

Analysis of Cultural Identity with The Help of Neurotechnologies

Mishina Anna Sergeevna

Faculty of Economics, Moscow State University; The Russian Presidential Academy of National Economy and Public Administration (RANEPA), Moscow, Russia; Intern Researcher of the All-Russian Public Organization "Russian Association for the Promotion of Science", Moscow, Russia.

ABSTRACT

The article discusses modern approaches to the study of cultural identity using neurotechnologies such as electroencephalography (EEG) and functional magnetic resonance imaging (fMRI). Examples of studies that demonstrate differences in neural activity across cultures, including perceptions of values, cognitive processes, and emotional responses, are described. The results show how culture influences brain activity, shaping differences in perception and behaviour. The integrative and disintegrative aspects of cultural identity are also discussed, and the potential application of the research to fields such as neuroeconomics, cross-cultural management, and social policy.

*Corresponding author

Mishina Anna Sergeevna, Faculty of Economics, Moscow State University; The Russian Presidential Academy of National Economy and Public Administration (RANEPA), Moscow, Russia; Intern Researcher of the All-Russian Public Organization "Russian Association for the Promotion of Science", Moscow, Russia.

Received: January 18, 2025; **Accepted:** January 21, 2025; **Published:** February 05, 2025

Keywords: Cultural Identity, Neurotechnology, Electroencephalography (EEG), Functional Magnetic Resonance Imaging (fMRI), Cultural Values, Cognitive Processes, Cross-Cultural Research, Neurophysiology, Integration Potential, Cultural Contexts, Emotional Reactions, Intercultural Dialogue, Neuroeconomics

Introduction

Cultural identity is a person's awareness of belonging to a certain cultural community, formed through interaction with cultural patterns and traditions. In the context of globalisation, when cultural boundaries are becoming more and more blurred, the study of cultural identity is of particular relevance. Modern technologies, including neurotechnology, Artificial Intelligence and machine learning, provide new tools for analysing and understanding this phenomenon.

Cultural identity as a concept is formed through the interaction and mutual enrichment of various cultural influences and is a complex process conditioned by many factors. As notes, 'cultural identity is the core of traditional culture, as well as a multifaceted and multifunctional phenomenon' [1]. It includes elements of ethnic identity, historical memory and traditions that are transmitted from generation to generation. Cultural identity has a significant integration potential. In a multipolar world, it can serve as a basis for the formation of dialogue between cultures. As notes, 'globalisation contributes to the growth of the mobilisation potential of local cultural identities' [2]. This interaction makes it possible to create new forms of cultural dialogue that support the disclosure of the national identity of each of its participants.

Cultural identity is also considered as an important component of the self-consciousness of the people in the context of globalisation. Global processes pose a threat of losing the uniqueness of cultural traditions. In this context, modern technologies can play a key role in realising and maintaining national identity, understanding the differences in the built-in response mechanisms of each culture.

This article discusses the main aspects of cultural identity and methods of its study using modern technologies, as well as the integrative and disintegrative potential of identity in the context of global challenges. Examples of using modern technologies to detect cultural differences and to analyse values at the neurophysiological level are presented, and two studies conducted by the authors of the article on comparing values between Russian and Chinese speakers are described.

Neurotechnologies as a Tool for Studying Cultural Identity

Modern technology opens new horizons for the study of cultural identity. state: 'Neurotechnologies can be used to analyse and shape cultural values' [3]. From the business point of view, their use allows revealing how different cultures perceive brands and products, and how the peculiarities of this perception influence the formation of identity.

Considers culture as a set of supra-biological programmes of human life activity, performing in society a role similar to the role played by genetic codes in the life of biological organisms [4]. However, today neurotechnologies make it possible to study cultural differences not only at the suprabiological level of social manifestations, but also at the level of neurophysiological reactions. Technologies such as electroencephalography (EEG) and functional magnetic resonance imaging (fMRI) make it possible to trace peculiarities of cognitive response patterns, neural reactions, and emotional perception in terms of brain activity. EEG is a non-invasive technique that measures the electrical activity of the brain using electrodes placed on the scalp. It provides high temporal resolution, making it suitable for studying dynamic cognitive processes. Studies using EEG have shown that cultural values can influence cognitive styles, emotional processing and decision-making. fMRI measures brain activity by detecting changes in blood flow, providing insight into the spatial localisation of brain function. This technique has played a key role in understanding how cultural context shapes cognitive processes related to values.

Studies using fMRI identify specific brain regions associated with value judgements that are influenced by cultural norms.

The results of numerous studies confirm that culture does indeed affect neural activity and the arrangement of brain structures in different ways. Regardless of the individual, their brain 'adjusts' to the culture in which they live, thereby contributing to their cultural identity. Below are a few examples from the literature to understand how neurotechnologies allow us to comprehend the interconnectedness and intertwining of identity vectors in different cultural and value dimensions. Such knowledge allows us to better understand the peculiarities and dynamics of the processes of constructing national and cultural identity.

The Brains of Different Cultures are Structured Differently: Examples

EEG-fMRI technology has been repeatedly used to study inter-brain synchronisation during social interactions to reveal how cultural differences manifest themselves in real-time communication between people. Chinese researchers conducted a literature review and systematised experiments on the analysis of brain rhythms during group or interpersonal interactions. The authors emphasise the role of shared cultural experience in shaping neural synchrony during social interaction - speakers of Eastern and Western cultures show different patterns of brain activity during social cognitive tasks. For example, East Asians tend to show stronger activation in the dorsal medial prefrontal cortex (DMPFC) and temporoparietal junction (TPJ), which are associated with understanding the mental state of others and regulating emotions. In contrast, Western cultures show greater activation of the anterior cingulate cortex (ACC) and ventromedial prefrontal cortex (vmPFC), which are associated with processing self-reference and emotional reactions.

Cultural self-esteem - how people perceive themselves in relation to others - also significantly affects inter-brain synchronisation. Research suggests that members of collectivistic cultures may show greater synchronisation in brain regions associated with social cognition when performing group-oriented tasks. In contrast, members of individualistic cultures showed greater brain rhythm coherence in areas related to personal relevance and individual decision making. Cultural norms regarding stress and emotional expression are also related to brain activity - in particular, differences are evident in areas responsible for emotional regulation. For example, carriers of cultures where suppression of emotions is considered the norm showed increased activity in ACC (Anterior Cingulate Cortex), which is one of the components of the emotion control system.

Studies have also shown that Americans and East Asians differ in their neural correlates in memory encoding tasks. Americans tend to have stronger activation of the right spindle gyrus for specific memory formation, while East Asians show greater activation of the left spindle gyrus and left hippocampus for general memory encoding. These differences indicate the importance of cultural factors not only on what information is remembered, but also on how it is processed at the neural level. In addition, East Asians show stronger connections between the left anterior part of the parahippocampal gyrus and temporal regions, while Americans showed stronger connections to frontal regions during social tasks. However, in general, synchrony in the theta and alpha bands was observed in both cultures during the performance of joint tasks.

The activation of individual brain regions during social interactions is caused, among other things, by cultural differences in interpreting one's own actions, decisions, emotional reactions and their consequences for oneself and others. This affects such behaviours as cooperation or competition, which are critical for processes of cultural integration or disintegration. Representatives of collectivistic cultures may show more pronounced activity in brain areas related to social thinking when making decisions affecting group well-being compared to representatives of individualistic cultures. Eastern cultural contexts emphasise ideas and practices of interaction, while Western cultural contexts emphasise independence.

Initially, these cultural differences were initially considered only in terms of social relations, but subsequent research has shown that they are also applicable to the performance of simple perceptual judgements. For example, Italian researchers compared reactions to commercial commercials for carbonated drinks between Chinese and Italians. It turned out that the Chinese group was more attentive to collective scenes, while the Italian group was more attentive to scenes with only one actor. The analyses focused on prefrontal cortex activity during viewing. In the Italian group attention to the singer was significantly higher, it remained high also in scenes with interpersonal interaction between two people and frames where the brand itself was presented, while the Chinese were more focused on scenes with group interaction, in frames with the brand logo attention was not as high as in the Italians.

Rare structural features of the brain are conditioned by culture from birth - a significant part of them is formed already in the process of adaptation to the factors of this or that culture - language, social practices, etc. Differences in educational systems can also be reflected in neurocorrelates. For example, studies comparing the performance of adolescents from Brazil and Germany on mind-shifting tasks showed that differences in performance were related to differences in educational systems rather than innate cognitive processing speed. In general, education plays a key role in the formation and maintenance of cultural identity. Modern educational technologies can contribute to the transmission of knowledge about culture and traditions to the next generations. It is important to introduce programmes that focus on the values of local culture and contribute to its preservation. As notes, 'educational systems should take into account the specificity of local cultures to form a stable identity in young people'. This will help to create a more harmonious society where different cultures will coexist on the basis of mutual respect.

Researchers from Leipzig also tried to find out whether language structure (syntax, morphology, phonetics) can influence neural structure. The study was conducted among Arabic and German speakers using diffusion-weighted fMRI (tractography), which made it possible to calculate the density of interaction between brain regions.

The results showed that Arabic-speaking participants in the experiment had more pronounced connectivity between the left and right hemispheres - a similar relationship was also observed for semantic language areas. It can be assumed that this brain structure was influenced by the very structure of the Arabic language, which has a rather complex semantic-phonological structure that requires deep processing. In turn, German speakers have stronger connectivity in the left hemisphere language network, which may be due to the complexity of syntactic processing of their language with its loose word order and grammatically heavy sentences.

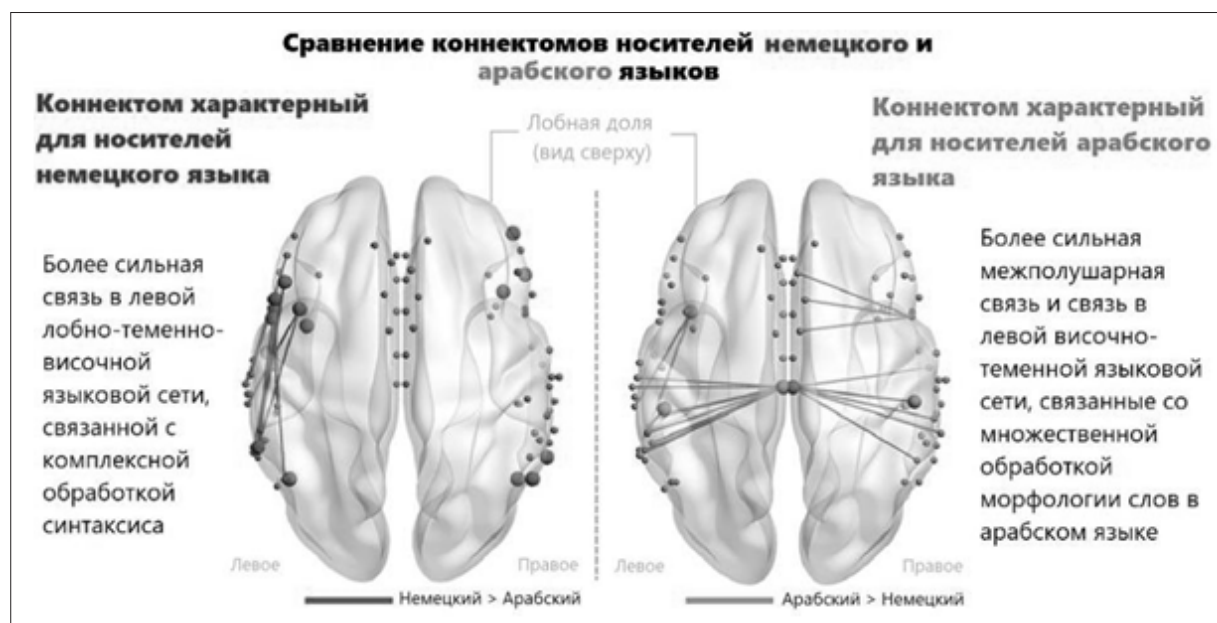


Figure 1: Comparison of Brain Structures of Native Speakers of German and Arabic [5].

Analysing Values Using Neurotechnology

One of the most important components of culture is the values shared by its bearers. Values play a key role in the formation of cultural identity. They serve as a basis for determining what is considered important and significant in the life of a person and society. According to 'personal values are both sources and carriers of meanings significant for a person'. Values not only influence the behaviour of individuals, but also shape their perception of themselves in the context of culture, attitude to other people and society as a whole. Cultural values can vary depending on the historical and social context. These differences influence the formation of stable qualities that make one sympathise or antipathise with certain cultural phenomena or people. Self-identification with certain values and norms of culture is the basis for the formation of individual and collective self-awareness.

The article by Italian authors discusses neural correlates associated with the 'like/dislike' reaction - with their help it is possible to draw conclusions about the 'localisation' of certain values in a person's head. EEG was used to compare the activity induced by viewing pleasant (the 'like' dataset) and unpleasant (the 'dislike' dataset) audiovisual content. Observations showed an increase in EEG activity in the theta band in the anterior regions of the left hemisphere. Brain activity is stronger in the 'Like' condition than in the 'Dislike' condition, with the exception of the beta band. The same article describes another 'cultural' experiment: using EEG spectral activity, it was proposed to assess the recognition of positive or negative hedonic values. By analysing EEG rhythms and tracking changes in the activity of certain structures associated with the processing and generation of emotions in humans (such as frontal and prefrontal cortex), it was possible to obtain some data on the emotional processing of certain messages. EEG spectral power analysis shows that the frontal hemispheres of the brain are lateralised differently with respect to motivational tendencies and emotions of 'appropriation' and 'rejection/rejection'. In particular, the left side of the prefrontal cortex mediates the desire to appropriate, to approach something, while the right side forms a component of the neural circuit conditioning the rejection of a less favoured option. On the basis of prefrontal asymmetry we can draw conclusions about whether a particular value attitude is close to a person.

Experiments Comparing Values Between Russians and Chinese People

Values can also be studied by means of semantic analysis of text arrays. The authors of this article recently conducted a study of the life values of Russian and Chinese residents: the samples were 887 and 559 questionnaires for each country. Participants were asked to name three words representing their free associations 'with something most important in life'. The word-association arrays were translated into English by an automatic translator, after which either the frequency of occurrence of individual words or the frequency of similar meanings, as determined using Roger's Thesaurus, were compared. The words 'family' and 'love' were the most frequent words in both samples, but the frequency of occurrence of these words, as well as most other words from the semantic core, differed significantly in each sample. Analysis at the level of semantic vectors showed that more than half of the meanings that Russian respondents called important and more than a third of the meanings important for Chinese respondents had significant differences in frequencies between the samples. There are 62 semantic groups of the Roger's thesaurus, the frequency of which is clearly different - these are the meanings on which the Chinese and Russian samples differ with regard to life values. There are also 26 semantic groups, the frequency of which is statistically similar and yet quite high in both samples - these are common meanings for both cultures. The results are published in the BRICS Journal of Economics - they allow us to expand the integration potential of identity, contribute to the strengthening of intercultural unity and harmony, as well as more effective cooperation between Russia and China.

Figure 1 shows the distribution of responses in the Russian and Chinese samples by age groups. The word clouds associated with each age group show the most frequent words that respondents used in their native language to express associations with something 'most important in life'. In the Russian-language clouds, it can be seen that while the most frequent words ('family', 'love', 'health', etc.) occur in all age groups, their relative contribution varies by age. In Chinese clouds, this trend is even more pronounced: while in the 10-19 and 20-29 age groups, the words and 手机 ('study' and 'mobile phone') are among the top three words, in the older age groups, these words are not even in the top five, and family (the words 家庭 and 家人) come first.

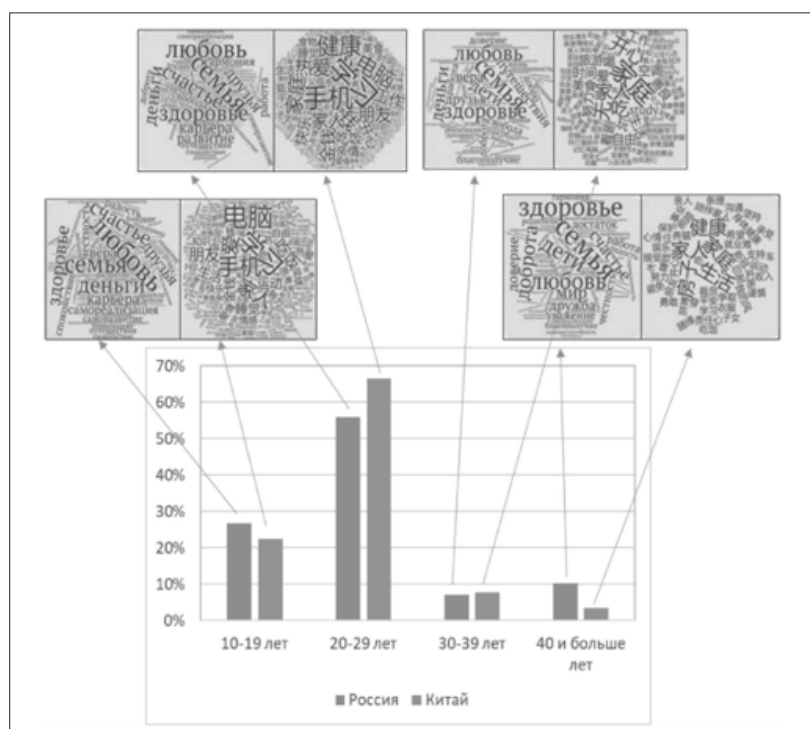


Figure 2: Distribution of Associations with 'The Most Important Thing in Life' in the form of Frequency Clouds in the Respondent's Native Language (Russian and Chinese) by Age Groups.

Source: Compiled by the Authors on the Basis of Survey Data

The collected text arrays about values were also used by the authors of the article in an experiment based on electroencephalography (EEG) technologies to analyse neurophysiological reactions to values in Russian and Chinese cultures. The study involved students from top universities - young people have a high integration potential due to their openness to new ideas and cultural practices. The

stimulus material consisted of two audio blocks: value words and neutral words. The fact of semantic distance between value words and non-value words was confirmed by the small value of cosine proximity of semantic vectors obtained from the corresponding arrays.

The interface and dynamic visualisation of brain signals run on Capsule software and are available even offline. The data obtained using the EEG hoop, were recorded and analysed in Excel format [6].

The results showed that Russians and Chinese respond differently to value stimuli, and within each culture it is possible to determine the degree of importance of value attitudes. The responses of Russians from Chinese differed at a significance level of $p < 0.05$. In general, the emotional response to value words was stronger than to neutral words. In addition, at least two metrics change differently in representatives of the two cultural groups with reliability at the level of $p < 0.1$ - Focus (Focus) and internal disagreement, excitement (Anger). Moreover, three metrics: Fatigue score (distracted attention), Relaxation index (state of calmness) and Stress (emotional excitement) reliably differ when listening to words with different semantic proximity to values ($p < 0.05$) - these indicators are higher when listening to a value block of words than when listening to a neutral one. In this way it is possible to identify which value attitudes really resonate with native speakers of the cultures. More detailed results of the analysis are being prepared for a separate publication.

The data obtained in the course of the experiment make it possible to specify what are the similarities and what are the differences in the perception of values between Russians and Chinese. This contributes to the formation of integration potential and can form the basis for further research in the field of neuroeconomics, cross-cultural management, and social policy. Moreover, knowing what values are really important to Russian youth on a neurophysiological level can strengthen the integration potential of Russian identity. Emphasising our common cultural and social values will create a more cohesive society. As notes, understanding the value meanings of a group can contribute to the formation of a unified identity [7-25].

Conclusion

Thus, cultural identity is an important aspect of human existence in the context of global challenges. Modern technologies provide new opportunities for its analysis, awareness and, as a consequence, maintenance and preservation. Finding cross-cultural differences in the neurocognitive perception of values, as well as emotional responses to values within the same culture, is important for many spheres of life, opening up a wide potential for interaction. The integrative potential of cultural identity can facilitate effective dialogue between cultures on both a narrower and global scale.

Reference

1. Taratorin EV (2020) Cultural identity as an important value-sense component of the self-consciousness of the people in the conditions of globalization, Culture in the Eurasian space: traditions and innovations 1: 4.
2. Demir Gökhan (2021) Globalized World: Cultural Diversity,

- Identity and Dialogue of Cultures, Zhytomyr State University named after I. Franko. I. Franko.
3. Andreiuk DS, Mishina AS (2024) Neuromarketing technologies as a factor of human modification: from consumer behaviour to cultural code, Social innovations and social sciences: a view from Moscow 1: 28-48.
 4. Stepin VS (2019) Human, Activity, Culture. St Petersburg: SPbGUP Publ: 800.Stepin VS (2019) The Mystery of the Long Journey..., National Academy of Sciences of Belarus, Institute of Philosophy, comp. Danilov AN (2019) Minsk: Belarускаia navuka Publ 286.
 5. Xuehu Wei, Helyne Adamson, Matthias Schwendemann, Tomás Goucha, Angela Friederici D, et. (2023) Native language differences in the structural connectome of the human brain, *NeuroImage*, 270: 119950-119955.
 6. Neiry Group (2024) <https://neiry.ru/>.
 7. Mishina A, Andreyuk D, Xu W (2024) Life values in Russia and China: Semantic analysis and comparison. *BRICS Journal of Economics* 5: 141-162.
 8. Andreiuk DS, Livitina AS, Sushko NS (2022) Semantic analysis of the group value structure using Roger's Thesaurus: automated algorithm. *Public Administration: electronic bulletin* https://www.researchgate.net/publication/360845620_Semantic_Analysis_of_Group_Values_Structure_Using_Roget_Thesaurus_Automated_Algorithm.
 9. Gerasimenko VV (2021) Ideology of conscious consumption and perception of brand values. *Scientific research of the Faculty of Economics: electronic journal*.
 10. Danilov A (2024) Cultural diversity in the global ethno-political space. *Political Expertise: Politex* 20: 86-94.
 11. Okhotnikova EA (2016) The influence of cultural and value orientations on the formation of ethnic identity, *Scientific and methodological electronic journal* 11: 1716-1720.
 12. Chernigovskaya TV (2021) Brain, language and consciousness. AST Publishing House
 13. Davidson RJ, Irwin W (1999) The functional neuroanatomy of emotion and affective style. *Trends in Cognitive Sciences* 3: 11-21.
 14. Davidson RJ (2000) Affective style, psychopathology, and resilience: brain mechanisms and plasticity. *American Psychologist* 55: 1196-1214.
 15. Davidson RJ (2002) Anxiety and affective style: role of prefrontal cortex and amygdala. *Biological Psychiatry* 51: 68-80.
 16. Davidson RJ (2004) What does the prefrontal cortex 'do' in affect: perspectives on frontal EEG asymmetry research. *Biological Psychology* <https://pubmed.ncbi.nlm.nih.gov/15130532/>.
 17. Hollunder B, Ostrem JL, Sahin IA (2024) Mapping dysfunctional circuits in the frontal cortex using deep brain stimulation. *Nat Neurosci* 27: 573-586.
 18. Jansen P, Paes F, Hoja S, Machado S (2019) Mental Rotation Test Performance in Brazilian and German Adolescents: The Role of Sex, Processing Speed, and Physical Activity in Two Different Cultures. *Front Psychol* <https://www.frontiersin.org/journals/psychology/articles/10.3389/fpsyg.2019.00945/full>
 19. Knyazev GG, Merkulova EA, Savostyanov AN, Bocharov AV, Saprigyn AE (2018) Effect of Cultural Priming on Social Behavior and EEG Correlates of Self-Processing. *Front Behav Neurosci* <https://pmc.ncbi.nlm.nih.gov/articles/PMC6186948/>.
 20. Markus HR, Kitayama S (1991) Culture and the self: implications for cognition, emotion, and motivation. *Psychological Review* 98: 224-253.
 21. Paige LE, Ksander JC, Johndro HA, Gutchess AH (2017) Cross-cultural differences in the neural correlates of specific and general recognition. *Cortex* 91: 250-261.
 22. Triandis HC, Bontempo R, Villareal MJ, Asai M, Lucca N (1988) Individualism and collectivism: cross-cultural perspectives on self-ingroup relationships. *Journal of Personality and Social Psychology* 54:323-338.
 23. Vecchiato G, Astolfi L, De Vico Fallani F, Toppi J, Aloise F, et. (2011) On the use of EEG or MEG brain imaging tools in neuromarketing research. *Comput Intell Neurosci* <https://pmc.ncbi.nlm.nih.gov/articles/PMC3180786/>.
 24. Vecchiato G, Astolfi L, Fallani FDV (2010) Changes in brain activity during the observation of TV commercials by using EEG, GSR and HR measurements. *Brain Topography* 23: 165-179.
 25. Zhang W, Andrews-Hanna JR, Mair RW (2022) Functional connectivity with medial temporal regions differs across cultures during post-encoding rest. *Cognition Affect Behav Neurosci* 22: 1334-1348.