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From physiological psychology to psychological physiology: Postnonclassical approach to ethnocultural phenomena

Aleksandr M. Chernorizov*, Aleksandr G. Asmolov, Eugeniya D. Schechter

Lomonosov Moscow State University, Moscow, Russia

* Corresponding author. E-mail: amchern53@mail.ru

In modern science, along with the "classic" and "non-classical" approach to solving fundamental and applied problems, there is an actively developing "postnonclassical" research paradigm. This renovation of general scientific methodology has been accompanied by the emergence of new experimental technologies and new scientific research directions based on them. "Social psychophysiology" is one such direction. It is formed within the frame of postnonclassical methodology at the intersection of neuroscience and psychology. This work is devoted to the analytical review of the methods, achievements and prospects of contemporary social neuroscience and social psychophysiology studying brain structures that are specifically related to the implementation of social forms of behavior and intercultural communication. Physiological studies of brain activity during social interaction processes, which are simulated using virtual reality environments, are analyzed, and the physiological approach to the study of the brain mechanisms associated with social perception, social cognition and social behavior is used. Along with the analysis of psychophysiological studies of the mechanisms of social perception and social cognition, we discuss the theories of "Brain Reading" and "Theory of Mind" and the underlying data concerning "Gnostic neurons recognition of persons and recognition of emotional facial expressions", "mirror neurons", "emotional resonance" and "cognitive resonance". Particular emphasis is placed on the discussion of a fundamentally new trend in the study of the relationship between the brain and culture (i.e., "cultural neuroscience"). Related to this connection, the following topics are raised: physiological mechanisms protecting the "individual distance" in communication between members of a personified community, psychophysiological approaches to the study of cross-cultural differences, physiological mechanisms of social classification (particularly the formation of attitudes toward representatives of various social groups and toward the content of socially oriented information), and psychophysiological approaches to the study of processes of social classification in the field of intercultural relations (racial perception, stereotypes and prejudices).

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Postnonclassical paradigm in brain science as a substrate of the psyche: Social neuroscience and social psychophysiology

In the 1850s physiological psychology became a key trend in the development of psychology as a true science; it was associated with the names of Wilhelm Wundt, Hermann von Helmholtz and Johannes Müller. This development is both historical and contemporary, in terms of the researchers who, following the logic of I.M. Sechenov, tried to reduce the mechanisms of mind functioning and development to its physiological mechanisms (in the broadest sense). An alternative position was expressed by L.S. Vygotsky (and others); this line of thinking was groundbreaking. In his diaries from the 1920s and 1930s, Vygotsky concisely formulated an analysis of cultural, psychological and physiological phenomena, from physiological psychology to psychological physiology. In various guises, this study of the relationship between cultural, psychological and physiological realities is expressed in the research of N.E. Vvedensky, A.A. Ukhtomsky and N. A. Bernshtein, E.N. Sokolov, P.K. Anohin, A.R. Luria and I.M. Feigenberg. The following ideas serve as postnonclassical and non-classical paradigms of the methodology of the XXI century: parabiosis by N.E. Vvedensky, functional organ and dominant by A.A. Ukhtomsky, the problem of forming the body by N.A. Bernstein, the neuronal stimulus model by E.N. Sokolov, concepts of the functional system by P.K. Anohin, the systematic localization of mental functions by A.R. Luria and probabilistic forecasting of brain activity by I.M. Feigenberg.

This article attempts to define the problem field of psychological physiology through the prism of non-classical and postnonclassical ideals of rationality (M.K. Mamardashvili, V.S. Stepin, MS Guseltseva). When examining problems with the relationship between the brain, mind and culture, the authors used nonclassical psychological physiology to defend the postulate of irreducibility of the laws of development of culture and mind to the physiological mechanisms of their implementation, as well as the methodological failure of any attempts to solve the Cartesian psychophysiological problem using different correlation techniques (even the most sophisticated) to bond the spaces in the Euclidean style instead of Riemannian or Lobachevskian styles. The development of modern science is characterized by a radical update of the conceptual framework. In addition to the "classic" and "non-classical" approach to solving fundamental and applied problems, there is an actively developing "postnonclassical" research paradigm (Mezzich, Zinchenko, Krasnov, Pervichko, Kulygina, 2013; Pervichko, Zinchenko, 2014; Zinchenko, Pervichko, 2012 a, b; Zinchenko, Pervichko, 2013). The introduction of the postnonclassical approach to science is accompanied by a reconsideration of not only the general scientific but also a concrete scientific methodology. The latter is expressed in the renewal of an ontological model of the research subject and, consequently, in the development of new experimental technologies and new scientific directions based on them.

Modern neurosciences and psychophysiology are not removed from the process of conceptual renovation. The rapid development of non-invasive imaging techniques in brain activity in the 1990s (e.g., functional magnetic resonance imaging, fMRI and positron emission tomography, PET) revealed to scientists new possibilities for studying the brain mechanisms underlying cognitive processes (perception, thinking, consciousness), social cognition and social behavior. Therefore, the last 10 years have resulted in a rapid formation of new interdisciplinary research areas at the intersection of neuroscience and social science (social psychology and behavioral economics in particular); these new research areas are called "social neuroscience" and "social psychophysiology" (Lieberman, 2007; Adolphs, 2009, 2010; Amodio, 2010). The process of "conceptual adjustment" led to the formation of new scientific communities and laboratories, (academic) periodicals and educational programs. Since 2006, two specialized journals have been published, "Social Cognitive and Affective Neuroscience" (SCAN) and "Social Neuroscience". There is also a scientific society "Society for Social Neuroscience", and fundamental monographs and tutorials have been published (Blascovich, 2000; Blascovich, Mendes, 2010).

Psychophysiology has undergone significant changes related to the change of scientific paradigms, which have transformed it from a so-called "classic" (Wundtian) psychophysiology into the modern science of the neural mechanisms of mental processes and states. Modern psychophysiology focuses not only on neurons and neural networks (macro-objects) but also separate organelles, molecular and genetic mechanisms of neural cells.

To signify this new level of research in modern psychophysiology, in 2006, Prof. Richard Magin proposed the term "nanoneuronics" (Akay, 2006). The knowledge domain (ontology) of modern psychophysiology is developing in "depth" (neurons), as well as increasing in "width" (different fields of psychology). There are actively forming fields of new competencies. Closely related innovative research areas, such as "cognitive psychophysiology" and "social psychophysiology", occupy prominent places among these new competencies. It is believed that human personality is created by conditions of life and upbringing. However, environment and culture are not the only influences. Social behavior has an evolutionary background, a real genetic basis that is created by (natural) selection and rooted in the instinctive behaviors of animals. The investigation of the biological foundation of social behavior, which is not always visible under the layers of culture, has not declined in importance; it is a task for researchers representing many scientific fields, including ethology, animal psychology, psychogenetics, evolutionary biology, evolutionary psychology, ethnography, and sociobiology (Asmolov, et al., 2013 2014; Dawkins, 2014; Wilson, 2015; Wilson, 1976). Brain structures associated with the service of social behavior and intercultural communication are studied within the framework of social neurosciences and social psychophysiology (Lorenz, 1998; Palmer, Palmer, 2003; Asmolov et al., 2013, 2014; Schechter, Chernorizov 2011; Falikman, Cole, 2014; Martin, Wiggs, Weisberg, 1997; Blascovich, 2000; Blascovich et al., 2010; Wangbing et al., 2011). In particular, the following brain mechanisms studied:

- social cognition (social, emotional and cultural intelligence);
- verbal and non-verbal (emotions, gestures) communication, including cross-cultural studies;
- ritualized behavior;
- aggression and altruism;
- social hierarchy;
- protection of " individual distance" in communication;
- dysfunction of social dialogue (social phobia, schizophrenia, autism).

These are complex studies that fully correspond to the spirit of modern psychophysiology, which is associated with a union of different scientific fields gathered around a common core, "a vector of cognition" (cognition of 'Man').

Psychophysiological investigation of the biological foundations of human social behavior is based on the analysis of the evolution of social relations in the communities of living organisms, according to the following scheme: systems in inanimate nature (living systems of community and anonymous communities), family groups and sexual dimorphism (personified communities) (Schechter, Chernorizov 2011; Asmolov et al., 2013, 2014). This approach allows the unification of various aspects of biological based investigations of social behavior within a single scheme of evolutionary development, and it emphasizes those fields that fall into the sphere of (competence of) social psychophysiology. The mechanisms underlying brain function may explain some of the features of human social behavior and also serve as a model for the organization of social relations in society (Bekhtereva, 1994).

Psychophysiological studies of brain activity in the processes of social interaction, simulated using virtual reality environments

Some of the most popular areas of social psychophysiology are studies of the specific features of brain activity in a virtual reality (VR) environment, models of the processes of ethnic cultural identity and formation of inter-ethnic and inter-confessional attitudes, behavior of "(virtual) avatars", and the development of communication skills with partners belonging to different cultures or ethnic groups. These studies investigate crucial aspects of the problem of security in the modern world (Zinchenko, 2011; Zinchenko, Zotova, 2014), in terms of terrorism (Zinchenko, Shaigerova, Shilko, 2011; Chaiguerova, Soldatova, 2013; Soldatova, Shaigerova, Shlyapnikov, 2008) extreme situations (Soldatova, Zinchenko, Shaigerova, 2011), extremism (Zinchenko, 2014), social instability (Dontsov, Perelygina, 2013), xenophobia (Soldatova, Nestik, Shaigerova, 2011), inter-ethnic and cross-cultural interaction (Pöppel, Bao, 2011), and migration and adaptation of immigrants in the host society (Soldatova, Shaigerova, 2002, 2015).

Combining VR systems with online brain activity registration has opened opportunities to objectively measure the intensity of the "immersion effect" of humans into VR, the so-called presence effect. Particularly promising is the use of modern non-invasive brain activity imaging methods, such as electroencephalography (EEG), magnetoencephalography (MEG), positron emission tomography

(PET) and functional magnetic resonance imaging (fMRI) (Wiederhold, Rizzo, 2005; Baumgartner et al., 2008). Thus, in their experiments with children (6-11 years) and adults (21-43 years), Baumgartner et al. (2008) used fMRI to reveal the brain correlates of subjective reality, such as the "feeling of immersion into the virtual space" ("effect of presence", "being there", "presence"). Using two types of virtual environment that cause a strong (high Presence) and weak (low Presence) sense of immersion in VR, the authors found that the critical factor in determining the ability of children (and adults) to experience the "presence effect" is the activity of two homologous brain regions in the dorsolateral prefrontal cortex of the right and left hemispheres (right DLPFC and left DLPFC, respectively). Through fMRI analysis of brain activity, it was revealed that there is a negative correlation between activity in the right DLPFC and left DLPFC and intensity of the subjective sense of VR immersion, which the test subjects rated on a subjective 5-point scale. More intense brain activity in the right and left DLPFC correlated with a weaker experience of presence (Baumgartner et al., 2008). Thus, the right DLPFC influences the experience of the "presence effect" by controlling the flow of visual information processed in the posterior parietal brain regions, which are responsible for assessing the perceptions of one's own body (or its part) in outer spaces. However, the left DLPFC influences the quality and intensity of the experience of presence by connecting with the medial prefrontal cortex, which is involved in regulating self-reflection activity and "introversively directed streams of consciousness" (Baumgartner et al., 2008). Interestingly, children 6-11 years of age generally have a more pronounced capacity for rapid and deep immersion in virtual reality than adults. According to the Baumgartner et al. (2008), this fact can be logically explained by the long ripening patterns of the prefrontal cortex during postnatal development. A number of studies investigating the presence effect, which is related to experiencing the illusion of movement through the virtual maze (illusion of vection) and the "out-of-body" phenomenon in VR, have revealed the brain mechanisms of coordination among the proprioceptive, visual and vestibular systems in the process of perceiving one's own body (Costantini, Haggard, 2007; Ehrsson, 2007, 2009), as well as space and spatial orientation (Keshavarz, Berti, 2014; Men'shikova et al., 2014; Zhang et al., 2014). Works devoted to the virtual 'out-of-body' phenomenon have raised the question of the role that multimodal stimulation plays in the formation of subjective perceptions of "physical self" (the body) and, more extensively, the mechanisms of "self-reflection" and "self-consciousness".

The ability of a person to immerse deeply into the virtual environment is extensively used in new forms of therapy that are based on virtual exposure methods (Muhlberger, Pauli, 2011). The basic idea of this trend is the use of virtual environment as an instrumental framework for behavioral therapy to treat fears, phobias, post-traumatic disorders, drug addiction and stress-related diseases (Selisskaya et al., 2004; Hoffman, 2004; Voiskunsky, Menshikova, 2008; Ignatiev et al., 2009). Psychophysiology methods are widely used for such psychotherapy sessions and to evaluate their efficiency (Hoffman 2004; Cornwell et al., 2006; Galatenko et al., 2012; Lobacheva et al., 2013).

Objective psychophysiological control of effect of presence is crucially important for modelling and studying (n virtual environments) complex social phenomena, such as inter-ethnic relationships.

Psychophysiological approaches to the study of social cognition and social behavior

Psychophysiological studies of the mechanisms of social perception ("Brain Reading", "Theory of Mind"): gnostic neurons of facial recognition and recognition of emotional facial expressions, mirror neurons, emotional resonance, cognitive resonance

In the last 10 years, there has been an independent scientific movement formed in neuroscience and psychophysiology. This deals with the study of brain mechanisms of social interactions (Hari, 2002; Shen, Liu, Yuan, 2011). As mentioned above, there are academic periodicals, monographs and tutorials devoted to the problems of social neuroscience ("SCAN"; "J. of Social Neuroscience", "J. of Cognitive Neuroscience", "J. Human Brain Mapping", "J. Culture and Brain").

Social dialogue and the biological uniqueness of individuals are necessary but insufficient signs of personification in the community. Another prerequisite is the presence of "inter-individual" relationships, that is, the relationships between an individual and other members of community as separate persons, with their own appearances and their own "inner worlds". This type of psychophysiological personification first appears in primates, and it develops maximally in humans, who may sophisticatedly perceive and evaluate the inner worlds of others as being different from their own worlds. In the process of communication, the evaluation of the psychological state of a partner is based on a variety of information about the individual, including his physical identity, the nature of movements of the limbs and body (postures, gestures), facial expressions, specific features of vocalization. These information processes are united in the so-called category "social cognition" or "social perception (intelligence)". In the evolutionary course of personalized communities, specialized mechanisms form in the nervous system of social animals, which maintain the social perception and selectively react to social stimuli. Modern physiological and neuropsychological studies define several types of such socially oriented neural mechanisms. Some are localized in the central nervous system and are associated with specific social signals: 1) acoustic signaling complexes (speech in humans), 2) gestures and poses, and 3) emotional facial expressions. Other mechanisms are localized in the peripheral nervous system and are associated with specialization of the autonomic nervous system for supporting social behavior (Blascovich, 2000). To express emotions in non-verbal communication, higher mammals use mimetic muscles, a special system of facial muscles formed in the process of evolution. These skin muscles perform a variety of functions in animals, from controlling the movements of whiskers and ears to forming various acoustic signals and emotional facial expressions. According to Charles Darwin, facial muscle movements and some ritualized movements of the extremities (or even of the whole body) can be regarded as an alphabet of this language of emotions, a type of emotional gesture. Due to the importance of mimetic muscles for human behavior, the motor cortex area responsible for the management of facial muscles is even larger than the zone responsible for regulating hand movements. According to some researchers, there are some "basic" emotions that are identified directly through facial expression and that can be regarded as social signals in the channel of non-verbal (emotional) communication (Izard, 1980; Ekman, 2010). The existence

of such incentive emotional signals of communication implies the presence of special mechanisms of their generation and recognition in the nervous system. Indeed, modern neurophysiological studies of brain of primates and humans indicate the existence of specialized neural mechanisms of facial and emotion recognition in the temporal cortex and amygdala (Jankowski, Takahashi, 2014). Neurons responsible for emotional facial expressions in the amygdala may be included in the system of regulating social relationships, which are naturally violated when the structure is damaged. For example, dominance dramatically changes in a hierarchically organized community of monkeys (Pribram, 1975). The results of psychophysiological studies of social perception have been confirmed through clinical observations. Thus, in the case of a bilateral lesion in the occipitotemporal cortex, a person develops the so-called neurological syndrome of facial agnosia (prosopagnosia): the inability to identify both familiar and unfamiliar faces in combination with the totally undamaged condition of all other cognitive brain functions. A characteristic feature of this syndrome is that together with the loss of ability to recognize specific individuals, patients continue to perceive their emotional expression appropriately, although impersonally (i.e., as "someone cries," "someone is laughing", "someone feels sad").

In 1937, G. Klüver and P. Bucy described a symptom of behavioral disorders in higher mammals following the bilateral lesions of the temporal anterior lobe (Klüver-Bucy syndrome). The syndrome includes several major symptoms, such as excessive caution and groundless anxiety, hyperorality (investigating objects by inserting them into the mouth), and hypersexuality (the distortion of emotions or diminished emotional affect, a feeling of being violated, distorted perception of the emotional meaning of signals).

Later, it was discovered that emotional changes, in the case of Klüver-Bucy syndrome, are associated with damage to the amygdala and that this type of distortion can vary greatly in different animals. Thus, cats become extremely aggressive after the destruction of the amygdala (untamed, similar to monkeys). In this manner, the clinical data validate the psychophysiological data about the leading role of temporal cortex neurons in perceiving (recognition) faces and neurons of the amygdala (i.e., in the perception of emotional facial expressions). Gnostic facial neurons, "neuron-detectors of a person" and "neuron-detectors of emotional facial expressions", are components of the neurophysiological system, which integrates information about other individuals, the so-called "Who" system. The "Who" system developed in phylogeny aimed to perform an important task to make it possible for individuals to interpret all kinds of information (including their psychological states) about other individuals, ultimately to determine their dispositions and intentions. The brain mechanisms used to identify individuals and their facial expressions are basic processes of social cognition, and damage to these mechanisms can lead to the destruction of the entire system of social adaptation.

At the end of the XX century, Italian researchers from the University of Parma (Universita` degli Studi di Parma) conducted neurophysiological experiments with macaques, and they discovered so-called mirror neurons (MNs) in the lower part of the frontal cortex (area F5 - analogue n. 44 in humans) (Gallese et al., 1996). MNs activated when the monkey was performing certain actions and when the monkey supervised the same actions being performed by the experimenter. MNs

proved to be selective. Each group reacted strictly to a certain action, and they did not react when the action was even slightly different. These findings strengthened the impression that MNs were mirroring: their action was as if the brain of the monkeys learned ("read") the brain of the experimenter, its external manifestations and physical actions.

With the use of fMRI, PET, MEG and EEG, several independent research groups found that some regions in the cerebral cortex in humans are activated when the individual performs certain actions and when he simply looks or imagines how these actions are performed by someone else. It has been shown that, in addition to the premotor cortex and inferior parietal gyrus, MNs are also found in the cingulate gyrus, somatosensory cortex and insula (Blakemore et al., 2005; Liepelt et al., 2009). The discovery of MN makes it possible to offer a simple explanation to the question of why we, in some cases, can understand the actions of others so quickly and easily. It is assumed that when we see another person move, in our brains, the same neurons are activated that work when we perform similar actions alone. Therefore, we actually feel what the other person is doing, and we can predict the continuation of his actions and goal without making any complex logical calculations. The discovery of MNs was the beginning of a new direction in neuroscience and psychophysiology: "Brain Reading" or "Theory of Mind". Data obtained within its framework showed the participation of the brain in the organization of social interaction (learning communication skills, predict the behavior of the communication partner), processes of emotional empathy and evolution of communication systems (from the poses and gestures - to speech) (Baars, Gage, 2010; Rizzolatti, Sinigaglia, 2008 — English, Oxford Press, 2006 Italian, Rafaello Cortina). There is experimental evidence indicating that MN distortion might be one cause of infantile autism (Ramachandran, 2014). In particular, this hypothesis explains some autistic features, such as the desire to fence oneself off from the outside world and avoid social contacts, difficulties in understanding and simulating actions and emotions of others and insensitivity to the feelings of others.

One of the most pressing issues for social psychophysiology and cognitive sciences is specific activity of the brain in terms of direct social contact (joint activities, communication): Is there such activity? If so, what are its mechanisms? In attempts to answer this question, the T.V. Chernigovskaya group proposed an original multidisciplinary approach based on a combination of methods of neurophysiology, psychology and linguistics (Chernigovskaya, 2007). Researchers studied the electroencephalograms (EEG) of two test subjects who participated in jointly solving cognitive tasks (involving visual-spatial orientation) under conditions of active social interaction (discussion). The hypothesis was that joint social actions involve simultaneous activity of certain communication partners in the brain.

The authors demonstrated that during solving cognitive problems in the situation of social interaction, the following activities were observed between the test subjects: (1) synchronization of electrical activity in the parietal area of the left hemisphere and (2) general changes in the frontal interhemispheric asymmetry EEG, which is typical for emotional support of communication. These data clarify the assumption widely discussed in the literature that the structures responsible for social communication are the prefrontal cortex, temporal lobe and temporoparietal junction. Note that the maximum temporal coupling in thee EEGs of partners dur-

ing the communication process was achieved during the period when the process of solving problems (social interaction) was the most efficient. The authors associated the dominance in the EEG synchronization in the parietal region of the left hemisphere to the formation of the "general focus of attention in the system" during the interaction process, including between the partners themselves, through problem solving and the communication environment. Data from brain activity synchronization, together with data from the psychological and linguistic analysis of interactions between partners in the process of solving problems, allowed the authors to formulate the concept of a new psychophysiological phenomenon: cognitive resonance. This phenomenon is a specific complement to another phenomenon that is extremely important for social contacts: the phenomenon of emotional resonance, associated with the establishment of emotional interaction (alignment) of partners in communication.

Psychophysiological mechanisms of protecting "personal distance" in communication between members of the personified community

It is obvious that individuals need to live together (communication). However, why is it that sometimes, we poorly tolerate the constant presence of even our nearest and dearest loved ones, and, moreover, interference in our internal world? Why is there a "repulsive force" that makes each of us available and "open to others" only to a certain extent? Where does this need for "maintaining individual distance" come from? To help us understand the origin of the need for "maintaining individual distance", we may make a comparison between human societies and biological communities, where gregarious life is not combined with an individual maintaining his distance. The spontaneous strive for individual autonomy combined with the need for living together/cohabitation/joint residence is not typical for all species. It is notably absent in the communities of insects; bees inside a hive feel comfortable with one another physically (i.e., touching). No fear of contact is observed among fish as well. A fish shoal forms a solid mass. In rat families, animals are always ready for close physical contact, inalterably friendly. What unites these communities? Insects, fish, and rats have no personality. All individuals are similar and recognize one another based on key features that are common for all members of the group (i.e., based on the principle of "friend-or-foe"). In contrast to this kind of impersonal (anonymous) groups, the full-featured community of humans is personified, and every member of a community has his own unique "set of key attributes" (individuality). The measure of individual distance can be expressed in terms of a distance between individuals, which allows one to protect himself efficiently in case of being attacked by a partner. Neurophysiological studies conducted on monkeys showed the involvement of mirror neurons in the mechanisms of purposeful behavior and, in particular, the specific activity to preserve individual distance (Thill, Svensson, Ziemke, 2011).

Territorial behavior is partly retained in humans. For example, there is an involuntary irritation that we feel when standing in line in a crowded space, or an individual feels discomfort when being alone. Animals also experience the physical "I", including one's own body, one's own territory, and sometimes one's close relatives, the carriers of common genes. The instinctive need to keep all of this is

manifested in the innate reflex of freedom. This term was introduced by I.P. Pavlov when he observed dogs who were unable to develop a new skill because of the strong exaltation: they constantly struggled against a leash because they could not stand captivity. People also have the reflex of freedom, but it manifests not only in response to the physical restraint but also to the mental infringement of "I". Methods of protection (keeping) "individual distance" are reactions of demonstrative aggression (anger), real aggression (attack) and selective behavior (fear). The defensive reactions are not the only means of protecting one's individuality; another method of expression and "self-protection from enslavement" is creative activity (Brodsky, 1987).

The following questions, related to preserving individual distance (personal space), remain open for investigation. 1) At which level of the animal world appears the need to preserve individual distance? 2) Why, in some cases (even among close relatives), is the desire to protect distance present, but in other cases (even with strangers), it is not? 3) Are there cross-cultural differences in efforts to preserve individual distance, and if so, what are the mechanisms of these differences?

Psychophysiological approaches to the study of cross-cultural differences

New directions in research of the relationship between the brain and culture, "cultural neuroscience"

Currently, the question of connection between social relations and neurobiology is not unusual or irrelevant to fundamental science. In modern neuroscience and psychophysiology, at the intersection of psychology, neuroscience, cultural anthropology and genetics, new types of research are gaining momentum: experimental studies of the connection between the brain and economy (neuroeconomics), the brain and politics (biopolitics), the brain and art (neuroesthetics) and, more generally, between the brain and human culture (cultural neuroscience) (Falikman, Cole, 2014; Zhou, Cacioppo, 2010; Kitayama, Uskul, 2011; LeClair, Janusonis, Kim, 2014). In light of these new lines of research, there are studies of the connection between brain plasticity and the acquisition of different forms of cultural experience and studies of physiological determinants of cognitive processes in different cultures (Millar et al., 2013; Kelkar, Hough, Fang, 2013). Ideas about existence of the brain structures that are substrates of social functions, internalized in the evolution and ontogeny, are naturally combined with the ideas of social neuroscience and social psychophysiology.

Brain and processes of social categorization

A mainstream neurocognitive and psychophysiological study of cultural phenomena is the investigation of the mechanisms of "social categorization", the perception of the social environment in the form of the categories of group membership and position in the social structure, which is associated with certain behavioral expectations (Contreras, Banaji, Mitchell, 2011). Modern social psychophysiology data provided evidence of specialization of the brain in relation to the processes of social categorization as an important factor in the evolution of Homo sapiens (Kinzler, Spelke, 2007).

The brain and social perception: attitudes towards different social groups and socially oriented information

There is evidence (EEG, fMRI, PET) of a statistically significant difference in the reactions of the human brain in the perception of different social groups: representatives of their own and of a "foreign" social group (Rilling, et al., 2008; Volz, Kessler, von Gramon, 2009; Vrticka et al. 2009; Van Bavel, Packer, Cunningham, 2008), carriers of different political views (Knutson et al., 2006; Rule et al., 2010; Falk, Spunt, Lieberman, 2011), representatives of different age groups (Leibenluft et al., 2004; Hoehl, et al., 2010), representatives of different sexes (Freeman et al., 2010). In these and many other studies, it was found that the perception of various social categories involves the same areas of the brain, which made it possible to formulate the hypothesis of an elementary universal mechanism in the brain providing representation of the social world (Shkurko, 2012).

Cross-cultural differences in the mechanisms of social cognition are also demonstrated in the works devoted to the study of cultural differences of perceiving social information (Ng et al., 2010; Harada, Chiao, 2010). Important discoveries were made in the field of perception of other people among representatives of collectivist cultures and individualistic cultures. In particular, it was found that in collectivist cultures (conventionally, Eastern cultures), the perception of close relatives or friends activated areas of the brain associated with the perception of their own "I". This finding can be interpreted as a consequence of including "dear and near people" (friends and relatives) into the self-concept. Such an effect is absent in individualistic cultures (conventionally, Western cultures). The fact that the differences between cultures are reflected in the specific activity of the brain confirms the need for further development of psychophysiological methods with the purpose of using them in cross-cultural and inter-cultural studies.

Psychophysiological approaches to the study of processes of social categorization in the field of international relations: racial perception, stereotypes and prejudices

In social neuroscience, when dealing with the processes of social categorization, maximal attention is given to the study of racial perception, stereotypes and prejudices (Ito, Bartholow, 2009; Dickter, Bartholow, 2007; Knutson, et al., 2007). Most research in this area is performed in the United States due to its practical importance in that country. Thus, the first pioneering research has revealed the role of the amygdala, usually associated with a reaction to emotionally significant stimuli, in the perception of people of another race (Hart et al., 2000; Phelps et al., 2000). Research of Cunningham and colleagues (Cunningham et al., 2004) demonstrated the importance of neuroscience research for understanding the cognitive processes involved in the perception of individuals of one's own and other races: fast (30 ms) activation of the amygdala in response to unconscious demonstration of people of other races was absent when the stimulus exposure time exceeded the threshold of conscious perception (0.5 s), which can be interpreted as a consequence of the suppression of the automatic stereotyped response by controlled processes. The differential response of the human brain to the exposure of representatives of an individual's race and/or ethnic group during the performance of different experimental tasks, from passive perception to imitation and meaningful judgments (Golby et

al., 2001; Richeson, et al., 2003; Lieberman et al., 2005; Adams et al., 2009; Bruneau, Saxe, 2010; Xu et al., 2009; Cheon et al., 2011; Losin et al., 2012), indicates that racial (ethnic) categorization is deeply rooted in the architecture of social cognition, possibly confirming the hypothesis of racial categorization as epiphenomenon of evolutionary formed mechanisms of recognition of coalitions (Kurzban, Cosmides, 2001).

However, already beginning to gain momentum is research on the neurophysiological basis of social cognition; there appears to be serious methodological problems. Thus, according to the classical neurophysiology and modern neuroscience, narrow brain specialization is not confirmed, even for the basic physiological (e.g., breathing) and psychological (attention, memory, emotions, speech, perception) processes. Considering socially loaded categories, such specialization is reliably captured only in the case of the perception/identification of faces (temporal cortex and adjacent amygdala). The task of finding brain correlates (patterns of brain activity) for multiple valued stimuli categories, such as "marital status", "political affiliation" or "social hierarchy", appears, from the point of view of the experimenter-neurophysiologist, to be an ill-posed problem for which there is no unique solution. In this sense, what is the fundamental difference between proposed research projects and an older project by F. Gall, which investigated the localization (in the brain) of such personality traits as "independence," "amor patriae" and so on? The proposed method of meta-analysis (analysis of the data obtained by different authors within the framework of socially oriented neurophysiological research) in this area has accumulated too little statistically significant material, and it has been contaminated by "noisy" differences in terms of specific experiments (Van Overwalle, 2009). Meta-analysis in the field of modern neuroscience and psychophysiology references works performed, as a rule, using fMRI and PET. First, the analysis of tomograms is a type of statistical analysis, with limitations to the accuracy and reliability of data on the localization of brain activity patterns. Second, fMRI and PET are unable to determine the type of physiological processes (arousal/inhibition) occurring in the activated areas, and they do not allow functioning areas to be detected with low energy requirements. This implies a possible situation: all activated zones (pixels/voxels of tomograms) are areas inhibited by the brain as those which disturb analysis of social categories, and areas which are actually associated with this analyses consume less energy, so that the methods are not able to detect them (due to space-time thresholds). fMRI and PET raise serious claims of physiological, technical and (mainly) methodological issues, the consideration of which would be extremely fruitful in planning research (including meta-analysis) in the field of social neuroscience (for review, see: Logothesis, 2008; Figley, Stroman, 2011).

Conclusion

Social behavior has an evolutionary background and a real genetic basis; it is also created by selection and is rooted in the instinctive behavior of animals.

Research of biological foundation of social behavior engages representatives of sciences such as ethology, animal psychology, psychogenetics, evolutionary biology, evolutionary psychology, ethnography, and sociobiology.

In the last 10 years, there has been rapid development of new interdisciplinary areas of research at the intersection of neuroscience and social sciences (social psychology and behavioral economics), social neuroscience and social psychophysiology. Within the framework of social neuroscience and social psychophysiology, brain structures associated with conducting social behavior and interpersonal communication have been studied. The approaches and methods used in social psychophysiology and neuroscience allow researchers to come close to understanding the evolutionary biological origins of the fundamental phenomena underlying social behavior, such as social perception, social cognition, social categorization and cross-cultural differences.

"Historical and evolutionary synthesis: the paradigm of diversity in the biological, social and mental systems." The purpose of this program is to (1) investigate the justification that diversity, specialization and symbiosis are universal phenomena that characterize many aspects of life; (2) analyze the role of mental diversity in the development of the biological, social and mental systems; and (3) analyze the causes of the unpredictability in the outcomes of evolutionary leaps in biological and social systems and objectively prove the laws of preadaptation (i.e., provide answers to future challenges in unexpected situations.

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References

Adams, R. B., Rule, N. O., Franklin, R. G. Jr., Wang, E., Stevenson, M. T., Yoshikawa, S., Nomura, M., Sato, W., Kveraga, K., & Ambady, N. (2009). Cross-cultural Reading the Mind in the Eyes: An fMRI Investigation. *Journal of Cognitive Neuroscience, 21*, 97–108.

Adolphs, R. (2009). The social brain: neural basis of social knowledge. *Annual Review of Psychology, 60*, 693–716. doi: 10.1146/annurev.psych.60.110707.163514

Adolphs, R. (2010). Conceptual challenges and directions for social neuroscience. *Neuron, 65*(6), 752–767. doi: 10.1016/j.neuron.2010.03.006

Akay, M. (Ed.) (2007). *Handbook of Neural Engineering*. New York: Wiley-IEEE Press.

Amodio, D. M. (2010). Can neuroscience advance social psychological theory? Social neuroscience for the behavioral social psychologist. *Social Cognition, 28*(6), 695–716. doi: 10.1521/soco.2010.28.6.695

Asmolov, A. G., Shekhter, E. D., & Chernorizov, A. M. (2013). Istoriko-evolutsionnyj podhod: vzaimnaya pomoshch kak factor evolutsii [The historical-evolutionary approach: Mutual aid as a factor of evolution]. *Voprosy psihologii [Issues in Psychology], 6*, 3–14.

Asmolov, A. G., Shekhter, E. D., & Chernorizov, A. M. (2014). Po tu storonu gomeostaza: istoriko-evolutsionnyj podhod k razvitiyu slozhnyh system [On the other side of homeostasis: The historical-evolutionary approach to the development of complex systems]. *Voprosy psihologii [Issues in Psychology], 6*, 3–15.

Baars, B., & Gage, N. (2010). *Cognition, Brain and Consciousness: Introduction to Cognitive Neuroscience.* London: Elsevier Ltd.

Baumgartner, Th., Speck, D., Wettstein, D., Masnari, O., Beeli, G., & Jancke, L. (2008). Feeling present in arousing virtual reality worlds: Prefrontal brain regions differentially orchestrate presence experience in adults and children. *Frontiers in Human Neuroscience, 2*. Retrieved from: www.frontiersin.org doi: 10.3389/neuro.09.008.2008

Bekhtereva, N. P. (1994). Zakony mozga i zakony obshchestva [Brain laws and society laws]. In D.I. Dubrovskij (Ed.), *Brain and Mind* (pp. 91–96). Moscow: Nauka.

Blakemore, S. J., Bristow, D., Bird, G., Frith, C., & Ward, J. (2005). Somatosensory activation during the observation of touch and a case of vision-touch synaesthesia. *Brain, 128*(7), 1571–1583. doi: 10.1093/brain/awh500

Blascovich, J. (2000). Using physiological indexes of psychological processes in social psychological research. In H.T.Reis & M. Charles (Eds.), *Handbook of research methods in social and personality psychology* (pp. 117–137). New York: Cambridge University Press.

Blascovich, J., & Mendes, W. B. (2010). Social Psychophysiology and Embodiment. In *Handbook of Social Psychology* (pp. 194–227). doi: 10.1002/9780470561119.socpsy001006

Brodskij, I. (1987). *Nobelevskaya rech* [Nobel Speech].

Bruneau, E. G., & Saxe, R. (2010). Attitudes towards the outgroup are predicted by activity in the precuneus in Arabs and Israelis. *NeuroImage, 52*, 1704–1711. doi: 10.1016/j.neuroimage.2010.05.057

Cheon, B. K., Im, D.M., Harada, T., Kim, J.S., Mathur, V. A., Scimeca, J. M., Parrish, T. B., Park, H. W., & Chiao, J.Y. (2011). Cultural influences on neural basis of intergroup empathy. *NeuroImage, 57*, 642–650. doi: 10.1016/j.neuroimage.2011.04.031

Chernigovskaya, T. V. (2007). The mirror brain, concepts, and language: The price for anthropogenesis. *Neuroscience and Behavioral Physiology, 37*(3), 293-302. doi: 10.1007/s11055-007-0014-7

Cornwell, B.R., Johnson, L., Berardi, L., & Grillon, C. (2006). Anticipation of public speaking in virtual reality reveals a relationship and startle reactivity. *Biological Psychiatry, 59*, 664–666. doi: 10.1016/j.biopsych.2005.09.015

Costantini, M., & Haggard, P. (2007). The rubber hand illusion: Sensitivity and reference frame for body ownership. *Consciousness and Cognition, 16*(2), 229–240. doi: 10.1016/j.concog.2007.01.001

Contreras, J. M., Banaji, M. R., & Mitchell, J. P. (2011). Dissociable neural correlates of stereotypes and other forms of semantic knowledge. *SCAN, 7*(7), 764–770. doi: 10.1093/scan/nsr053

Cunningham, W. A., Johnson, M. K., Raye, C. L., Gatenby, J. C., Gore, J. C., & Banaji, M. R. (2004). Separable neural components in the processing of Black and White faces. *Psychological Science, 15*, 806–813. doi: 10.1111/j.0956-7976.2004.00760.x

Dawkins, R. (2014). *Samoe grandioznoe shou na zemle. Dokazatel'stva evolutsii* [The greatest show on Earth. Evidence for evolution]. Moscow: ACT: CORPUS.

Dickter, Ch. L., & Bartholow, B. D. (2007). Racial ingroup and outgroup attention biases revealed by event-related brain potentials. *SCAN, 2*, 189–198. doi: 10.1093/scan/nsm012

Dontsov, A., & Perelygina, E. (2013). Tense situations and the significance of stability for psychological security. *Psychology in Russia: State of the Art, 6*(2), 20–31. doi: 10.11621/pir.2013.0109

Ehrsson, H. H. (2007). The experimental induction of out-of-body experiences. *Science, 317*, 1048. doi: 10.1126/science.1142175

Ehrsson, H. H. (2009). How many arms make a pair? Perceptual illusion of having an additional limb. *Perception, 38*(2), 310–312. doi: 10.1068/p6304

Ekman, P. (2010). *Psihologiya emotsij* [Psychology of emotions]. Saint Petersburg: Piter.

Falikman, M. B., & Cole, M. (2014). Kul'turnaya revolutsiya v kognitivnoj nauke: ot nejronnoj plastichnosti do geneticheskih mehanizmov priobreteniya kul'turnogo opyta ["Cultural Revolution" in Cognitive Science: From Neuroplasticity to Genetic Mechanisms of Acculturation]. *Kulturno-istoricheskaya psihologiya [Cultural-Historical Psychology], 3*, 4–18.

Falk, E. B., Spunt, R. P., & Lieberman, M. D. (2011). Ascribing beliefs to ingroup and outgroup political candidates: Neural correlates of perspective taking, issue importance and days until the election. *Philosophical Transactions of the Royal Society of London. Series B, Biological sciences*, *67*(1589), 731–743. doi:10.1098/rstb.2011.0302

Figley, Ch., & Stroman, P. (2011). The role(s) of astrocytes and astrocyte activity in neurometabolism, neurovascular coupling, and the production of functional neuroimaging signals. *European Journal of Neuroscience, 33*(4), 577–588. doi: 10.1111/j.1460-9568.2010.07584.x

Franks, D. D. (2010). *Neurosociology: The nexus between neuroscience and social psychology.* New York: Springer-Verlag. doi: 10.1007/978-1-4419-5531-9

Freeman, J. B., Rule, N. O., Adams, R. B., & Ambady, N. (2010). The neural basis of categorical face perception: Graded representations of face gender in fusiform and orbitofrontal cortices. *Cerebral Cortex, 20*, 1314–1322. doi: 10.1093/cercor/bhp195

Galatenko, V. V., Livshitz, E. D., Podolskii, V. E., Chernorizov, A. M., & Zinchenko,Yu. P. (2012). Automated real-time classification of psychological functional state based on discrete wavelet transform of EEG data. *International Journal of Applied Mathematics, 2*5 (6), 871–882.

Gallese, V., Fadiga, L., Fogassi, L., & Rizzolatti, G. (1996). Action recognition in the premotor cortex. *Cognitive Brain Research, 119*, 593–609. doi: 10.1093/brain/119.2.593

Golby, A. J., Gabrieli, J. D. E., Chiao, J. Y., & Eberhardt, J. L. (2001). Differential responses in the fusiform region to same-race and other-race faces. *Nature Neuroscience, 4*, 845–850. doi: 10.1038/90565

Harada, L., & Chiao, Y. (2010). Differential dorsal and ventral medial prefrontal representations of the implicit self-modulated by individualism and collectivism: An fMRI study. *Social Neuroscience, 5*, 257–271. doi: 10.1080/17470910903374895

Hari, R. (2002). *The social brain.* Retrieved from: http://www.project-syndicate.org/commentary/the-social-brain

Hart, A. J., Whalen, P. J., Shin, L. M., McInerney, S. C., Fisher, H., & Rauch, S. L. (2000). Differential response in the human amygdala to racial outgroup vs ungroup face stimuli. *NeuroReport, 11*, 2351–2355. doi: 10.1097/00001756-200008030-00004

Hoehl, S., Brauer, J., Brasse, G., Striano, T., & Friederici, A. D. (2010). Children's processing of emotions expressed by peers and adults: An fMRI study. *Social Neuroscience, 5*, 543–559. doi: 10.1080/17470911003708206

Hoffman, H. (2004). Tselitel'naya virtual'naya real'nost [Healing virtual reality]. *V mire nauki [In the World of Science], 11*, 36–43.

Ignatiev, M. B., Nikitina, A. V., & Vojskunskij, A. E. (2009). *Arhitectura virtual'nyh mirov* [Architecture of virtual worlds]. Sankt-Peterburg: GUAP.

Ito, T.A., & Bartholow, B.D. (2009). The neural correlates of race. *Trends in Cognitive Sciences, 13*(12), 524–531. doi: 10.1016/j.tics.2009.10.002

Izard, I. (1980). *Emotsii cheloveka* [Human emotions]. Moscow: Moscow University Press.

Jankowski, K.F., & Takahashi, H. (2014). Cognitive neuroscience of social emotions and implications for psychopathology: Examining embarrassment, guilt, envy, and schadenfreude. *Psychiatry and Clinical Neurosciences, 68*(5), 319–336. doi: 10.1111/pcn.12182

Kaplan, J. T., Freedman, J., & Iacobony, M. (2007). Us versus them: Political attitudes and party affiliation influence neural response to faces of presidential candidates. *Neuropsychologia, 45*, 55–64. doi: 10.1016/j.neuropsychologia.2006.04.024

Kelkar, A. S., Hough, M. S., & Fang X. (2013). Do we think alike? A cross-cultural study of executive functioning. *Culture and Brain, 1*(2–4), 118–137. doi: 10.1007/s40167-013-0010-4

Keshavarz, B., & Berti, S. (2014). Integration of sensory information precedes the sensation of vection: A combined behavioral and event-related brain potential (ERP) study. *Behavioural Brain Research, 259*(1), 131–136. doi: 10.1016/j.bbr.2013.10.045

Kinzler, K. D., & Spelke, E. S. (2007). Core systems in human cognition. *Progress in Brain Research, 164*, 257–264. doi: 10.1016/S0079-6123(07)64014-X

Kitayama, Sh., & Uskul, A. K. (2011). Culture, mind, and the brain: current evidence and future directions. *Annual Review of Psychology, 62*, 419–449.doi: 10.1146/annurev-psych-120709-145357

Knutson, K. M., Wood, J. N., Spampinato, M. V., & Grafman, J. (2006). Politics on the brain: An fMRI investigation. *Social Neuroscience, 1*(1), 25–40. doi: 10.1080/17470910600670603

Kurzban, R., Tooby, J., & Cosmides, L. (2001). Can race be erased? Coalitional computation and social categorization. *Proceedings of the National Academy of Sciences, 98*(26), 15387–15392. doi: 10.1073/pnas.251541498

Knutson, K. M., Mah, L., Manly, C.F., & Grafman, J. (2007). Neural correlates of automatic beliefs about gender and race. *Human Brain Mapping, 28*, 915–930. doi: 10.1002/hbm.20320

Kurzban, R., Tooby, J., & Cosmides, L. (2001). Can race be erased? Coalitional computation and social categorization. *PNAS, 98*, 15387–15392. doi: 10.1073/pnas.251541498

LeClair, J., Janusonis, S., & Kim, H. S. (2014). Gene–culture interactions: A multi-gene approach. *Culture and Brain, 2*(2), 122–140. doi: 10.1007/s40167-014-0022-8

Leibenluft, E., Gobbini, M. I., Harrison, T., & Haxby J. V. (2004). Mothers' neural activation in response to pictures of their children and other children. *Biological Psychiatry, 56*, 225–232. doi: 10.1016/j.biopsych.2004.05.017

Lieberman, M. D., Hariri, A., Jarcho, J. M., Eisenberger, N. I., & Bookheimer, S. Y. (2005). An fMRI investigation of race-related amygdala activity in African American and Caucasian American individuals. *Nature Neuroscience, 8*, 720–722. doi: 10.1038/nn1465

Lieberman, M. D. (2007). Social cognitive neuroscience: A review of core processes. *Annual Review of Psychology, 58*, 259–289. doi: 10.1146/annurev.psych.58.110405.085654

Liepelt, R., Ullsperger, M., Obst, K., Spengler, S., von Cramon, D. Y, & Brass, M. (2009). Contextual movement constraints of others modulate motor preparation in the observer. *Neuropsychologia, 47*(1), 268-275. doi: 10.1016/j.neuropsychologia.2008.07.008

Lobacheva, E. M., Galatenko, Yu. N., Gabidullina, R. F., Galatenko, V. V., Livshitz, E. D., Lukashenko, T. P., Vetrov, D. P., Lebedev, A. E., Podol'skii, V. E., Lebedev, V. V., Isaychev, S. A., Chernorizov, A. M., & Zinchenko, Yu. P. (2013). Automated real-time classification of functional states based on physiological parameters. *Procedia — Social and Behavioral Sciences, 86*, 373–378. doi: 10.1016/j.sbspro.2013.08.582

Logothetis, N. K. (2008). What we can do and what we cannot do with MRI. *Nature, 453*, 869–878. doi: 10.1038/nature06976

Lorenz, K. (1998). *Oborotnaya storona zerkala* [Behind the mirror, a search for a natural history of human knowledge]. Moscow: Respublika.

Losin, E. A. R., Iacobony, M., Martin, A., Cross, K. A., & Dapretto, M. (2012). Race modulates neural activity during imitation. *NeuroImage, 59*, 3594–3603. doi: 10.1016/j.neuroimage.2011.10.074

Martin, A., Wiggs, C. L., & Weisberg, J. (1997). Modulation of human medial temporal lobe activity by form, meaning and experience. *Hippocampus, 7*(6), 587-593. doi: 10.1002/(SICI)1098–1063(1997)7:6<587::AID-HIPO1>3.0.CO;2-C

Men'shikova, G., Kovalev, A., Klimova, O., Chernorizov, A., & Leonov, S. (2014). Testing the vestibular function development in junior figure skaters using the eye tracking technique. *Procedia – Social and behavioral sciences, 146*, 252–258. doi: 10.1016/j.sbspro.2014.08.123

Mezzich, J. E., Zinchenko, Y. P., Krasnov, V. N., Pervichko, E. I., & Kulygina, M. A. (2013). Person-centered approaches in medicine: clinical tasks, psychological paradigms, and post-nonclassic perspective. *Psychology in Russia: State of the Art, 6*, 95–109. doi: 10.11621/pir.2013.0109

Millar, P. R., Serbun, S. J., Vadalia, A., & Gutchess, A. H. (2013). Cross-cultural differences in memory specificity. *Culture and Brain, 1*(2–4), 138–157.doi: 10.1007/s40167-013-0011-3

Mitchell, G. P., Macrae, C. N., & Banaji M. R. (2006). Dissociable medial prefrontal contributions to judgments of similar and dissimilar others. *Neuron, 50*, 655–663. doi: 10.1016/j.neuron.2006.03.040

Muhlberger, A., & Pauli, P. (2011). Virtuelle realität in der psychotherapie [Virtual reality in psychotherapy]. *PiD – Psychotherapie im Dialog, 12*(2), 143–147. doi: 10.1055/s-0031-1276816

Ng, S. H., Han, S., Mao, L., & Lai, J. C. L. (2010). Dynamic bicultural brains: fMRI study of their flexible neural representation of self and significant others in response to culture primes. *Asian Journal of Social Psychology, 13*, 83–91. doi: 10.1111/j.1467-839X.2010.01303.x

Palmer, J., & Palmer, L. (2003). *Evoluzionnaya psihologiya. Sekrety povedeniya Homo sapiens* [Evolutionary psychology. Secrets of Behavior of Homo sapiens]. Saint Petersburg: Preim-EVROZNAK; Moscow: OLMA-PRESS.

Pervichko, E. & Zinchenko, Y. (2014). Epa-0571 — postnonclassical methodology in modern psychiatry and clinical psychology: Opportunities and perspectives. *European Psychiatry, 29*(1), 1. doi: 10.1016/S0924-9338(14)77961-1

Phelps, E. A., O'Connor, K. J., Cunningham, W. A., Funayama, E. S., Gatenby, J. C., Gore, J. C., & Banaji, M. R. (2000). Performance on indirect measures of race evaluation predicts amygdala activation. *Journal of Cognitive Neuroscience, 12*, 729–738. doi: 10.1162/089892900562552

Pöppel, E., & Bao, Y. (2011). Three modes of knowledge as basis for intercultural cognition and communication: A theoretical perspective. In Sh. Han & E. Pöppel (Eds), *Culture and Neural Frames of Cognition and Communication* (pp. 215–231). Heidelberg: Springer-Verlag. doi: 10.1007/978-3-642-15423-2_14

Pribram, K. (1975). *Yazyki mozga* [Languages of the Brain]. Moscow: Progress.

Ramachandran, V. (2014). *Mozg rasskazyvaet, chto delaet nas lud'mi* [The brain tells us what makes us humans]. Moscow: Kariera Press.

Richeson, J. A., Baird, A. A., Gordon, H. L., Heatherton, T. F., Wyland, C. L., Trawalter, S., & Shelton, N. J. (2003). An fMRI investigation of the impact of interracial contact on executive function. *Nature Neuroscience, 6*, 1323–1328. doi: 10.1038/nn1156

Rilling, J. K., Dagenais, J. E., Goldsmith, D. R., Glenn, A. L., & Pagnoni, G. (2008). Social cognitive neural networks during in-group and out-group interactions. *NeuroImage, 41*, 1447–1461. doi: 10.1016/j.neuroimage.2008.03.044

Rizzolatti, M. A., & Sinigilia, K. (2012). *Zerkala v mozge* [Mirrors in the Brain]. Moscow: Yazyki slavyanskih kultur.

Rule, N. O., Freeman, J. B., Moran, J. M., Gabrieli, J. D. E., Adams, R. B. Jr., & Ambady, N. (2010). Voting behavior is reflected in amygdala response across cultures. *SCAN, 5*, 349–355. doi: 10.1093/scan/nsp046

Selisskaya, M. A., Vojskuskij, A. E., Ignatiev, M. B., & Nikitin, A. V. (2004). Primenenie virtual'noy real'nosti v kachestve psihoterapevticheskogo sredstva dlyz pomoshchi stradayushchim ot psihologicheskih fobij [The use of virtual reality as a psychotherapeutic means to help humans suffering from psychological phobias. Research project]. In *Tehnologii informazionnogo obshchestva — Internet i sovremennoe obshchestvo: Trudy VII Vserossijskoj obedinennoj*

konferentsii [Technologies of Informational Society — Internet and the Contemporary Society. Proceedings of the VII Russian Conference] (10–12 November). Saint Petersbirg.

Shaiguerova, L., & Soldatova, G. (2013). Long-term impact of terrorist attack experience on survivors emotional state and basic beliefs. *Procedia — Social and Behavioral Sciences, 86*, 603–609. doi: 10.1016/j.sbspro.2013.08.621

Shekhter, E. D., & Chernorizov, A. M. (2011). Sotsial'naya psihofiziologiya [Social psychophysiology]. In Yu.I. Aleksandrov (Ed.), *Psihofiziologiya* [Psychophysilogy]. (pp. 419–437). Saint Petersburg: Piter.

Shkurko, A. V. (2012). Role behavior: A neurosociological perspective. *Social Science Information, 51*(3), 338–363. doi: 10.1177/0539018412441751

Sokolov, E. N. (2008). *Ocherki po psihofiziologii soznaniya* [Essays on Consciousness]. Moscow: Moscow University Press.

Soldatova, G. V., & Shaigerova, L. A. (2002). Psikhologicheskaya adaptatsiya vynuzhdennykh migrantov [Psychological adaptation of forced migrants]. *Psikhologicheskii zhurnal [Psychological Journal], 23*(4), 8–28.

Soldatova, G. V., Shaigerova, L. A., & Shlyapnikov, V. (2008). Psikhologicheskie posledstviya terroristicheskogo akta: opyt Beslana [The psychological effects of a terrorist attack: the experience of Beslan]. *Psikhologicheskii zhurnal [Psychological Journal], 30*(6), 15–26.

Soldatova, G. V., Nestik, T., & Shaigerova, L. A. (2011). Printsipy konstruirovaniya tolerantnosti i upravleniya riskami ksenofobii [Design principles of tolerance and risk management xenophobia]. *Natsional'nyj Psihologicheskij Zhurnal [National Psychological Journal], 2*(6), 60–80.

Soldatova, G. V., Zinchenko, Yu. P., & Shaigerova, L. A. (2011). Terroristicheskii akt kak ekstremal'naya situatsiya v obshchestve riska [An act of terrorism as an extreme situation in the risk society]. *Natsional'nyj Psihologicheskij Zhurnal [National Psychological Journal], 2*(6), 98–112.

Soldatova, G. V., & Shaigerova, L. A. (2015). Refleksiya mnozhestvennosti vybora v psikhologii mezhkul'turnykh kommunikatsii [Reflection of multiple choice in the psychology of crossr-cultural communication]. *Psikhologicheskie issledovaniya, 8* (40), 10. Retrieved from: http://psystudy.ru

Thill, S., Svensson, H., & Ziemke, T. (2011). Modeling the development of goal-specificity in mirror neurons. *Cognitive Computation, 3*(4), 525–538. doi: 10.1007/s12559-011-9108-1

Van Bavel, J. J., Packer, D. J., & Cunningham, W. A. (2008). The neural substrates of in-group bias: A functional magnetic resonance imaging investigation. *Psychological Science, 19*, 1130–1138. doi: 10.1111/j.1467-9280.2008.02214.x

Van Overwalle, F. (2009). Social cognition and the brain: A meta-analysis. *Human Brain Mapping, 30*, 829–858. doi: 10.1002/hbm.20547

Vojskuskij, A. E., & Menshikova, G. Ya. (2008). O primenenii system virtual'noj real'nosti v psihologii [On using virtual reality system in psychology]. *Vestnik MSU. Seriya 14. Psihologiya [Moscow University Psychology Bulletin], 1*, 22–36.

Volz, K. G., Kessler, T., & von Gramon, Y. D. (2009). In-group as part of the self: In-group favoritism is mediated by medial prefrontal cortex activation. *Social Neuroscience, 4*, 244–260. doi: 10.1080/17470910802553565

Vrticka, P., Andersson, F., Sander, D., & Vuilleumier, P. (2009). Memory for friends or foes: The social context of past encounters with faces modulates their subsequent neural traces in the brain. *Social Neuroscience, 4*, 384–401. doi: 10.1080/17470910902941793

Wangbing, Sh., Chang, L., & Yuan, Y. (2011). Social cognitive neuroscience perspective for unification psychology. *Psychology, 2*(8), 841–845. doi: 10.4236/psych.2011.28128

Westen, D., Blagov, P. S., Harenski, K., Kilts, C., & Hamann, S. (2006) Neural bases of motivated reasoning: An fMRI study of emotional constraints on partisan political judgment in the 2004 U.S. presidential election. *Journal of Cognitive Neuroscience, 18*, 1947–1958. doi: 10.1162/jocn.2006.18.11.1947

Wiederhold, B. K., & Rizzo, A. (2005). Virtual reality and applied psychophysiology. *Applied Psychophysiology and Biofeedback, 30*(3), 183–185. doi: 10.1007/s10484-005-6375-1

Wilson, E. O. (1976). *Sociobiology: The New Synthesis*. Cambridge, MA: Belknap Press.

Wilson, E. O. (2015). *Smysl sushchestvovaniya cheloveka* [The meaning of human existence]. Moscow: Alpina non-fiction.

Xu, X., Zuo, X., Wang, X., & Han, S. (2009). Do you feel my pain? Racial group membership modulates empathic neural responses. *Journal of Neuroscience, 29*, 8525–8529. doi: 10.1523/JNEUROSCI.2418-09.2009

Zhang, X., Ordocez de Pablos, P., & Xu, Q. K. (2014). Culture effects on the knowledge sharing in multi-national virtual classes: A mixed method. *Computers in Human Behavior, 31*, 491–498. doi: 10.1016/j.chb.2013.04.021

Zhou, H., & Cacioppo, J. (2010). Culture and the brain: Opportunities and obstacles. *Asian Journal of Social Psychology, 13*, 59–71. doi: 10.1111/j.1467-839X.2010.01302.x

Zinchenko, Yu. P. (2011). Security psychology as social systemic phenomenon. *Psychology in Russia: State of the Art, 4*, 307–315. doi: 10.11621/pir.2011.0010

Zinchenko, Yu. P, Shaigerova, L. A., Shilko, R. S. (2011). Psikhologicheskaya bezopasnost' lichnosti i obshchestva v sovremennom informatsionnom prostranstve [Psychological safety of a person and society in the modern information space]. *Natsional'nyj Psihologicheskij Zhurnal [National Psychological Journal], 2*(6), 48–59.

Zinchenko, Yu. P., & Pervichko, E. I. (2012 a). The methodology of syndrome analysis within the paradigm of "qualitative research" in clinical psychology. *Psychology in Russia: State of the Art, 5*, 157–184. doi: 10.11621/pir.2012.0010

Zinchenko, Yu. P., & Pervichko, E. I. (2012 b). Postneklassicheskaja metodologija v klinicheskoj psihologii: Nauchnaja shkola L. S. Vygotskogo–A. R. Lurija [Postnonclassical methodology in clinical psychology: Vygotsky-Luria school]. *Nacional'nyj Psihologicheskij Zhurnal [National psychological journal], 2*(8), 42–49.

Zinchenko Y. P., & Pervichko E. I. (2013). Nonclassical and Postnonclassical epistemology in Lev Vygotsky's cultural-historical approach to clinical psychology. *Psychology in Russia: State of the Art, 6*, 43–56. doi: 10.11621/pir.2013.0104

Zinchenko, Yu. P. (2014). Extremism from the perspective of a system approach. *Psychology in Russia: State of the Art, 7*(1):23–33. doi: 10.11621/pir.2014.0010

ZinchenkoYu, P., & Zotova, O. (2014). Security in the worldview of Russians. *Psychology in Russia: State of the Art, 7*(1), 50–61. doi: 10.11621/pir.2014.0010

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