Dialogical Structure of the Brain and the Ternary System of the Mind: The Neurosemiotics of Yuri Lotman

Диалогическая структура мозга и троичная система психики: нейросемиотика Юрия Лотмана

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Opinion

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ABSTRACT

Yuri Lotman (1922–1993) was a semiologist, literary critic, and cultural historian from Soviet Russia. He is credited with founding the multidisciplinary Tartu-Moscow School of Semiotics. As a cultural theorist and humanist, he was highly influential across many fields, but his contributions to theories about the brain as a semiotic system have often been overlooked.

Topics such as the asymmetry of the brain hemispheres, the "untranslatable" specialization of their respective "languages", interhemispheric dialogue, and the unity of consciousness were frequent subjects of discussion within the scientific community that formed around the multidisciplinary Tartu-Moscow (and Leningrad) group. Recently, scholars such as E. Andrews and T.V. Chernigovskaya have highlighted the influence and relevance of the "neurosemiotic" model proposed by Yu.M. Lotman in the late 1970s. However, our impression is that a fundamental aspect, which Yu.M. Lotman considered indispensable for the functioning of any "thinking system", has been overlooked in the application of this model to contemporary studies of neurophysiology. This aspect is the intersemiotic translation device that Yu.M. Lotman calls the "semiotic boundary". We can consider this as a "third" structure of intersection between the two hemispheres, which actively operates to translate specialized information systems reciprocally. In this paper, we will attempt to restore its significance according to an interpretation updated to the most recent discoveries in cognitive neuroscience.

АННОТАЦИЯ

Юрий Михайлович Лотман (1922–1993) — советский семиотик, литературовед и культуролог. Ему приписывают основание междисциплинарной Тартуско-московской семиотической школы. Как теоретик культуры и гуманист, он оказал большое влияние на многие области человеческого знания, но его вклад в теории о головном мозге как семиотическом устройстве часто отходит на второй план.

Такие темы, как асимметрия полушарий головного мозга, «непереводимая» специализация используемых ими «языков», межполушарный диалог и единство сознания, были частыми предметами обсуждения в научной среде, сформировавшейся вокруг междисциплинарной московско-тартуской (и ленинградской) группы. В работах последних лет ученые Э. Эндрюс и Т.В. Черниговская заострили внимание на актуальности нейросемиотической модели Ю.М. Лотмана, которая зародилась еще в конце 1970-х годов. Однако сложилось впечатление, что при применении этой модели в современных нейрофизиологических исследованиях был упущен из виду фундаментальный аспект, который Ю.М. Лотман считал неотъемлемым в функционировании любой «мыслящей системы». Этот аспект представляет собой средство интерсемиотического перевода, называемое Лотманом «семиотической границей». Его можно рассматривать как «третью» структуру пересечения двух полушарий, активно работающую над двусторонним переводом специализированных информационных систем. В настоящей статье мы попытаемся восстановить его значение, опираясь на интерпретацию, обновленную с учетом последних открытий в области когнитивной нейронауки.

Keywords: *Yuri Lotman; hemispheric asymmetry; multimodal semiotics; semiotic boundary*
Ключевые слова: *Юрий Лотман; межполушарная асимметрия; мультимодальная семиотика; семиотическая граница*

A "NEUROSEMIOTIC" MODEL

Tatiana Chernigovskaya in [1] revisited theoretical framework of Yuri Lotman, highlighting the generative role of "noise" in semiosis as a dynamic force stemming from the asymmetry of the cerebral hemispheres. She interprets noise not as an obstacle to communication, as in Jakobson's classical model [2], but as a creative tension fostering new meanings through the interplay of the hemispheres' distinct cognitive styles [3]. While my approach builds upon Lotman's dialogism and the semiotic potential of hemispheric asymmetry, it diverges by introducing the concept of *semiotic boundary*, which Yu.M. Lotman originally used in cultural analysis but largely overlooked in neuroscience. Here, the semiotic boundary is not merely a site of tension but an active mediator, translating and integrating the "languages" of the left and right hemispheres. By reframing Lotman's insights, this paper proposes a novel explanation of interhemispheric communication as a structured process generating cohesive cognitive and cultural outputs.

In the article by Tatyana Chernigosvkaya [4], it is mentioned that Yuri Lotman delivered a significant lecture at a seminar in Tartu in 1981, focusing on the "problem of semiogenesis and the functional specialization of the brain hemispheres as a model of intellectual processes". The researcher, who was present at the event, recalls that this seminar was an important platform for discussing experimental findings from the *Laboratory of Functional Asymmetry of the Human Brain* (Institute of Evolutionary Physiology, Russian Academy of Sciences) [4]. Reflecting on these discussions 40 years later, Tatyana Chernigovskaya acknowledges Lotman's remarkable foresight in *conceiving the bipolar structure of the brain as a minimal semiotic unit*, anticipating by decades the neuroscientific discoveries on cerebral lateralization. Although "he did not speak directly about physiology", Yu.M. Lotman had intuited that the bipolarity of the hemispheres is not only a functional organization but also a key principle in the generation of meaning, applicable to both the brain and culture. Lotman's insights, T.V. Chernigovskaya emphasizes, remain highly relevant even today [1].

Thus, from the standpoint of cultural semiotics, we have a direct and remarkable testimony that not only did Yuri Lotman conceive his own neurocognitive theoretical model, but that it was held in high regard among Russian cognitive neuroscience researchers [5]. In the vast literature of criticism and commentary on Yuri Lotman, many complex cultural concepts such as the Semiosphere or the concept of "explosion" are interpreted in various ways, often neglecting that, even within the system of culture, the concept of "mind" was fundamental to Yu.M. Lotman. His central international compendium of writings is titled Universe of the Mind [6]. The subtitle of The Semiosphere is "Asymmetry and Dialogue in Thinking Systems" [7]. In theoretical interpretations, these concepts tend to disappear, despite Lotman's constant reiteration of the fundamental concept of his epistemology: the isomorphism between individual and the collective of minds, the latter understood as culture.

The "mind" of a culture, its collective consciousness, is the result of interaction between different languages that are often incomprehensible to each other (language but also dance, music, painting, and even fashions or everyday behavior). It is also the result of interactions with other cultures, which bring new languages and customs through exchanges, like an intersubjective exchange [8]. Yuri Lotman believed that the brain, as a semiotic system where sensory and cognitive information circulates in different patterns between the hemispheres, and between the individual mind and its interlocutor, operates according to the same mechanisms. In fact, as Yu.M. Lotman explained, semiotics as an autonomous discipline was born as the science of information [9]. From this position, the study of culture was integrated into the study of complex information systems and was interested in many scientific fields, including cybernetics and biological or physical systems. Semiotics sought to uncover the general laws governing complex systems [10]. In this context, Lotman's work on brain semiotics, particularly the concept of the "semiotic boundary" [6] as an interhemispheric translation device, plays a pivotal role in bridging the fields of semiotics and cognitive neuroscience.

KEY ARTICLE

The article "Kul'tura kak kollektivnyj intellekt i problemy iskusstvennogo razuma" (Culture as a Collective Mind and the Problems of Artificial Intelligence) is fundamental for understanding the multidisciplinary approach of Yuri

Lotman and the Tartu-Moscow group [10]. The Italian translation of this work was published in the same year in the proceedings of the annual international semiotics congress, in an edition that Yu.M. Lotman personally oversaw [11]. To introduce the problem of culture as a collective mind and as a model for instructing intelligent machines, Yuri Lotman begins with the formula of an immutable law of cybernetics, according to which "the stability of the system increases with the variability of its elements". This law also applies to the information processed and shared by the brain's hemispheres, which, to achieve homeostatic stability (unity of consciousness), must resolve their specificity and asymmetry through mutual exchange (dialogue). Observations made on cultural mechanisms highlighted that only humans were capable of processing data from experience into not only abstract concepts, but also new ideas, through dialogue with other individuals, groups, and cultures. These studies, which were also conducted by R. Jakobson [12], L.S. Vygotsky [13, 14], and V.V. Ivanov [15, 16], led Yu.M. Lotman to assert that the difficulties in translating languages did not block the circulation of information, but rather qualitatively transformed it, favoring the emergence of new texts and messages capable of reinterpreting new states of systems [1, 2, 17]. Translation between languages needed to be mediated by devices that were not reversible, term-by-term exchanges, but rather metaphorically elaborated, leaving space for idiosyncratic interpretations. Yu.M. Lotman believed that this was the true source of human semiotic creativity.

The brain operates in the same way, as inferred from the article [11], because an individual's creativity emerges from the ability to metaphorize otherwise untranslatable information, given that the codes of the respective hemispheres are specialized for very different functions. Yu.M. Lotman explains these concepts whenever he talks about the artistic abilities of poets, writers, painters, etc. [6]. The "new thought" that emerges through creative interhemispheric dialogue is not merely information added quantitatively to one or the other hemisphere. Here, we seem to discover the distinction Yu.M. Lotman identified between the brain and the mind: the mind exists as the qualitative emergence of an informational surplus "new" information generated by translations as metaphorizations, which arises from the joint work of the two hemispheres but is semiotized by humans in the texts of culture. This occurs in intersubjective relationships, in inter- and intra-cultural relations, and also in inner mental dialogue [6].

We think this hypothesis is of immense importance for current neurosemiotic studies, as it anticipates the issue raised by G. Tononi's Integrated information theory about consciousness in its "physical substrate": the more specialized the information of each brain hemisphere is, the more the total information requires integration at the metal-level of the global system [18]. While Tononi "solves" the problem through a mathematical formula that measures a certain quantity of integrated information required for the emergence of consciousness, Yu.M. Lotman proposes a qualitative model of extended consciousness, where cultural information exceeds biological information in the metasemiotic systems that are isomorphic to both individual and collective minds.

CONTINUOUS AND DISCRETE

The analogy of cultural asymmetry and brain structure asymmetry (also) implies the relationship between discrete languages and continuous languages and the problem of their reciprocal equivalence in texts based on them [11]. By continuous languages, the author refers to the language of painting, sculpture, architecture, or continuous sound, where "reading" does not occur by arranging elements along a temporal line, but rather where symbolic configurations appear as immediate, spatial, and timeless states. Discrete languages include natural language, writing, logical thought, articulated movement, and others in which the code is organized into segments oriented along a temporal line toward a result. For the study of these latter languages, Yu.M. Lotman observes, we have many tools of analysis, while for investigating continuous languages, we have none. "Among other things, their role (like that of right-hemisphere consciousness) is not secondary" [11]. What does the scholar mean by "right-hemisphere consciousness"? He evidently refers to the problem of inner dialogue. We know that the debate on this theme was vibrant during those years. V.S. Bibler [19] had written a paper on the "process of internal dialogism as a clash of radically different thinking logics" [1]. Meanwhile, V.V. Ivanov, considered the co-founder of Cultural Semiotics, was working on different forms of sensory processing on the different semiotic languages in the asymmetric brain [15]. If one were to design an artificial thinking machine, Yu.M. Lotman states, it would need to be equipped with a mechanism describable as an "infant consciousness block" or a "mythological birth mechanism" because *only the "polar opposition between texts formed in such a framework and those formed within*

the logical-discrete mechanism provides the metaphorism necessary for elaborating new communications" [11].

Let us attempt to penetrate Lotman's complex language. The concept of "infant consciousness block", if understood as the interruption of childhood psychological development following trauma in affective relationships, was a psychological condition described by the Italian child neuropsychiatrist Giovanni Bollea [20]. Although Yuri Lotman does not explicitly cite G. Bollea, his works had been widely known since the 1960s. This "block" manifests in children as difficulty in understanding and integrating their emotions, thoughts, and perceptions, leading them to retreat into a parallel reality that serves as a defense mechanism against emotionally painful self-experiences. The affected child avoids verbal communication, struggles to articulate their emotions, and fails to develop a coherent sense of self. As a result, they seek refuge in a fantasy world dominated by reassuring symbolic entities that provide an alternative to an intolerable reality. Lotman's concept may also be linked to disruptions in child-adult relationships, as explored by L.S. Vygotsky [14] in his notion of the "zone of proximal development (ZPD)", (as his interpretation of artistic thought), which describes the gap between what a child can achieve independently and what they can accomplish with guidance. So Yu.M. Lotman appears to be referring to a childlike mind that operates recurrently through images and symbols. As further confirmation of this interpretation, Yu.M. Lotman also discusses the "mythological birth mechanism" as a mode of narrative construction by symbols [6], where relationships between phenomena are considered not through logical connections but through associations in a magical-mythological continuum. Here, the reference can be aptly directed toward the concept of "savage thought" described by C. Lévi-Strauss, whom Yu.M. Lotman cites in the article along with M. Mauss. Thus, the world is read "like tarot cards", where the relationships between the figures provide the required information, rather than the order in which the cards are drawn or the spatial arrangements. For an extremely rational person (who heavily uses the left hemisphere), this "primitive" or "childish" language is utterly nonsensical (insane). To explain this incompatibility of thoughts, our semiologist guides us through one of his most elegant yet complex insights: (A thinking system) "can be defined as a mechanism that, in addition to intelligent behavior, possesses potential capacities for non-intelligent (insane) behavior, and thus can choose at any moment between the two opposite strategies" [11]. It is tacitly evident that in this study Yuri Lotman critiques the cybernetic theory of the "metaphorical brain" proposed by M.A. Arbib [21] (cited by Yuri Lotman in the article), according to whom there are no issues of dialogue and integration between the two hemispheres. For the same reason, Yu. Lotman would probably not have agreed with Arbib's theory of language learning [22] through imitation via embodied simulation [23] based on the discoveries related to mirror neurons [24], which the semiotician did not have the opportunity to know in time. We believe, instead, that he would have drawn different conclusions from the role of intermodal translation performed by mirror neurons, as we will propose below.

THE SEMIOTIC BOUNDARY AND THE BRAIN

A hypothetical mediation mechanism between the two hemispheres would functionally be located at the center of the polar-tension axis, not only maintaining the system's homeostatic balance but also bringing elements of the hemispheres' languages closer together in a shared field of tension. The further apart the two elements are on the axis, the more difficult it will be for them to be mutually translated. But it is precisely in this tension effort that the most effective metaphors are realized and the most unpredictable thoughts capable of sometimes "exploding" the order of a previous system and forcing its components to find a new balance for an effective renewal of thought [8]. These are phenomena that occur only in the conscious emerge, thinking activity of the individual, such as the "mad" thought of a physics genius or the unheard-of metaphors of a poet, which, in turn, can trigger sense-explosions leading to epochal renewals, such as historical artistic genres.

Lotman's semiotic boundary is a semiotic mediation structure described extensively in The Semiosphere [7]. In culture, it can be explained through various examples and one we propose is that of a mercantile border city where merchants and buyers from many languages meet, and are forced to understand each other in simple market exchanges. Not only can the languages be mutually incomprehensible, but so can the objects themselves, whose uses or artistic values may be unknown, thus complicating exchange values. In these cases, mediators, evaluators, customs officers, experts, bilinguals, etc., are essential to populate the border spaces, making possible a continuous enrichment mechanism for cultures, where the main exchanges are of new ideas and thoughts. However,

even this Samarkand has its own cultural conception of itself, emerging from the languages of power, institutions, dominant culture, and the nobility, shaping a widespread local sentiment. Thus, enveloping the spheres of semiotic interaction, a sphere emerges in which culture seeks to identify itself, in a self-description mechanism that, in constructing the "we", also defines the "others": foreigners, the marginalized, the uneducated.

Interhemispheric communication, even within an individual's consciousness, does not consist merely of input-output circulation but includes self-awareness that arises from metaphorical translations between discrete and continuous languages and would not be possible outside a world of intersubjective semiotic interactions.

THE INTERHEMISPHERIC METAPHORICAL TRANSLATION SYSTEM

It is natural to think of the interhemispheric boundary translation zones as analogous to the various brain commissures. We propose that these commissures collectively form a coherent interhemispheric translation zone. The functions of the corpus callosum were known to Lotman, thanks to the pioneering work of R. Myers, R. Sperry, and others on split-brain studies [25]. As previously mentioned, Russian neuroscience was highly advanced in the study of cerebral asymmetry and, thanks to the profound contributions of A.R. Luria, it also made significant progress in understanding the cognitive development and the systemic functions of the brain [26].

More recent studies suggest that the commissures are involved not only in pre-selecting messages but also in controlling balance, coordinating sensorimotor functions, and mediating proprioceptive signals [27]. This latter function is especially intriguing, as it seems to suggest a functional continuity with the other commissures.

We first examine the anterior commissure. The metaphorical interparietal dialogue, particularly in the interaction between the two inferior parietal lobules (IPL), has been studied in depth by Indian neuroscientist V.S. Ramachandran [28]. He noted that the IPL (both right and left) is a true hub for the integration and exchange of different sensory (visual, auditory, tactile) and motor languages [29]. The cross-modal interactions of these languages, depending on the qualitative interference of their components, allow the human mind to combine new ideas through metaphorization processes. In this way, the researcher formulates hypotheses about creative thinking, particularly in archaic Indian art. For example, the statues of the Indian deity Shiva with four arms do not represent monstrous humans but rather a being who, in his cosmic dance, dominates the heavens and the earth. The movement of the arms is what spins the cosmic wheel in which the figure is inscribed, according to the cycle of time. V.S. Ramachandran and E.M. Hubbard [30] hyphothesizes that this is a metaphorical way to merge the discrete language of sequential execution of individual gestures with the continuous language of holistic vision. The IPL is deeply involved in embodied simulation of movements and their mirrored understanding, to the point that this lobule is densely populated with mirror neurons.

The IPL, situated at the intersection of various specialized areas, according to the authors, selects and coordinates sensory and motor languages, laying the foundation for cognitive metaphorization. It is also involved in proprioception, which aligns with the function of the corpus callosum that we highlighted. Imaging studies have shown that neuronal activity in the right IPL increases when there is an incongruity between observed and executed movement, suggesting that this region is involved in internal control of posture, closely linked to the mirror neuron system [31].

Now, let's turn to the hippocampal commissure. The hippocampus is primarily known for its role in memory and spatial orientation, but its connections with other brain areas, including motor and sensory systems, make it important for regulating posture and balance, engaging the proprioceptive system [32]. Proprioception is the ability to perceive and recognize the position of the body and its parts in space without external sensory input (seeing oneself, being touched). The interconnection between the two parts of the hippocampus via the commissure allows bilateral integration of proprioceptive information from muscles, joints, and tendons. This proprioceptive function allows us to have an awareness of the body's totality in relation to the environment, such as when we must prepare for unexpected external reactions, where we do not yet know which muscles or joints will need to be activated. It also enables us to mentally reach the smallest muscles of the body, which are part of our embodied experience, and to consciously recall and sequentially execute all the gestures required for complex procedures like playing the piano [33].

If we place these two functions on a bipolar axis, the first will appear as a continuous, unarticulated vision,

suspended from goal-oriented action, like when we perceive danger or face a choice but do not yet know what to do. The second will appear as the execution of a proprioceptive program, studied segment by segment, as in a solo concert performance or competitive dance, where the subject focuses on each muscle and joint in the continuous feedback between perception and proprioception.

The proprioceptive system also allows us to internalize and become aware of the axial coordinates of movement [34]: back/forward and the maintenance of an upright posture, as well as the low/high axis that passes through the body's center of gravity. We become aware of these axes (as well as the right/left "balance") when the body moves toward an object of interest (goal-oriented procedure) or when the body "plays" with proprioceptive balance, such as when a child learns to stand and walk, or in the "wild" movements of dance [35]. Proprioception is perceived as both bilateral and lateral/subtle (as in fine manual work), making its function "third" in relation to hemispheric specializations. Because it is involved in intersubjective relationships through the mirror neuron system, proprioception lends itself to the role of an extended "collective proprioception", allowing an entire culture to order and share the meanings of its world. For example, the high/low axis hosts entire symbolic systems that vary across cultures, such as heaven/earth; divine/human, importance/futility, royalty/subjugation; prestige/disdain, and so on. This third, metaphorical-tensional function allows us to describe proprioception as a boundary or metaphorical filter for translation between perception and cognition.

CONCLUSION

In this article, we have proposed interpretations of some of Yuri Lotman's profound ideas, which could still shed light on current debates in cognitive neuroscience. The semiotic boundary, as part of a ternary structure of the brain-body system, should be understood as follows: the corpus callosum facilitates the transfer of already processed information, ready to be quickly implemented in the contralateral system, functioning as a pre-selection and mediated routing mechanism.

The anterior commissure modulates the tension between the two associative parietal lobes, regulating the selection of sensory and sensorimotor message exchanges. The hippocampal system regulates, via the commissure, the oscillation between static and dynamic proprioception and between body balance/imbalance. By recording new movements marked by emotional significance, it reinforces its importance for long-term memory. The translation system could be further supported by other commissures, such as the cerebellar vermis or the recently discovered interthalamic commissure. According to this vision, the two hemispheres communicate along the continuous/discontinuous axis as follows.

Information emitted by the left hemisphere on articulated segments of actions or sensory languages, passing through the boundary system, would be decomposed into symbolic units according to semantic configurations influenced by the environment. In these atemporal grids, each symbol derives meaning from immediate relationships with other symbols, based on topological and metaphorical criteria. A symbol can either fit into an already established cognitive configuration or demand new interpretive grids around its evocative power. These atemporal configurations of symbols would then present themselves to the opposite hemisphere as "nodes" for possible fragments of new, creative (or corrective) syntactic chains to be integrated into goal-oriented action.

Since the exchanged elements are "bent" toward a function not predicted by the natural behaviors of the species, this metaphorical distortion brings new ways for the mind to know or recognize the world. This is the key to human creativity. The structure of the mind is ternary because proprioceptive and cognitive consciousness functions as a metalinguistic layer above cerebral bilingualism. However, the individual mind cannot function unless it is immersed in broader systems, from intersubjectivity to culture and interculture. The semiosphere, as Yu. Lotman defines it, is a "system of systems".

While this work aims to provide a theoretical reflection on Yuri Lotman's ideas and their potential applications within the framework of cognitive neuroscience, we acknowledge its intrinsic limitations as a speculative endeavor. Specifically, the absence of empirical integration or practical evaluations stems from the independent position of the author, without access to research centers or laboratories capable of experimentally testing the proposed hypotheses. The arguments presented here are intended primarily to stimulate theoretical and interdisciplinary discussion, offering an interpretative model that necessitates further exploration and validation through empirical research. We encourage the scientific community to consider these insights as a starting point in future investigations that may examine the practical implications of the neurosemiotic

model and its potential contributions to understanding cognitive and cultural functioning.

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