelerations»	«jerkily»
	«not yanking, without fuss»	«yanking, fussing around»
<i>Driving intensity</i>	«changes lanes promptly and confidently», «manoeuvres quickly»	«changes lanes slowly», «can't pull out, brakes»
<i>Action length</i>	–	«just waiting there», «staring too long»
<i>Violation of rules</i>	«ran a red light, got to the oncoming lane, didn't let the pedestrian cross»	–

We have applied content analysis to the respondents' comments (Table 7). As a result, 66% of comments on driving activity turned out to be gender-related. These comments addressed driving speed, roughness, intensity, and time and spatial characteristics. The characteristics were bi-polar and ascribed either to a male, or to a female driver. They corresponded to the gender-specific driving features identified earlier. Thus, as respondents' evaluative comments contained references to such features, the latter must be perceivable to various road users.

The next and final step in the research was to compare respondents' comments with the observed behaviour of drivers. A combined analysis of audio and video

materials allowed the process of the respondent's perception and conception of a driver's activity to be reconstructed: an objective description of the driving activity, in comparison with the latter's verbal characteristics and attribution to a specific gender subject, allowed the respondent's attention focus to be identified. Thus we were able to watch the mechanism of stereotyping in action, at the very moment of gender stereotypes' appearance (Table 8).

Table 8. Combined Analysis of Audio and Video Materials

Driver's actions	<ul style="list-style-type: none"> • Moves as if to start the manoeuvre but breaks off; • Waits for something for a long time; • Slows down; • Performs the manoeuvre too slowly compared to other traffic members; • Resumes the initial position after evaluating his/her actions as wrong; • Much viewing activity not accompanied by any actions related to the manoeuvre. 	<ul style="list-style-type: none"> • Performs the manoeuvre quickly and without preliminary orientation; • Crosses the intersection before other traffic members; • Accelerates the speed; • Performs the manoeuvre at intensive traffic and simultaneously observes the traffic around; • Much viewing activity accompanied by the performance of the manoeuvre; • Continues riding despite the red light.
	▼	▼
	DRIVER'S PASSIVE BEHAVIOUR	DRIVER'S ACTIVE BEHAVIOUR
Driver's gender categorization	Attribution to a FEMALE DRIVER	Attribution to a MALE DRIVER
	▼	▼
<i>Interpretation of the driver's behaviour: attributive characteristics of gender behaviour (samples)</i>		
Drivers, traffic police officers, pedestrians	«Confidence is lacking. Waits too long, there was a chance to cross, plays safe, looks around often but is not moving. A young girl who hasn't driven much yet».	«Very cheeky, expects to squeeze in but nobody lets him — male behaviour»; «Dashed from the lights — obviously wanted to be first. The boy's a road hog!».

Thus, a comparison of audio and video materials shows that respondents made gender-related remarks while observing drivers' most complicated manoeuvres. Drivers' passive behaviour was attributed to a female driver, whereas active behaviour was interpreted as male. Therefore, 'activity vs. passivity' as the universal binary opposition may be taken as an implicit condition and factor in the actualization of gender stereotypes with all road users. Slow and step-by-step manoeuvre performance by women, and its quick unbroken performance by men, are noticed by road users and become the foundation for the gender interpretation of behaviour (Table 9).

Thus, the results have generally confirmed the hypothesis of the research and allowed the following conclusions to be made:

1. Gender stereotypes of road users are an important determinant of social relations in the traffic community. They are actualized in complex, uncommon and challenging traffic situations.

2. Gender stereotypes determine the process of road users' perception and interaction, even when the object's sex is unknown. In this case their actualization is triggered by the procedural characteristics of the drivers.
3. These characteristics are gender-specific and form the foundation of drivers' gender behaviour. The characteristics are perceivable to all road users who implicitly differentiate them applying the 'activity/passivity' criterion; are reflected in comments on driving activity; and are linked by the observers to the driver's sex without any other objective grounds for this.
4. Gender stereotypes of road users are a gender-based interpretation of the driving style, including normative ideas of men and women's psychological and behavioural features.

Table 9. 'Grain of Truth' within the Stereotype

	Drivers' Real Behaviour	Road Users' Comments (samples)	Gender Stereotype Content
Female drivers	Performed the manoeuvre slowly	<i>«Stands still and waits to be let through, or is afraid and plays safe»</i>	Caution Hesitancy
	Distributed attention among various traffic objects (including non-relevant ones)	<i>«Turning her head but not moving. Don't know what she's doing»</i>	Patterned mindset Foresight
	Took time to prepare to the manoeuvre (two stages)	<i>«Winking too long — you cannot possibly guess when exactly she will start off»</i>	Unpredictability
	Didn't control the efficiency and safety of the completed manoeuvre	<i>«Never looked in the right mirror while changing lanes — not once!»</i>	Egocentrism
	Got distracted (attention elsewhere)	<i>«Drove up and stopped! Didn't she have time to check the map beforehand?».</i>	Inclination for risk
Male drivers	Performed the manoeuvres quickly	<i>«Pressed the accelerator to be the first to leave the right lane — as if it was vital to dash rapidly»</i>	Desire for leadership, Pushy character
	Distributed attention among the most important traffic objects	<i>«Didn't look at the sign or notice the trolley bus. Didn't look and just drove off»</i>	Attention / Lack of attention to the road situation
	Quick orientation in the road situation	<i>«Oriented himself quickly, made sure there were no obstacles and drove off».</i>	Impulsivity, Active disposition, Predictability for others
	Controlled the efficiency and safety of a completed manoeuvre	<i>«Checks the road situation»</i>	Pragmatic character
	Violated the rules of the road (running a red light, etc.)	<i>«40 km/h speed limit — who cares! 20 km/h speed limit — even more so! By all means, it's a man at the wheel. And he went through two solid lines to overtake!»</i>	Non-observance of the rules of the road

5. The Russian traffic community is dominated by traditional gender stereotypes. The male driver image serves as a benchmark, whereas the female driver image is presented as a secondary and incompetent road user. Even though this view is shared by all members of the traffic community, female drivers included, the latter have a positive self-image allowing them to maintain a compensatory self-stereotype. Such gender stereotypes support the gender asymmetry in this social area becoming rooted in individual consciousness and self-replicating in drivers' road behaviour.

Conclusion

The present research offers a new angle on the study of social stereotypes. Its principal result is that stereotypes are no longer treated as a priori images with respect to male/female subjects. In other words, stereotyping as a social cognitive mechanism and the resulting gender stereotypes have for the first time been investigated, not just as an object's a priori image, categorized and conceived within a gender subgroup system, but also as attributes of interaction between the subject and the object of stereotyping. It was possible to abandon the apriority since the study focus was shifted from verbal clichés to their actualization in gender behaviour and the latter's individual analysis. This enabled us to identify the conditions and mechanisms of actualization of gender stereotypes among subjects interacting in a road traffic situation and to reveal the perception mechanisms triggering this process.

In reconstructing the process of actualization of gender stereotypes in perception of drivers' activity and behaviour, we came to single out the 'activity-passivity' characteristic as the underlying condition of the verbal clichés appearance. 'Gender knowledge' contained in the stereotypical image affected the perceptual process and conditioned the perception of behavioural features which subsequently allowed the attribution of a particular sex to the subject. Afterwards, the subject was ascribed all intentional characteristics of the gender subgroup and his/her behaviour was interpreted accordingly. The gender stereotype in this case acted rather like an attributive scheme determining individuals' interaction and mutual perception. Thus, in spotting the moment of actualization of gender-related remarks in comparison with the object's actual behaviour, we identified the very moment when road users felt the necessity to invoke gender clichés as a form of social knowledge which helps evaluate, understand and order the whole perceived context of road traffic — not as intact and safe, but rather as socially logical and predictable.

Besides, stretching in our analysis beyond the views of social reality and addressing the reality itself, we have managed to clarify the long-standing problem of the 'grain of truth' within the stereotypical ideas of various social objects and phenomena. It turned out that the content of the stereotype reflects actual features of the reality in question — in our case, of gender-specific driving behaviour. We may thus conclude that differences between gender subgroups are produced, along with the adopted gender role, by the objective gender-specific behaviour of male and female drivers. However, the quality of driving is emphasized in accordance with the gender asymmetry dominating the traffic community views, and gender stereotypes maintain the current gender inequality both in the individual consciousness

and in the interaction between gender subgroups, implanting attributive schemes of interpretation corresponding to the socially formed gender expectancies.

Thus, with due acknowledgement of the cognitive paradigm and of the study of gender stereotypes in personal representation, this research abandons the retrospective approach to the study of stereotyping. Stereotyping is viewed in action, and gender stereotypes are analysed in the moment of their appearance as satisfying the need for socially stable and commonly shared ideas. The actualization of gender stereotypes may be triggered not only by the object of stereotyping, but also by its activity involving a number of gender-specific features which underlie gender behaviour. In the present research, perception of these features is universal to all road users and actualizes gender stereotypes as attributive schemes which determine road users' interaction.

Thus, the hypothesis put forward in the research has been confirmed, and the analysis results allow us to construe the mechanism of stereotyping as a form of social cognition of the world, and gender stereotypes — as attributive schemes of the world's description.

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Model of trust in work groups

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A multi-dimensional model of trust in a small group has been developed and approved. This model includes two dimensions: trust levels (interpersonal trust, micro-group trust, group trust, trust between subgroups, trust between subgroups and group) and types of trust (activity-coping, information-influential and confidentially-protective trust). Each level of trust is manifested in three types, so there are fifteen varieties of trust. Two corresponding questionnaires were developed for the study. 347 persons from 32 work groups participated in the research. It was determined that in a small group there is an asymmetry of trust levels within the group. In particular, micro-group trust is demonstrated the most in comparison with other trust levels. There is also an asymmetry in the manifestation of interpersonal trust in a group structure. This is demonstrated by the fact that in informal subgroups, in comparison with a group as a whole, interpersonal confidential and performance trust is the most manifested. In a small group and in informal subgroups there are relationships between trust levels which have certain regularities.

Keywords: small group, informal subgroup, trust, trust levels, types of trust.

Over the past two decades, interest in the problem of organizational trust has significantly increased in industrialized countries (Kramer & Tyler, 1996; Mayer et al., 1995; McAllister, 1995; Schindler & Thomas, 1993). The growing interest in trust is explained by the fact that it is treated as a social capital that influences the economic effectiveness of organizational performance. In other words, trust can assist in information exchange, decrease control and management costs, and favor the development of inter- and intra-organizational relations, etc. (Shaw, 2000; Dirks, 2000; Zand, 1972).

Some authors review studies on trust based on different levels of analysis, including individual trust, team trust, organizational trust, and interfirm trust (Fulmer & Gelfand, 2012). Special attention is paid to trust in work groups and teams due to their predominance in organizations and importance for their members. Trust in a group affects group effectiveness (Aubert & Kelsey, 2003; Jarvenpaa et al., 1998; Webber, 2008), group development (Cohen et al., 1980), cooperative behavior and cohesion (Baron et al., 2003), willingness to exchange resources (Dirks & Skarlicki, 2004), execution of instructions by employees and the efficiency of their work (Dirks, 2000), and adaptation of newcomers in a group (Moreland & Levine, 2002), etc.

However, there are several important aspects which have not been comprehensively covered in research works. First, there is no common viewpoint on the nature of trust, which due to the complicated nature of such a phenomenon. If we generalize the existing definitions, it is possible to single out several aspects of trust manifestation: (a) trust is a conviction in sincerity, honesty, decency, (b) trust is a reliance on current opinion or somebody's authority, and (c) trust is a conviction in other person's responsibility, and an expectation of actions that conform to generally accepted work standards. It is common for many definitions to recognize the following properties of trust: trust arises in situations that are characterized by uncertainty and risk; trust is connected with expectation of a certain result; trust is situationally and personally specific. In the simplified treatment, trust is understood as the general affective state (Pescosolido, 2003). However, there are two components in trust: cognitive and affective (McAllister, 1995; Webber, 2008). Cognitive-based trust is formed on the basis of actual knowledge, which the truster has about the trustee, while affective trust consists of emotional relations between people. Thus, there is a necessity to create such a conceptual framework that would allow different aspects of trust manifestation to be comprised.

Second, the attention of the authors is focused primarily on interpersonal trust in a dyad or a group as a whole. For example, the study of the trust of full-fledged members of work groups to quasi-members (Moreland & Levine, 2002), trust of subordinates to a superior (Dirks, 2000), and the role of interpersonal trust in effectiveness of virtual orders (Aubert & Kelsey, 2003). At the same time, the peculiarities of interpersonal trust in psychological group structure, that is in informal subgroups, between representatives of different informal subgroups in a group, etc. are not taken into consideration. Trust between an individual and a small group, between an individual and an informal subgroup, and between informal subgroups in a group, is not actually investigated. It should be noted that informal subgroups are formed in small groups of different types — in formal small groups (e.g., production groups, project teams, sport teams, the families consisting of three or more persons) and informal small groups (the company of friends on rest). For example, in work groups and groups of office workers of 5-15 persons, the number of informal subgroups varies from one to four (Sidorenkov, 2004, 2010). In such groups informal dyads and triads are met much more often, and ones consisting of 5 persons are met very seldom. On average, more than half of group members are included in informal subgroups. That is why ignoring informal subgroups does not allow a complete picture of specific features of trust in a group to be seen. In our research we are focused on informal subgroups within formal small groups. However, the offered model of trust can extend to informal small groups.

Multi-dimensional model of trust manifestation in a group

On the basis of the micro-group theory (Sidorenkov, 2006, 2010) a multidimensional model of trust in a small group has been developed, and it includes two dimensions: levels and types of trust manifestation. In the most general terms *trust* is understood as selective relationship of one subject (individual, subgroup, group) to

another, based on evaluation of some characteristics of the other and readiness to interact with him in a certain way, and on a feeling of personal safety (well-being) as a result of this interaction.

Levels of trust in a group

A small group, as a system, has three structural levels of group activity: *individual*, *subgroup*, *group*. Each of them acts as a subject that performs certain functions in relation to the others, and is also immanently more widely presented. In spite of the hierarchy of the levels, they are not in strict collateral subordination and they are dynamic in their interaction, depending on the internal and external conditions of the life activity of the group.

In a small group there can be intralevel relations (individual — individual, subgroup — subgroup) and interlevel relations (individual — group, individual — subgroup, subgroup — group) (Figure 1).

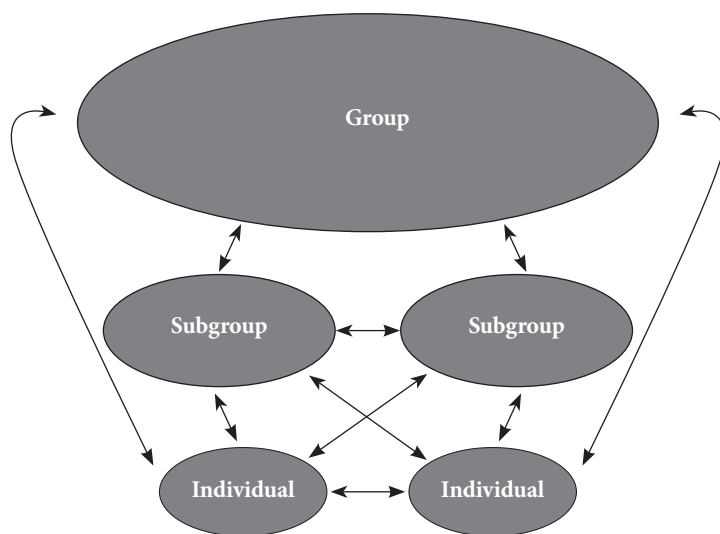


Figure 1. Intra- and interlevel relations in a small group

Therefore it is possible to allocate five levels of trust in a small group:

- *interpersonal (IT)*: trust between individuals within informal groups, between representatives of different informal subgroups, between representatives of subgroups and members not included in subgroups, and between members not included in subgroups;
- *micro-group (MGT)*: trust of individuals to an informal subgroup and trust of a subgroup to separate individuals;
- *group (GT)*: trust of individuals to a group and trust of a group to separate individuals;
- *between a subgroups (SST)*: trust between informal subgroups, between subgroups and members not included in them;
- *between a subgroup and a group (SGT)*: trust of an informal subgroup to a group and trust of a group to a subgroup.

Types of trust in a group

There are three major fields of social activity of an individual, a subgroup and a group: *performance, communication, and moral actions*. In each field of activity a type of trust corresponding to it is manifested: activity-coping, information-influential, and confidentially-protective trust. Each type of trust includes three components: cognitive (conviction of a subject in presence — absence of certain characteristics, inherent in the object of trust), affective (positive — negative evaluation of the object of trust), behavioral (readiness of a subject to interact with an object of trust in a certain way). Activity-coping trust (ACT) is based on a positive–negative evaluation of knowledge and skills of another individual (subgroup, group) and represents a conviction in its ability to efficiently perform an activity or to contribute to the common cause, as well as a readiness to cooperate with it. Such trust is determined by the competence and responsibility of another subject in the process in doing certain work. In respect of this trust, the following utterances are typical: ‘I am sure he (she) will do the job the way it should be done’, ‘I am sure that the group/subgroup will be able to join efforts and complete the set task’. Information-influential trust (IIT) is based on a positive–negative individual estimation of a viewpoint of another object, and it represents confidence in the rightness of his/her opinion, as well as a readiness to perceive information and to be influenced by him/her. Such trust is determined by the competence of another individual (subgroup, group) in respect of questions which are indefinite and significant for the one who trusts. The following utterances are typical for such a type of trust: ‘I am sure he (she) can size up the situation comprehensively and take the correct decision’, ‘I am sure that the group/subgroup is thinking in the right direction’. Confidentially-protective trust (CPT) is based on positive–negative individuals’ estimation of the moral portrait of another object, and it represents confidence in his (her) decency, as well as readiness to be open with him (her) and to rely on him (her) on the basis of the feeling of personal safety. For such a type of trust the following utterances are typical: ‘I could tell him (her) my secret thoughts and be sure that he (she) will not betray me’, ‘I am sure that the group/subgroup will support me if anything threatens me’. So as fields of social activity (performance, communication, moral actions) are often presented in these or those reality situations, types of trust are interconnected.

Levels and types of trust in a group

Two dimensions of trust are integrated with each other, so each level of trust is manifested in three types. Thus, there are *fifteen varieties of trust*: interpersonal performance trust, interpersonal information trust, interpersonal confidential trust, etc. For example, interpersonal confidentially-protective trust is based on an individual’s estimation of the moral portrait of another object, and it represents confidence in his/her decency, the individual’s readiness to be open with another individual and to rely on him/her on the basis of the feeling of personal safety. Group activity-coping trust is based on an individual’s estimation of the possibilities of team work of all members of the group, and represents confidence in the group’s ability to successfully solve problems, as well as the individual’s readiness to participate in team work with members of the group.

Thus, the purpose of this research is to study the levels and types of trust in work groups, including the socio-psychological structure of the groups (informal subgroups and outside members, relations between them). We put forward the following hypotheses:

Hypothesis 1a: Different levels of trust have, in comparison with one another, different degrees of manifestation within a group as a whole, and within informal subgroups.

Hypothesis 1b: Types of trust can have a different degrees of expressiveness at a given level of trust. Types of interpersonal trust are more strongly manifested within informal subgroups than in a small group as a whole.

Hypothesis 2a: In a small group and informal subgroups there is a straight or feedback relationship between levels of trust, which is displayed in a positive or negative correlation.

Hypothesis 2b: In a small group and informal subgroups there are certain connections between types of trust that are displayed in positive correlation; the quantity of these relationships depends on level of trust.

In this research the trust of individuals to other individuals, subgroups and the group, and also trust between subgroups, and between subgroups and the group as a whole, was studied. In it the mutual trust between individuals, between individuals and subgroups, and between individuals and the group, was not considered.

Method

Participants

347 employees from 32 groups participated in the research. The groups varied in age and sex composition. The age of the subjects was within the range of 18 to 57 years. Both male and female groups were examined, and also groups with different ratios of males to females (there were 59.8% females and 40.2% males). These groups are small businesses or primary structural units in various organizations involved in motor vehicles (3 groups) and catering (2) service, trading in (7) and sales of real estate (2), fire-fighting (4) and military (2) units, hospitals (2), etc. The strength of the groups varied from 6 to 24 persons (groups consisting of 8-12 persons predominated). The average size of group was 9.1 members. All groups were organizationally and psychologically established. These small groups had been in existence for at least one year.

Measures

Informal subgroups. To single out in groups informal subgroups and members not included in them, a *formalized algorithm*, developed by Gorbatenko (1984) is used. A sociometric poll of the group members is conducted to the non-specific criterion: 'Select the group members, with whom you maintain the closest relations'. A non-parametric procedure is used. This algorithm consists of the following actions: (a) compilation of the 'description' matrix to characterize the concrete status of the grouped variables, (b) determination of the numerical value of the links (similarity) among the grouped members, and construction of a similarity factors ma-

trix, (c) arrangement of individuals into subgroups and identification of the index, which characterizes the quality of these subgroups, and (d) selection of the 'densest' subgroups. On the basis of comparison between the formalized algorithm data and the experts' assessments, it was found that the empirical indices of the algorithm accuracy (by quantity and composition of the subgroups) in different groups vary from 78 to 100%.

The method identifying informal subgroups and outside members is tied with the questionnaires (QIT and QGMT).

Interpersonal trust. *Questionnaire of Interpersonal Trust in Groups and subgroups (QIT)* was developed (Sidorenkov & Sidorenkova, 2007). Study of the degree of characteristics, shown in points is carried out on a 7-point scale basis (from *completely agree* (1) to *completely disagree* (7)). QIT includes three sub-scales for the estimation of three types of interpersonal trust (IT) — activity-coping (ACT), information-influential (IIT), and confidentially-protective (CPT) trust. Each type of trust includes three components: cognitive, affective, and behavioral. These trust components were considered for the selection of the questionnaire items. The Questionnaire consists of 12 items (with a reverse formulation) — 4 for each subscale ('I avoid straight talks' (CPT), 'I can not rely on the opinion of others in respect to disputable points' (IIT), 'Sometimes I doubt that others do the job the way it should be done' (ACT)). QIT consists of two parts: 'Among those with whom I maintain close relations' and 'In the group as a whole'. The first part allows the study of interpersonal trust in informal subgroups, and the other — in a small group as a whole. The complete examination variant makes it possible to obtain three indices of interpersonal trust: ACT-G-I, IIT-G-I and CPT-G-I, and three indices of trust inside the subgroups: ACT-S-I, IIT-S-I, CPT-S-I. Test measurements by subscales may vary from 4 to 28. The higher the numerical value of subscales, the stronger this or that type of trust is manifested.

The Cronbach's alpha values for the subscales were ACT-G-I (.78) and ACT-S-I (.79), IIT-G-I (.69) and IIT-S-I (.71), CPT-G-I (.77) and CPT-S-I (.76). Test-retest correlations for subscales were .72 (ACT), .77 (IIT), and .75 (CPT).

Group and micro-group trust. *Questionnaire of Group and Micro-group Trust in a Group and a subgroup (QGMT)* is developed according to the same scheme as in the previous Questionnaire. It also includes three subscales, but for the study of three types (ACT, IIT, CPT) of group (GT) and micro-group (MGT) trust. (Group / microgroup trust is trust of the members to the group / informal subgroups.) QGMT consists of 12 items (with a reverse formulation) — 4 for each subscale. Each type of trust includes three components: cognitive, affective, and behavioral. The Questionnaire consists of two parts: 'Those with whom I maintain close relations' and 'Group as a whole'. The first part is dedicated to studying micro-group trust, the other — to studying group trust. Examinations can be carried out in the complete or in the concise variant. The first option allows the determination of three group trust indices (ACT-G, IIT-G, CPT-G) and three microgroup trust indices (ACT-MG, IIT-MG, CPT-MG), while the second option yields only three group trust indices (ACT-G, IIT-G, CPT-G). Test measurements by subscales may vary from 4 to 28.

The Cronbach's alpha values for the subscales were .81 (ACT-G) and .71 (ACT-MG), .75 (IIT-G) and .76 (IIT-G-MG), .79 (CPT-G) and .74 (CPT-MG). The cor-

relation coefficients between two tests (test-retest reliability) for subscales were .69 (PT-G), .78 (InfT-G), and .83 (CT-G).

Trust between subgroups. To evaluate trust between subgroups, a relative index is used. It is calculated from correlation of the data, obtained from two parts of the QIT. That is: in each sub-scale, the index in 'In the group as a whole' is divided by the index in 'Among those with whom I maintain close relations', and then is multiplied by the constant 10. Numerical values may vary from 1.4 to 70, but often they are in the interval from 5 to 10. For example, the closer the index is to 10, the less is the difference between interpersonal trust in a group on the whole and in informal subgroups. In this case it is possible to say that there are trust relationships between informal subgroups.

Trust of subgroups to a group. It is also determined implicitly, but on the basis of correlation of indexes of two parts of QGMT. In each sub-scale, the index of the part 'Group as a whole' is divided by the index of the part 'Those with whom I maintain close relations' and is multiplied by the constant 10.

Procedure

Both questionnaires are included in the computer technology *Integrated Social-psychological Diagnostics of a Group (ISPDG)*, and they are integrated with a formalized method of depicting informal subgroups and members not included in them (Sidorenkov & Pavlenko, 2007).

The research was computerized, applying ISPDG, which allows: (a) to ensure consistency of research conditions due to the permanence of the implemented program, (b) to automatically control the work of the research participants, as well as to block the research and to warn in case of skipping some tasks or misrepresentation of answers, and (c) to automatically process the results, etc. The functional capabilities of the software drastically raise the validity of the results obtained through the computer format of examination, as compared with the paper format.

Results

Informal subgroups in a group

In all tested groups, informal subgroups were detected. The number of subgroups in groups varies from two to four (except for two groups, each of which has only one subgroup). On average, more than half of group members (60,4% individuals) were included in subgroups. In different groups, the number of persons included in subgroups varies from 28 to 97%. Dyads (52.2% of subgroups) predominate in groups, and triads (32.4%) are also often found. subgroups consisting of four persons (12.6%) are formed much more seldom, and subgroups consisting of five (1.9%) and six (0.9%) persons appear very seldom.

The obtained results give grounds to investigate: (a) interpersonal trust not only in a group on the whole, but in informal subgroups, and between representatives of different subgroups, etc. and (b) micro-group and group trust, trust between subgroups and trust between subgroups and a group.

Manifestation of levels and types of trust

The results (Table 1) will be considered separately by interpersonal trust, micro-group trust, group trust and trust between subgroups, trust of subgroups to a group, because to estimate the manifestation degree of the first three levels absolute indexes are used, and to estimate the other two levels — relative indexes are used, which makes it impossible to compare them.

Table 1. Levels and types of trust in a small group (average score)

Types of trust	Trust levels				
	IT	GT	MGT	SST	SGT
ACT	13.6(18.5/13.1)	17.0(17.3/16.8)	20.4(20.9/19.5)	7.4	8.3
IIT	12.5(15.6/12.3)	17.3(17.1/17.4)	20.3(20.8/19.6)	8.2	8.5
CPT	11.3(18.7/11.0)	17.4(17.2/17.6)	20.8(21.3/20.4)	6.4	8.3

Note: The figure before round parenthesis is an index of trust in a group as a whole, and the figure in parenthesis is an index of trust in members of informal subgroups (before parenthesis) and members not included in informal subgroups (after parenthesis).

First, we should analyze the degree of trust manifestation levels taking into consideration each type (H1a). In a group as a whole, individual's trust to subgroups (MGT) is manifested the most, trust to group (GT) is less manifested, and interpersonal trust (IT) is the least manifested. All differences between mean values are statistically significant ($p < .001$) for each type of trust: ACT, IIT, CPT. In a total-group context, no difference was discovered between members of informal subgroups and members not included in subgroups by the degree of demonstration of trust level manifestation. In informal subgroups there is another tendency: by each type, MGT is the most manifested, IT is less manifested, and GT is the least manifested. IIT is an exception which, on the contrary, is less manifested at the level of interpersonal trust in comparison with trust to a group. Statistically significant differences were revealed between all levels of trust manifestation ($p < .001$ и $p < .01$).

If we draw attention to the other two levels, trust of subgroups to a group (SGT) in a group as a whole is manifested more strongly than trust between subgroups (SST). A statistically significant difference between mean values is present in such types of trust as ACT and CPT ($p < .001$).

Second, conversely, we compare indexes of trust types by each level of their manifestation (H1b). Significant differences of mean values were determined:

- 1) at the interpersonal trust level:
 - in informal subgroups between CPT and IIT ($p < .001$), between IIT and ACT ($p < .001$);
 - of members of subgroups with representatives of other subgroups and members not included in subgroups between CPT and IIT ($p < .01$), between IIT and ACT ($p < .01$);
 - of members not included in subgroups between CPT and IIT ($p < .01$), between CPT and ACT ($p < .001$);
- 2) at the level of trust between subgroups: between CPT and IIT ($p < .001$), between CPT and ACT ($p < .01$), between CPT and ACT ($p < .01$).

Relationship between levels and between types of trust

Let's study relationships between levels of trust manifestation (H2a) separately, by each type (Table 2). I

n a small group as a whole, a statistically significant relationship between the following levels is detected: interpersonal trust and trust between informal subgroups (direct relationships by CPT and ACT types); micro-group trust and trust between subgroups (feed-back by IIT type); microgroup trust and trust of subgroups to a group (feed-back by IIT type); group trust and trust between subgroups (direct relationship by PT type); group trust and trust of subgroups to a group (direct relationship by ACT, IIT and CPT types); trust between subgroups and trust of subgroups to a group (direct relationship by ACT type).

In informal subgroups there is a statistically direct relationship between interpersonal trust and micro-group trust (ACT, IIT, CPT), and between micro-group trust and group trust (IIT, CPT). Besides, in the first case the relationship is closer than in the second. There is no relationship between interpersonal and group trust, just as in a group as a whole.

Let's refer to relationships between types of trust (H2b) separately by each level (Table 3). There is a certain sequence of growing correlation between ACT, IIT, and CPT from level to level. That is: the weakest relationship is at the level of interpersonal trust, a closer relationship is at the level of micro-group trust, and the strongest relationship is at the level of group trust.

Table 2. Correlation between trust levels (separately by type)

Types and Levels of trust		Trust levels			
		MGT	GT	SST	SGT
CPT	IT	.23 (.51*)	.25 (.18)	.71*	-.13
	MGT	1	.28 (.38**)	.05	.08
	GT	-	1	.26	.69**
	SST	-	-	1	.32
	SGT	-	-	-	1
IIT	IT	.01 (.35**)	.03 (.14)	.34	.07
	MGT	1	.11 (.36**)	-.56**	-.61**
	GT	-	1	.09	.59**
	SST	-	-	1	.41
	SGT	-	-	-	1
ACT	IT	0 (.46**)	.31 (.23)	.59**	.24
	MGT	1	.19 (.27)	.01	-.27
	GT	-	1	.77*	.74*
	SST	-	-	1	.76*
	SGT	-	-	-	1

Note: The figure before parenthesis is a correlation of indexes of the group as a whole, and the figure in parenthesis is a correlation among members of informal subgroups. * $p < .001$, ** $p < .05$.

Table 3. Coefficients of correlation between types of trust (separately by each level)

Types of trust	Levels and Types of trust								
	IT			MGT			GT		
	CPT	IIT	ACT	CPT	IIT	ACT	CPT	IIT	ACT
CPT	1	.43***	.55***	1	.71*	.64**	1	.77*	.73*
IIT	–	1	.67**	–	1	.75*	–	1	.81*
ACT	–	–	1	–	–	1	–	–	1

Note: * $p < .001$, ** $p < .01$, *** $p < .05$.

Discussion

1. A different degree of manifestation of trust levels in a group as a whole and within informal subgroups allows us to speak of a phenomenon of *asymmetry of trust levels in a group* (H1a). Predominance of micro-group trust over group trust is explained by the fact that a subgroup is considered by individuals to be a more integral unit, with an ability to more effectively realize functions in relation to its members, than a group as a whole.

Domination (in a group as a whole) of group trust over interpersonal trust plays a compensational role in case of a decrease in the latter, thus supporting the psychological integrity of a group as a whole. A higher degree of manifestation of micro-group trust in comparison with other levels in an informal subgroup ensures psychological integrity and relative stability of a subgroup, and its behavior as a collective unit.

Predominance of trust of subgroups to a group over trust between subgroups by CPT type, is possibly connected with the fact that: (a) a group, in comparison with some subgroups, is perceived as a higher unit, which is in some way able to protect the interests of group members in the external environment and (b) some other subgroups are considered to be a potential threat source inside a group. Similar correlation of these levels of trust by ACT type is explained by the fact, on the one hand, that a group has greater resources than some separate subgroups, and on the other, that there is a competition between separate subgroups. A lack of difference between these levels by IIT type is explained by the fact that knowing the opinion of other subgroups in respect of some important issues is no less important than knowing the opinion of a group, especially if we speak about the development of relations between subgroups.

Interpersonal trust by all types is much more strongly manifested in subgroups, than in a group as a whole, that is indicative of the phenomenon of *asymmetry of interpersonal trust manifestation in a group structure* (H1b). This can be explained in the following way: (a) members of a subgroup have characteristics which are more similar and generally significant in comparison with other group members, (b) the strength of relations and intensity of interaction in subgroups is much higher than in a group as a whole, and (c) one of factors of sub-grouping individuals is trust in each other. Besides, in subgroups interpersonal CPT and ACT are more strongly manifested, and interpersonal IIT is more weakly manifested. Predominance of the

first type of trust can be explained by the fact that it is crucial to ensure a feeling of personal safety, which is more successfully realized in a subgroup than in the context of a group as a whole. This is even more evident when there is an aggressive environment in a group and people have a fear of staying alone. Predominance of CPT is connected with the fact that in subgroups, in comparison with a group as a whole, people can rely on responsibility and assistance of others to a greater extent, and that means they can perform their main work more successfully.

2. There is a certain relationship between levels of trust in a group (H2a), which in general can be described as follows: (a) in informal subgroups and by cumulation of members not included in them, there is a connection between levels of trust that are hierarchically close to each other: IT–MGT–GT, (b) in a group as a whole trust between subgroups is a binding level between all the rest, and (c) an increase or decrease of one level of trust causes correspondent or opposite manifestation of another level.

Relationship between interpersonal trust and trust of individuals to a subgroup. When a subgroup is successful in maintaining its position in a group or it demonstrates a high work productiveness, this leads to an increase of members' trust to their subgroup, and further, to a strengthening of interpersonal trust to it. If interpersonal mistrust is growing in a subgroup, this may lead to trust to a subgroup decreasing.

Relationship between individuals' trust to subgroups and to a group. If a group can stand up for its opinion, defend its interests, or show high results of work in an organization, this gives assurance to members of subgroups in the possibilities of not only the group as a whole, but of their subgroups too.

Trust relationship between subgroups, on the one hand, and trust relationship of individuals to a group and subgroups to a group, on the other. When suspicion between subgroups is growing in a group, this results in a decrease of trust to the group. Growth of trust to a group, in its turn, can, but not so evidently, result in a strengthening of trust between subgroups.

Trust relationship between subgroups, on the one hand, and trust relationship of individuals to a subgroup, on the other hand. In case of a progression of conflict and mistrust between subgroups, trust of members to their subgroups will grow. However, if a subgroup is ineffective in the process of interaction with other subgroups, trust of its members will be decreased, and trust to some other subgroups or a group on the whole may increase.

A different degree of manifestation and a certain sequence of growing correlation between trust types (H2b) from level to level is indicative of a different degree of their presence in the minds of individuals. That is: a stronger differentiation of trust types is observed at the level of interpersonal relations (low correlation), a lower one at the level of relation to subgroups (intermediate correlation), and the least one at the level of relation to a group (highest correlation). This regularity is explained by the fact that in the minds of individuals, a subgroup, and, especially, a group is presented in more generalized characteristics, than separate individuals are.

In addition we would like to note, that in a group as a whole there is a very weak or weak correlation, and between types at this or that level there is a middle or high correlation. A higher correlation between types of trust is explained by the fact that we speak about types of one and the same phenomenon at one and the same level of its manifestation.

Future research

Several prospects for further studies are possible. First, it's necessary to examine forms of manifestation of trust levels in a group. For example, interpersonal trust may be *personified* and *depersonified*. Personified trust is specified by the individual characteristics of group members. Depersonified trust is impersonal trust that is mediated by (a) micro-group trust; (b) trust between subgroups; and c) group trust.

Secondly, it is necessary to study the characteristics of a subject and an object of trust, which directly affect trust between them. The matter of man's particularities which influence his/her trust and trust to him/her, has been more or less investigated. At the same time, the characteristics of a subgroup or a group as a subject or an object of trust have not been substantially investigated.

Thirdly, in the research particular characteristics of trust of individuals to a subgroup and a group have been examined. In contrast, it is no less important to investigate the trust of a subgroup and a group to an individual.

Fourthly, another important question is the following: what level and what type of trust has the most significant impact on group effectiveness.

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