BRAIN. Broad Research in Artificial Intelligence and Neuroscience
e-ISSN: 2067-3957 | p-ISSN: 2068-0473
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2026, Volume 17, Issue 1, pages: 194-216
Submitted: October 24th, 2025 | *Accepted for publication:* January 3rd, 2026

Causality in the Brain and AI During Information Processing: The Subjective Value of Information Drives the Physical Processes

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factor of a person's ability to identify the subjective value of information acts as an information-processing operator, that is, as a factor of controlling, determining (orchestrating) the information process. It was found that in the case of AI systems, it should also be considered that the reason and driver of the information process in them is, despite their entirely physical nature, the subjective value of those information processes, which is initiated by a person within the framework of biological or social values. Next, the general information -processing mechanism in neuronal networks of the human brain is described, which in this paper (using the well-known terms of Gazzaniga and Tononi) is called "Bottom-Up and Top-Down mechanism of integration of past experience (information) through subjectively active mental phenomena." Here it is argued that a General Theory of Brain Information Activity cannot be created without considering the functional role of mental phenomena in the brain. The point of view is advocated that, by embodying integrated experience through mental phenomena into the structure of voluntary motor acts, the human subject (agent) can change the surrounding physical world from states of an "undesired present" to states of a "desired future". And this, in turn, testifies to the deep functional and causal connection of physical processes and the psyche, pointing to the modelling (through the phenomenon of information) nature of the psychic. Based on this statement and considering the totally physical nature of modern AI systems, it is argued that the latter remain governed by the subjective values of a person (developer, programmer, and user). The very functional architecture of modern AI remains as a system of choosing one of the most probabilistically correct outputs ("answers", "decisions") on a continuum of combinatory possibilities of a specific technical device, but, in any case, through the subjective values of a person.

Keywords: *information; social values; networks; mental phenomena; networks; subjective evaluation; decision-making; mental phenomena; cognitive evaluation; perception and interpretation; "indifference" of physical causality with respect to biological and social values; causal ability of information; the ability to subjectively evaluate; Bottom-Up and Top-Down mechanism of information integration through mental phenomena; functional cooperation of subjective evaluation and freedom of choice during processing information; free choice of information on networks continuums; continuums of combinatory possibilities of a technical device.*

How to cite: Soloviov, O. Dyachenko, Y., Soloviov, S., & Litvinova, O. (2026). Causality in the brain and AI during information processing: The subjective value of information drives the physical processes. *BRAIN. Broad Research in Artificial Intelligence and Neuroscience*, *17*(1), 194-216. https://doi.org/10.70594/brain/17.1/14

1. Introduction

In modern science, *causality is* considered one of the key factors in the functioning of any self-organised structures (Farnsworth, 2025), whether artificially created or natural. Causality, in fact, underlies any process, including informational activity. Therefore, identifying the specificity of causal patterns during information processing in intellectually active systems is one of the most difficult problems of modern science, if only because the status of the phenomenon of information as a causal factor has hardly been discussed anywhere. Nevertheless, this problem appears most acutely in the science of brain information activity. Moreover, as shown in the work of Soloviov (2024), this problem of the effectiveness of information as a causal factor can be solved not only through functional analysis, as is usually done, but by causal inclusion of mental phenomena in the direct processing of information in the brain. On the other hand, it is well known that in any modern artificial intelligence system, due to its physical nature, only physical causality operates. But such causality is characterised by the fact that it always provides only one degree of freedom, which denies the possibility of freely manipulating, integrating information in a totally physical, non-semiotic, non-virtually functioning "environment". That is why, in this article, one of the main tasks will be to compare causality, which should happen within the logic of the information process, and which acts, firstly, in the brain through the mediation of psychic phenomena (Damasio, 1999; Soloviov, 2023; Soloviov, 2024; Giotakos, 2023) and, secondly, in electrical networks of AI.

This "eternal" problem has given rise to the inability of human thinking to explain many problems related to the nature of human existence, including the Mind-Body Problem, the Hard problem of consciousness, and the problem of the essence of the brain's informational activity. However, in our time, humanity has already accumulated knowledge that gives hope for overcoming this Rubicon. Thus, the body of knowledge underpinning the present study draws on several foundational theoretical frameworks in cognitive science and neuroscience, including Clark's (2015) treatment of uncertainty within theories of consciousness, Friston's (2012) dynamic causal modelling, Damasio's (1999) somatic marker hypothesis, Tononi's (2008) integrated information theory, Hills's (2019) account of the neuroprocesses underlying free will, and Giotakos's (2023) analysis of the intentionality of conscious processes.

Within neuropsychological frameworks, many researchers who have studied, or are currently studying the brain and the activity of mental phenomena have contributed to the interpretation and movement of these indicated issues.

Many works in neuropsychology do not merely describe the neural correlates of subjectively experienced mental phenomena but instead demonstrate the causal capacity of mental states to shape their corresponding, physically implemented behaviour, as shown, for example, in studies on the neural coding of subjective value (Polanía, Woodford, & Ruff, 2019).

But this, at first glance, convincing message itself must be explained at a deeper level of research. It must answer the question "How is information recorded in the structure of mental phenomena embodied in a person's physically active motor acts, making them intellectual?" We can even reformulate this question on a more conceptual level. Namely: "How does information control the physics of the body?" In addition, the problem of causality in the brain is not only relevant because it has historically matured to attempts to solve it but also demanded by the practice of human existence. Against this background, the comparison of causality in the brain and in AI systems is not limited to abstract or speculative considerations. Thus, in this study, we do not intend to explore in detail any practically oriented examples of the implementation of human subjective values in machine intelligence. We will be interested in the conceptual level of such implementation.

Therefore, the purpose of this research is to identify, analyse and compare the ability of intelligent systems to evaluate the expediency of information and make its selection and integration during information processing both in artificial intelligence devices (AI) and in naturally formed human brains by means of the phenomenon of subjective evaluation. Our attempt to show the fundamental role of subjective assessment as a driver of the information process in human neuronal

networks (hereafter NNs), against the background of physical causality operating in AI is what, in our opinion, can completely change the understanding of the essence of information processes in the brain.

Consequently, based on the set goal, in the second section of the work we will focus on the methodological specifics of the study and the corresponding methods. Additionally, we will interpret the terms used, which, in our opinion, require this. In the third section (Subsection 3.1) the general brain mechanism of information activity of the brain, which occurs through the causal inclusion of mental phenomena in the information activity of NNs of a brain, will be described. Subsection 3.2. will be devoted to a comparison of the methods of information processing in NNs of a brain and modern AI through the methodology specified in Section 2.

2. Methodology, Methods, and Terms Specificity

The methodology of this study, due to the need to explain the general brain mechanism of information processing, uses the method of functional and therefore causal inclusion of psychic phenomena in the informational activity of neuronal networks developed by us. A second method, specific to this study, is causal analysis of information activity in neuronal networks of the brain and in AI systems, which is applied for comparative purposes.

Through the method of semantic-pragmatic analysis it was found that cognitive phenomena such as feelings, emotions, sensations, mental images, thoughts, and experiences carry a significant amount of subjective-evaluative component in their content-structure (Soloviov, 2008). And this evaluative component almost always (excluding cases of mental pathology) limits its evaluative function to the framework of biological or social expediency of external objects and phenomena, information about which is either perceived by a person or already fixed in a person's brain (Soloviov & Litvinova, 2023).

This research certainly could not have happened without the method of *introspection* (despite its "bad reputation" in objective-oriented science). However, the methodology of this research, which is based on the inclusion of mentally, subjectively functioning phenomena in the information processing, not only allows, but even provokes us to search for functional and causal cooperation between the *physical* and the *mental* in the brain. For example, in this study it was necessary to take into account that most mental constructs (sensations, images, thoughts and similar phenomena n) are mental representations that record in their structure information about objects and phenomena of the world around us (Soloviov, 2008). And this information, being embodied in the mental cognitive constructs, may be subjectively assessed only in the mental "sphere" for the ability to integrate, generate information and to form a person's physically functioning intellectual behaviour (Soloviov, Dyachenko, & Kozak, 2019).

The set of methods and procedures outlined above allowed us to account for the fact that specific brain structures—including the frontal cortex (Riemann et al., 2024), the limbic system and amygdala (Fernandez de Gamarra-Oca et al., 2024), and the cingulate cortex (Chen, Liang, & Han, 2024; Mugnol-Ugarte et al., 2024; Westbrook, Lamichhane, & Braver, 2019)—are involved in the realization of managerial mental phenomena such as subjective evaluation, decision-making, and volitional effort.

While other NNs implement the functions of perception, memory storage, and the implementation of motor acts. Such NNs, because they provide exactly these subordinate functions, acquire the status of controlled, subordinate neural networks. This technique, associated with giving NNs the status of managerial and controlled either through the mental phenomena they implement or through their functions, allowed us to find a functional place for mental phenomena and processes that relentlessly accompany the information activity of the brain. In addition, such criteria for establishing hierarchical relationships between neural networks in the brain by means of mental phenomena allowed us to explain the possibility of the functioning in the brain exactly through informational (non-physical) interaction of neural networks with each other. Hence, this information interaction, as the arguments below show, must be implemented not only through the bioelectric activity of NNs due to the impossibility of a one-dimensional sequence of bioelectric signals to transmit multidimensional

systemic information complexes. A bioelectric impulse, due to its frequency parameters, cannot transmit multidimensional information processed in the human brain in any way. It can only transmit frequency signals from one node of the NNs to another in time. Bioelectric discharges, as purely physical phenomena, can serve only as signal indicators that point to the final recipient of the corresponding informationally mediated mental construct in routine (stimulus–reactive) situations.

Then how can information, framed in mental multidimensional information constructs, such as mental images, be recorded and integrated in the NNs of a human brain? This is evidenced, for example, by the fundamental facts of electrode stimulation of the brain during neurosurgical operations (Soloviov, 2023). In these operations, through the method of stimulation by the electrodes of NNs, recorded human experience in their structure, neurosurgeons provoked the actualisation of fragments of experience in the minds of the operated patients in the form of a "stream" of changing over time mental images. (Penfield, 1937; Soloviov, 2023). This allows us to assert that bioelectric impulses are directly related to the implementation of multidimensional mental constructs in the human brain. But, at the same time, considering the extremely high information capacity of the NNs structure of the brain, we insist that it is precisely due to this information capacity and the simultaneous activity of many structural elements of these NNs that the human brain can implement multidimensional mental images. Therefore, modern research directly calls bioelectricity in NNs “cognitive glue”, which ensures the compatible information activity of neurons in the brain through the coherence of the physiology of NNs and the cognitive manifestations of their information activity (Levin, 2023). All this indicates that in the nervous tissue of the brain, the physical clearly cooperates with the mental.

Now we are ready to talk about the general mechanism of information processing in the brain through mental phenomena. We named this mechanism, following Gazzaniga (2002), but with our addition, "the mechanism of Up and Down directed information flows, which ensures the integration of information (Tononi, 2008) through the action of mental phenomena in the brain." The essence of the functioning of this mechanism is well demonstrated against the background of the methodologically basic question for the investigation: "Why does a physically existing and physically functioning human brain "paradoxically" process information biologically or socially expediently?"

At the last stage of the research an attempt was made to consider the information process in a human brain, which is governed by the factor of subjective evaluation (Polanía, Woodford, & Ruff, 2019; Soloviov, 2024) against the background of information-processing mechanisms in modern AI systems. (This also applies even to AI systems, which already have specialised blocks capable of "independently" implementing the "subjective evaluation" procedure, but in which all processes, without exception, are provided, unlike living systems, in a physical way.) And this comparison provides, in view of the new approach proposed here in the explanation of information processes in the brain, our second methodological technique, which allows us to draw a sufficiently informative conclusion about the fundamental difference in information processing in living and artificial intelligent systems. Here again we return to the question that was asked some sentences ago. This question is formulated as follows: "Why does AI, being a purely physical entity, with all its "wires", boards, processors, circuits, electricity, feedback, chemical processes, and even quantum mechanical technologies, nevertheless, "paradoxically" processes information biologically or socially expediently?". The answer to this conceptually and methodologically important question will allow us to focus our efforts on solving the problem of whether modern AI can truly be an independent thinker. And one of the main criteria for this "free thought" could be the ability of AI to care about its own “body”, its own "survival", its own "social status", to love itself, to be egocentric.

Here we must warn that further, when we use the terms *subjective assessment, psyche and psychic*, we will mean any subjectively carried out activity, including what is meant by the term’s "consciousness", "unconscious psychic", "mind", and so on. However, under the circumstances indicated below, any subjectively functioning phenomenon or informational, mentally implemented process is primarily based on the functioning of the phenomenon of subjective value (Polanía, Woodford, & Ruff, 2019). Subjective cost is a mental phenomenon through which, in our opinion, a person reveals the degree of biological or social appropriateness of information and the success of any

information operation or motor action in controlling information processing in the psyche and one's own behaviour. Therefore, subjective value is a mental phenomenon that is realized by the corresponding structures of the limbic region of the brain, through which the subjective (individual) cost of surrounding biological and socially significant objects is revealed. So, subjective value is a valuable driver of the information process in the brain at any of its stages (Soloviov & Litvinova, 2023). It is precisely because of the ability to subjectively evaluate information that physically active NNs act biologically/socially expediently.

3. Results and Discussion

Next, we need to identify, analyse, and compare the ability of information processes, both in the brain and in artificial AI devices, to assess the biological/social appropriateness of information and to select and integrate it. Let us start with the brain, since the biggest problem of this work is precisely the problem of the mechanism of general information activity of the brain, which, by and large, has not yet been described in science. And then, in the appropriate section, we need to do a comparative analysis of information processes in AI devices and the brain. Moreover, based on the methodology of this article, we need to do all this through a causal analysis of information processes.

3.1. Brains Act Through Psychic Phenomena

In this section we will try to present the general mechanism of functioning of information processes in the human brain. This mechanism should function through mental phenomena that are realized during the corresponding bioelectrical activity of the brain's NNs and that invariably accompany the information activity of our brain. But, given the goal set in the work, in this section, as we delve deeper into the subtleties of the brain's information activity, we must constantly keep in mind the question: "Is it possible for a particular information process that can be implemented in a psychically active brain to be carried out within the framework of a totally physically operating AI device?"

The essential "paradox" of brain activity, resolving which allows us to understand how it works. Modern Brain Science, in our opinion, has come to a standstill because of a problem that it cannot yet see. We formulate this problem in the following question, which reveals a paradigmatic contradiction in our knowledge about the informational activity of the brain. Indeed, on the one hand, our brain, with all its neuro-electrical, neuro-molecular, neuro-ionic processes, is, by and large, a physically existing, physically functioning and physically (objectively) researched entity. However, on the other hand, for some reason, its information activity is "paradoxically" biologically/socially expedient, as if the informational processes of the brain obey some unknown management factor that takes care of the biological or social problems of the existence of humans. In this case, we must consider the fact of this “paradox” against the background of another fact, which is that not a single physical law supports the biological or social expediency of any physical processes (including quantum mechanical ones). So, the question of what makes the "physics" of the brain process information in such a way is a key question, the answer to which could completely change the paradigm of our understanding of how the brain works. However, for this, it is necessary to understand, in turn, the question of which causal factors act during information activity in neural networks of the brain (Manzotti & Jeschke, 2016).

Therefore, here we have set ourselves the intermediate task of sequentially, step by step, considering the conditions and corresponding mental phenomena that we believe are directly involved in the processing of information in the brain. After this, we provide a description of the basic mechanism of information processing in the brain, which we call "the mechanism of Bottom-Up & Top-Down integration of information through mental phenomena".

The subjective value of information is the driver of the information process in the human brain: a short answer to the above “paradox”. This answer is as follows: the brain, even though its activity is implemented through physical laws, processes information biologically/socially expediently

precisely because of the ability of NNs of the limbic area of the brain to subjectively evaluate biological/social cost of information about stimuli in the surrounding world. However, this manifestation of the value of information can only occur through other mental phenomena (for example, mental images), in which this information can be represented in a form free from the physical causality of its "carriers" (specialised NNs that record experience in their structure). Here we draw on Penfield's classic neurosurgical data and modern fMRI data (Abitbol et al., 2015; Fernandez de Gamarra-Oca et al., 2024).

Why and how do certain NNs of the brain implement a person's ability to subjectively evaluate information about external objects, phenomena, and information operations? *Subjectivity* is a multidimensional phenomenon. However, its most significant functional characteristic is the ability of living beings to evaluate in a subjective way information and quality of information operations with the position of biological or social expediency. This happens because subjective evaluation is the key functional mental aspect of information operation in the brain. The ability of humans to implement a subjective assessment, in our opinion, is necessary precisely for the information process in their brains to occur biologically/socially expediently.

Here it may be appropriate to think that some NNs, which by themselves implement through their bioelectric activity certain manifestations of subjective assessment, can also determine other NNs in the brain to be active biologically/socially expediently. Ultimately, the entire brain, not just the neural networks that directly implement a person's ability to subjectively evaluate something, functions biologically or socially expediently. (Soloviov, 2015; Soloviov, 2023). The only exceptions are mental evaluative phenomena that are associated with a person's craving for alcohol and drugs. However, they are not evolutionarily natural in the spectrum of all biologically appropriate mental "motivators" for informational and motor activity of human beings.

Subjective assessment can manifest itself in various evolutionary forms - feelings, emotions and experiences. Most often, subjective evaluations are realised in the form of an emotion, in which the evaluative component of one or another representation manifests itself. Informational contents that function in the "Global Workspace" of consciousness (Baars, 1988) in the form of mental images, thoughts, or feelings are subject to the detection of subjective value (price) on subjective scales of "biologically/socially good – biologically/socially bad". One of the key moments in this mechanism is as follows: In the moment when a person subjectively (for example, positively) evaluates something new, exactly in this moment this person faces uncertainty. It occurs because this person does not have the information to get this desired "something".

Fundamental Causal Role of Subjective Evaluation in Information Processing. The ability of living beings to ensure the identification of the subjective value of biologically and socially significant external objects (information about them) makes it possible to "calculate" the biological and social cost. It may occur on subjective scales "good - bad", "satisfaction - dissatisfaction", "positive - negative", "intense pain - no pain", "maximum hunger - no hunger", "maximum thirst - no thirst", "maximum sexual desire - no sexual desire", etc. Such “calculation” of the biological or social cost of objects and phenomena by means of *subjective evaluation* should ensure the management of the information executive functions in the brain (Abitbol et al., 2015; Damasio, 1999). So, such functions are the function of perceiving information from the outside, the function of memorisation, the function of integrating information (combining fragments of experience) and the function of incorporating integrated information into the regulation of motor acts of a living being.

Without the action of *subjective evaluation* in the brain, neither motivation (since a self-regulating living being should be motivated only by biologically or socially valuable external objects), nor attention (since the focus of a living being’s attention should reflect the most biologically or socially expedient objects) can take place in it. A person’s thinking process should be continuously accompanied by a subjective assessment of each stage of thinking as part of regulation through feedback, which should correct the adequacy of thought. So here it makes sense to accurately characterise the phenomenon of subjective assessment through a definition. We will call ***subjective***

assessment *a mental phenomenon that is formed in the relevant structures of the limbic region of the brain, through which the subjective value of surrounding biological and socially significant objects, and information about them, is revealed, and which is a valuable driver of the information process in the brain at any of its stages.*

Since subjective evaluation is the main factor in the direct processing of information for the purpose of its integration (Tononi, 2008), subjective value (Glimcher & Tymula, 2022; Goedegebure et al., 2022; Cui & Cao, 2023; Kaiser, 2024; Kobayashi et al., 2021; Chen, Liang, & Han, 2024) can be considered a factor that, unfolding its causal ability on neural networks, including networks of long-term memory (Soloviov, 2023), forms what Baars (1988) called a Global Workspace.

As a conclusion to this subsection, it can be stated that the mental (conscious) process and the NNs that directly implement it, due to the phenomenon of subjective assessment, function not according to the "logic" of physical processivity, but rather according to the logic of biological/social expediency. It will be shown below that this unfolding of the information process directly occurs through the hierarchical relationships of NNs among themselves, which are created precisely because of the mental phenomena implemented by these NNs (Soloviov & Litvinova, 2023).

Hierarchical relations of neural networks during information processing are conditioned by mental phenomena implemented by them. A large number of studies declare that certain NNs of certain structures and cortical fields of the brain realise during their bioelectrical activity corresponding mental phenomena - emotions, sensations, experiences, feelings, representations, thoughts, (Addis, Wong, & Schacter, 2007; Bushnell et al., 1999; Cox et al., 2010; Damasio, 1999; Posner & Rothbart, 2004). From the entire continuum of such mental phenomena, we select two of their groups, which radically differ in their functional significance. The first of them has a clearly managerial, controlling meaning (Soloviov & Litvinova, 2023). The most demonstrative example here can be the networks of the limbic brain and some fields of the frontal cortex, which realise, for example, the mental phenomena of subjective evaluation and decision-making (Vaidya, Sefranek, & Fellows, 2018). We call such brain structures and networks managerial or controlling precisely because they implement managerial mental phenomena in their content, significance and function based on information cumulated, combined, and integrated through them. (Soloviov & Litvinova, 2023). Their managerial nature consists in the fact that they carry out the functioning of the phenomenon of subjective assessment and the mental phenomena functionally derived from it, such as decision-making, voluntary effort. Other brain networks, in contrast to those mentioned above, we call controlled or subordinate networks. They can be distinguished from the above by the fact that they do not perform any management functions themselves but only ensure the fixation of information at certain moments of information processing or are networks with the help of which a certain information process can be unfolded. (An example of mental phenomena, by means of which such brain structures are functionally included in the information process, can be a mental image, thanks to which information can be integrated in a subjectively determined form.) Without going into details, such brain structures and cortical fields include neural networks that are directly involved in three fundamental information processes in the brain. They are, firstly, perception processes, secondly, memorisation, and thirdly, the implementation of already integrated information (Tononi, 2008) into the structure of voluntary motor acts.

Some authors quite reasonably associate such hierarchical relationships in NNs with the presence of bidirectional neural pathways (Tomoya et al., 2024), one of which can carry information for its integration "upwards", while the other provides the control flow of signals "downwards". The main characteristic of controlled NNs is that both NNs that implement perception and those that implement memory and motor functions are structured as columns (Mountcastle). These columns should be responsible either for the perception of "units" of experience in the general "field of perception", or for the preservation of a "unit" of a certain fragment of experience, or for the activity of a certain muscle in the structure of the body's muscular activity. In other words, controlled NNs, unlike managerial NNs, represent functional continua consisting of such columns that allow the

combination of the information recorded in them. The absence of rigid ties between columns facilitates such an opportunity for information manipulation carried out by managerial NNs.

To demonstrate the meaning of hierarchical relationships between structures and NNs of the brain, which are created precisely because of the action of mental phenomena in the brain, let us use a simple social analogy. Any contemporary country, business or public organisation has its own hierarchically functioning management system, where its management core is located (a parliament, a president, a government, board of directors). Information must be integrated by these management institutions, which thus acquire the competence to manage the social structures under their control using the already integrated information. The brain, like this social hierarchy, also relies on a person's ability to evaluate everything through subjective evaluation. So, it is no exception: subjectivity, as mental phenomena, acts in social and biological systems (in their brains) as the factor of organising information processing. In the next subsections, we will show how, precisely thanks to the phenomenon of subjective evaluation, a hierarchical process of information processing arises in the brain, which we call the organisation of the information process "from the bottom up" and "top down".

Essence of Integration Information process in Brains. The essence of the process of information integration (Tononi, 2008) consists in combining and generalising fragments of experience, because of which a more complex, more explanatory, more generalising information concept of mental nature (mental image, thought, idea) is obtained. With the help of such a concept, a living being more effectively counteracts the factor of external novelty (uncertainty, lack of information). At the same time, Integrated Information Theory (IITl; Tononi, 2008) does not explain how such more complex informational contexts are formed in the networks of the brain. In the next subsection this probable explanation will be demonstrated.

A deeper explanation for why information integration is related to greater human adaptability to novelty and uncertainty (Clark, 2015; Friston, 2012) is as follows. Integrating fragments of experience, that is, being able to "see" several fragments of one's experience simultaneously in the sphere of one's consciousness (Global Workspace), a person can reveal patterns of varying degrees of generalisation. This, since such patterns, having been checked through real practice in the past, are "true" not only within the framework of the past, but also within the framework of the present and likely future, makes it possible to predict and model the future.

Subjective Evaluation and Free Choice as independent from physics of the brain factors for selection and integration information in the framework of Bottom-Up & Top-Down processing. Subjective assessment is a main condition of a person's ability to choose from the continuum of memory accumulated in the brain exactly the information that is needed in specific problem conditions for the elimination of uncertainty. It is because a human person (any living being with a highly organised brain) cannot choose without evaluating what is chosen from (Soloviov & Litvinova, 2023). The functional connection between the phenomena of subjective evaluation and freedom of choice is that the expedient act of freedom of choice of information on the continuum of information fixed in “one's own brain" can only occur due to the ability of a person to choose precisely subjectively (i.e. biologically/socially) valuable information concerning a concrete problem. Freedom of choice is, in turn, an unconditional condition for the functioning of the Bottom-Up & Top- Down mechanism of integration of information in the brain, because this mechanism cannot function without the selection of biologically or socially expedient information on continuums of information fixed in brain networks.

Continuums of information recorded in the brain, as well as possible information that can potentially be the result of integration, are the informational basis of degrees of a human person’s behavioural freedom (Hills, 2019). Freedom of arbitrary acts of a person, freedom of choice of purposes, and all forms of social freedoms (freedom of religion, freedom of speech, freedom of political views, etc.) are secondary forms of primary freedom, which is an *intra-psychic aspect of information processing* in the human brain. In philosophical literature, such a psychological-neurological explanation of freedom through the concept of continuums of information

fixed in the human brain and the ability of a person to subjectively evaluate something "from within himself", as a manifestation of a person's inner mental being, can be associated with the term "human existence" (European dictionary of philosophy: Ukrainian context, 2024).

Bottom-Up & Top-Down flows of information in neural networks serve only to integrate information through subjective evaluation and other mental phenomena. Integration of information (Tononi, 2008) is the process which ensures the creation of new and more general information by means of accumulation of information already fixed in the brain ('old' information). Living beings require the creation of new and generalized information to generate behavioural responses to environmental uncertainty (i.e., information deficits). Human beings, in particular, require integrated information to creatively transform the surrounding world from states of an "unwanted present" into states of a "desired future," drawing on prior experience (Soloviov & Litvinova, 2023).

The mechanism of integration of information in natural networks of the brain is based on the ability of the limbic region networks to qualitatively (not quantitatively, as in a computer) evaluate information about external stimuli and to direct physical processes occurring through neural networks of other structures that implement information operations. (Soloviov, 2015) So, exactly subjective valuation, in our opinion, directs (causes, orchestrates) information processes in neural networks to biological/social expediency. We remember (we fix in the NNs of our brain) mainly what is subjectively significant for us. For example, we are interested , first, in what we are afraid of and what is of value to us in our life. We think mainly about what is subjectively important to us. We suggest that the perception of information in the human brain and the brains of evolutionary highly developed animals occurs by means of subjective value as well. The process of integration of information in our brain can be controlled (determined, orchestrated) exactly through subjective value. We insist that even the storage of information in the brain is controlled through subjective value. Can we directly observe information processing and regulate it in the physically functioning NNs themselves? We cannot. Are we capable of directly observing and regulating this processing during thinking? Yes, we are capable.

On the other hand, is the psychic image of a person you know presented to you as information so that you can evaluate it ? Yes, that's exactly right.

This t has been shown by many classical and modern experimental and clinical data using stimulation of brain structures by electrodes (Penfield, 1937), by means of fMRI and by other methods (EEG). If so, we can ask ourselves one more question: Why do networks of our brains functionally 'need' psychic phenomena during information processing? The answer is as follows: It is precisely because they, being totally physical, i.e. existing totally in the present with all their elements and processing, cannot, on their own, reflect information about the past to integrate it into adequate mental models of future interactions of living beings with the physical world. In general, networks functionally 'need' their own psychic activity because the subjective choice of exactly needed information may occur only in the psychic sphere (sphere of consciousness), where only the factor of subjective value may act as the factor of choice and processing of information. A mental image displaying, for example, the space around a living system, reflects at the same time a continuum of possibilities for real movement in the space in different directions. Besides, brain NNs functionally 'need' mental phenomena because the integration,combining , of experience already fixed in the brain cannot be carried out in exclusively physically active networks due to their inability to form new biologically/socially appropriate neural synaptic connections (Soloviov, 2015). These and other functional impossibilities in exactly physically active brain networks may be compensated precisely by psychic phenomena. Hence, we should explain the mechanism of operation of information in the brain by the appeal to various mental phenomena.

Figure 1 shows the most generalised scheme of information integration (Tononi, 2008) in the brain through mental phenomena. Information, spreading generally in the direction from sensory input to motor output, can be delayed in structures that store memory until it is needed to solve the corresponding problems (see "Memory fragments"). However, the most important thing here is that information can be integrated only at the level of managerial NNs and only under the auspices of the managerial mental phenomena of subjective assessment, decision-making, etc. implemented by them

(see Figure 1, large rectangle “Control neuronal networks”). This becomes possible because information, being initially fixed in the structure of NNs, through mental phenomena (mental images, etc.) loses its "attachment" to its physical carriers and becomes manipulated, combined, and integrated by the subject through subjective assessment, forming a Global Workspace (Baars, 1988).

However, the results of mentally implemented integration of information in controlling NNs must be embodied in the most obvious and objectively manifested way in the physical structure and dynamics of motor acts. In this case, we must think that at the final stage of the information process, orchestration (management) of motor structures through integrated information must occur. This orchestration “in the direction” from mental to the physical, because in the control networks of the brain causally active integrated information is presented in the form of mental contents, must take place precisely because the integrated information is fixed in the mental contents as a factor of controlling the "physics" of controlled neural networks (Soloviov, Dyachenko, & Kozak, 2019). In this way, the results of informational activity of control structures will be embodied in the structure and dynamics of motor acts of a living being. Thus, a living being, and first of all a human being, can change the surrounding physical world through voluntary motor acts from the state of "unwanted present" to the state of "wanted future".

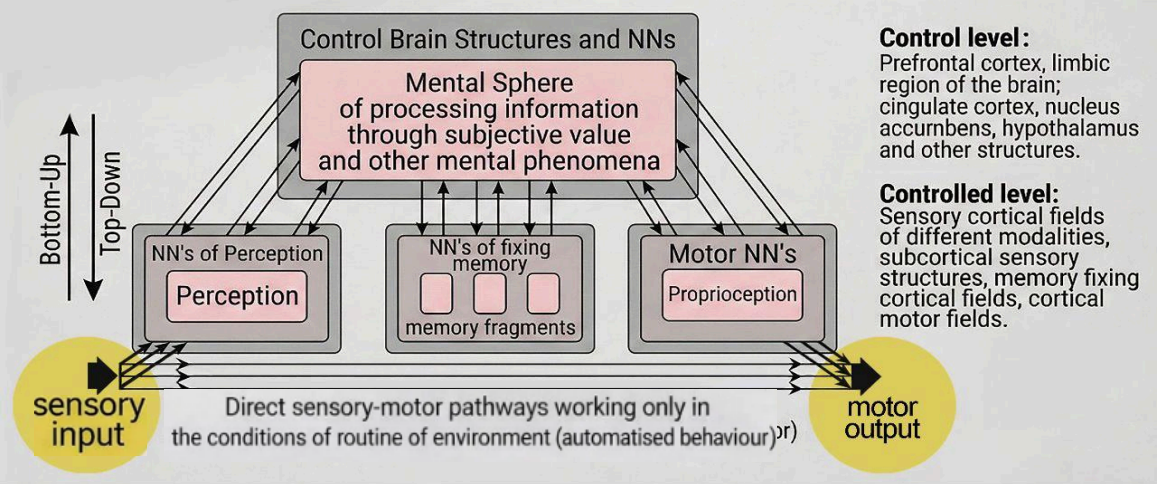

Figure 1. Scheme of activity neural networks of the brain directed to integrating information by means of mental phenomena to form informationally well-formed motor acts.

Notes: symbols and their interpretations.

- *All dark rectangles, that include into themself smaller pink rectangles, symbolize NNs that perform functions associated with the functional capabilities of mental phenomena exactly they implement.*
- *Small, pink rectangles, localised in the middle of larger gray rectangles, symbolise fragments of a person's experience, which are actualised in the form of mental images during the bioelectrical activity of NNs that are the "carriers" of this very experience.*
- *Lines with arrows – nerve links between networks of the brain.*
- *The labels “Control level” and “Controlled level” indicate, respectively, the brain structures and NNs “located” in the figure exactly at this level, which implement the corresponding mental phenomena of either a managerial or controlled nature.*
- *Arrows – direction of information causation of one network on the other networks.*

Source: Developed by the authors based on their own research (2020)

So, here we propose a mechanism of brain functioning, which is based on our hypothesis that the hierarchical relations of the main structures of the brain depend on the functional contents of the mental phenomena that are realised by them.

It is precisely these hierarchical relationships that constitute a necessary condition for the functioning of a global information-processing mechanism in the brain. Since the work of Gazzaniga and colleagues, this mechanism has been conceptualized in terms of bottom-up and top-down processing (Gazzaniga et al., 2002). As demonstrated in this section, information integration in the brain occurs through the interaction of these two information flows—bottom-up and top-down—which operate via hierarchical relationships between brain structures.

Mental phenomena, consciousness in general, that is, everything that functions in a subjective way, are what integrate information that, in our opinion, functions even in NNs of the brain that do not have direct, fully formed neural connections between themselves (Soloviov, 2015).

All arrows (see Figure 1) somehow pointing up characterise the global flow of information in the direction of Bottom-Up, and the arrows somehow pointing down indicate the flow of information Top-Down. The first of these delivers information to the executive level for integration, in line with Tononi's Integrated Information Theory (IIT; Tononi, 2008).

The second, global in the brain, downward-directed flow of information controls the controlled networks through the already integrated "on top" information. That is the "Top-Down" flow of information controls the processes of accumulation, preservation, integration and, in the end, the implementation of integrated information into the structure of motor acts, making them biologically or/and socially expedient. This functional, as well as causal, participation of psychic phenomena in information processing is symbolised in Figure 1, by certain structures and NNs of the brain, which are symbolised by grey rectangles and realise mental phenomena, which are symbolised by the inclusion of smaller coloured rectangles within their boundaries. It is this hierarchical organisation of the information process, which is formed through mental phenomena, and which is implemented by certain structures and NNs of the brain, that ensures the biological or social direction (*intentionality*, according to the ideas of Husserl and Brentano) of information processes in the brain. So, mental phenomena are the functional aspects of "their" NNs.

We can also demonstrate the explanatory power of this scheme in this way. We know that we can control our attention, that is, control the NNs of the brain that implement the function of perception, only through our ability to subjectively evaluate. After all, the act of attention presupposes that something should already be positively (or negatively) evaluated against everything else that is less subjectively significant within the framework of the problem being solved. (see Figure 1, some bidirectional arrows connecting *Sensory Input* with the control NNs of the brain). Moreover, we know that we can only select information for direct use during its integration through our ability to evaluate it in a concrete problem (see the corresponding arrows connecting the control structures of the brain and the structures that fix memory fragments (Sruthi, Khamaj, & Asthana, 2023). But we can also integrate information during thinking only through continuous subjective assessment of the methods and results of this integration, which is carried out in the brain's control networks.

Simplifying a bit, we can describe the brain as a large-scale neural network that, if stretched, generally extends from sensory inputs to motor outputs (see Figure 1). Accordingly, muscle motor movements are the result of all information activity of the brain. This represents the main direction of the movement of information in the brain, which indicates that the brain must generate "intelligent" (or at least biologically or socially expedient) motor acts to change the surrounding world from the state of "undesired present" to the state of "desired future" by means of integrated information.

However, information in the networks of the brain, as already mentioned, flows during its processing not only in the direction from sensory inputs to motor outputs. Furthermore, it is necessary to consider the large number of feedback loops within the brain (see Figure 1), which connect brain structures of different hierarchical levels (Tomoya et al., 2024). Therefore, the information moving in the direction from the sensory inputs to the motor outputs to be embodied in the structure of voluntary motor acts, must be sequentially processed also in the Bottom-Up & Top-Down directions (Gazzaniga, Ivry, & Mangun, 2002). This constitutes a necessary condition for controlling the biological and/or social expediency of processing information through the phenomenon of subjective evaluation. After all, it is precisely in such a neuro-psychic mechanism of Bottom-Up & Top-Down that the subjective assessment within the framework of feedback implemented by the neural structure reveals the probabilistic expediency of stimuli.

Psychic (conscious) processes orchestrate, and cause physical brain processes during Bottom-Up & Top-Down activity organisation. Many cortical fields of the human brain can be differentiated by their involvement in such information operations as perception (i.e., here we are talking about the perception as the mental way to know the present), and memory storage (here we are

talking about storing information about the past in mental form). Another information operation we may call the integration experience in the models of the future, which is most often associated with the functions of the frontal cortex (Mugnol-Ugarte et al., 2024). Thus, in this section, general subjectively active processes (psyche, consciousness), understood as informational processes, will be considered within the framework of the concept of the "physical arrow of time" (see Figure 2). This will make it possible to understand how the functional cooperation of physical causality and informational causality through mental phenomena ensures the integration (unification, generalisation) of information and how this integrated information is embodied in the structure of physical voluntary motor acts. Thus, this embodiment, in turn, makes it possible to truly transform the surrounding physical world from the states of an "undesirable present" to the states of a "desirable future".

Within our concept of including mental phenomena in "tissue" of information processing, which occur in physically active NNs of the brain, we are forced to explain how integrated information, fixed in the corresponding mental phenomena formed under the auspices of managing NNs, can ensure the management of controlled NNs. In other words, we have the opportunity in this section to describe the mechanism of influence of information, which, being formed and integrated in managing NNs in the form of mental phenomena, can change the structure of bioelectric flows in subordinate NNs. Without such a concept, we will be deprived of the opportunity to describe how the control NNs can informationally change the structure of physically occurring motor acts based on *subjective assessment* and *personal integrated experience*. However, in this case, we must assume that integrated experience, functioning in the form of mental contents (for example, form spatial images), must somehow rebuild the functional structure of *physical causality*, in the NNs of the motor cortex of the brain. NNs are neurochemical structures in which optimal neuroelectric activity is directly related to the actualisation of their functions (Soloviov, 2023). Thus, psychically fixed integrated information in managing NNs can help us to identify the dynamic changes in trajectories of bioelectric impulses in controlled NNs, including the motor cortex, and to understand the functional meaning of such physical changes. This is important in the context that these trajectories of neuroelectric activity in controlled networks must be dynamically changed during the control, management and orchestration of controlled networks, within the framework of the "Bottom-Up & Top-Down" mechanism.

Further, we will move on to the analysis of the content of Figure 2 to explain the causal role of integrated information and its functional connection with the phenomenon of freedom of choice during information processing. This will allow us to explain the phenomenon of the person's *freedom of choice* within the framework of the concept of the *physical world*. Thus, Figure 2 symbolises the physical environment in which a human person exists with their brain, consciousness, subjective values, and freedom of choice (see the small, coloured circle marked as **S** (subject).

The temporal structure of the physical world is characterised by the arrow of time (see Figure 2). The arrow of time represents the past (which no longer physically exists, but can be presented in the form of information in a person's brain) and the future, which does not physically does not exist yet and will never exist (that is why the arrow of time in the appropriate place is indicated by a dotted line and referred to as the "*probable future*"). The Front of the Present "moves" along the *Arrow of Time* in the direction from the Past to the Probable Future, separating them. Several examples of physical causal processes are depicted in the upper part of the line of Front of the Present in the form of mathematical symbolisations - hyperbola, linear dependence, and periodic nonlinear forms (see Figure 2, a, b, c). These elements of the drawing symbolise mathematically well-predictable processes (the continuation of physical causal lines from the past to the probable future based on integrated information derived from past experience). Below *a,b,c*, we see the stochastically formed "physical causal lines" (characterising turbulence in the flow of a large mass of water) crossing the Front of Present (see Figure 2, d). This implies the worst predictability of the future (although, with all the necessary data, it is assumed that future "causal lines" in the future could be identified here).

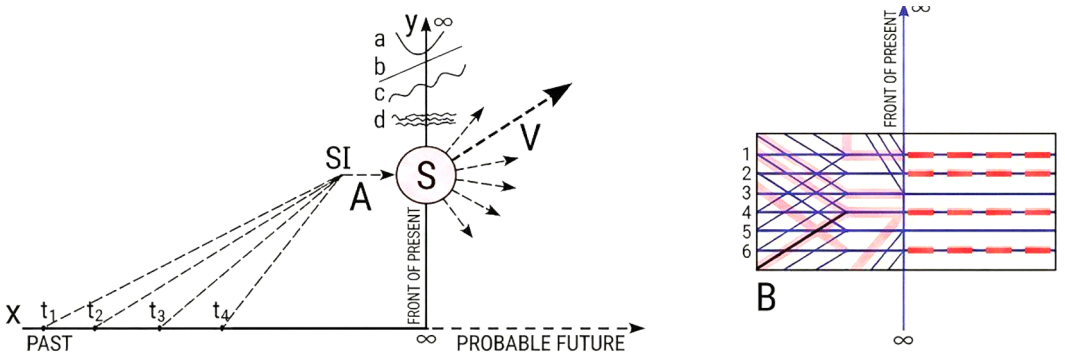

Figure 2. The scheme demonstrating the mechanism of functioning of information causality occurring by means of subjectively active processes (psyche, consciousness), which change the structure of bioelectric flows in the NNs of the brain in the framework of hierarchical relationships of control and subordinate NNs during processing information

Notes: symbols and their interpretations:

- *Horizontal scale X symbolises the "physical" arrow of time, where the past does not already physically exist, but it can be represented in a person's consciousness only in the form of information about it, fixed in her/his brain. In addition, we must consider all that physically existed in the past principally cannot be changed due to its physical non-existence now. But the future on the arrow of time does not physically exist yet. Nonetheless, it can be presented in a person's mind in the form of a probable future, for example, as a person's plans, purposes, beliefs, dreams. Here we argue that all these mental constructs are or the mental aspects of the process of integration of information or the result of the process of integration of information, which occur based on experience, and which are realised only in the sphere of consciousness (see text) as a sphere of processing information.*
- *Vertical scale Y symbolises the front of the present 'moving in the direction from the Past to the Probable Future'. This 'Front' represents a physically existing moment in time, during which it is possible to influence the future, physically affecting the physical processes that "came" to this present moment from the Past. In other words, it is now of the present that it is possible to restructure the past causality and form other causality that «shapes the future». For convenience, this one-dimensional 'scale' Y can display not only a three-dimensional "physical" space, but also all conceivable "spaces" ("spaces" of meanings, "spaces" of goals, "spaces" of the choice of a movie on the list of movies), i.e. all the "spaces" that our consciousness can open out before us and in which we can choose something subjectively desirable through our subjective assessment.*
- *a, b, c - symbolising mathematically and graphically well-predictable causal lines, where there is a linear or non-linear (periodic) causal relationship (respectively, expressed by a parabola, straight line and sinusoid). The dashed lines represent the future causal lines or vectors of possible future causality (future "causal lines").*
- *d – symbolisation of causality (causal lines) in extremely physical highly dynamic (turbulent) processes, characterised by poor predictability, which, however, is associated only with a "simple" lack of information. Points a, b, c, d should emphasise the conceptual difference between physical and informational causality.*
- *A – The pink circle, denoted by the letters S (Subject), symbolises a human person with a correspondingly highly developed brain and psyche (consciousness). Dotted vectors (dotted lines with arrows) scattering from the circle symbolise the range of possibilities of the owner of this brain and this consciousness. This range of possibilities for the future is limited by the information fixed in the brain of this person (for example, a person will never be able to choose the Fiji Islands for his summer vacation if she/he does not know anything about them). This "fan" of possibilities can be deployed only in the sphere of consciousness, psyche, but not in NNs by themselves that implement these mental (psychic) processing. The pink chromaticity of this circle (like the pink chromaticity of the element B of this fig.2, and in the previous fig.1) means that the object under study has not only a physical, but also a subjective nature.*
- *SI, MO – Sensory Input and Motor Output of the Brain.*
- *T1 – t4 - Moments of the past, information about which, being stored in the memory of a person (see the thin straight lines connecting these points of the timeline with an arrow SI (sensory input). This information, being integrated in the consciousness sphere into a single information concept, participates in the formation of more complicated, more generalised mental models of the future, which must be embodied in future reality through physically implementing voluntary motor acts of a person.*
- *V - a vector symbolising the free choice of the future through the mental phenomenon of subjective assessment on a "fan" of possibilities unfolding in the sphere of consciousness. This subjective choice is based on the corresponding integrated experience and determines the physically occurring motor acts of the living system, which changes the physical world in a subjectively desired direction.*
- *Fragment B. Here, the ability of NNs of the brain's management structures to systemically manage, orchestrate the corresponding bioelectrical activity in the controlled structures through integrated information formed in them is demonstrated. The moment of such control is shown, where on the line of Front of Present, bioelectric activity in cortical columns, for example, of motor cortex on lines 2,3,6, systemically changes, but on others it systemically does not change. (The lines marked in pink symbolise the optimal bioelectrical activity of NNs for the implementation of functions; the pink dotted lines denote the bioelectrical activity of NNs 'in the future'). This becomes possible precisely because integrated information can be causally effective precisely when it is implemented in mental constructs (proprioceptive balances, for example (*Antohe, Rata, & Rata, 2021*)). In this case, in objectively conducted observations of bioelectrical activity of neural networks of controlled structures, such activity should really appear to be spontaneous. But within our concept of hierarchical top-down regulation of controlled neural networks by managerial neural networks through the mediation of mental phenomena, this change in bioelectrical activity at the front of the present is caused by this systemic, informational regulation through mental phenomena. Nevertheless, objective studies simply cannot record ("see") this subjectively implemented systemic, informational influence of control neural networks on the physically implemented activity of controlled neural networks due to their subjective, non-physical nature.*

Source: Developed by the authors based on their own research (2020)

Still lower on the line of Present, there is a small, coloured circle symbolising the human person (see symbol A). The colour of this circle symbolises the fact that this "physical body" can accumulate and create new information through its integration by means of the phenomenon of subjective evaluation. This person, being physically existing, is located precisely on the line of the Front of the Present, i.e. on the line that symbolises the border between the past and the future, where it is possible to influence changes in the "causal lines" carried out in the past. Thin dotted lines extending from points t1 – t4 on the Arrow of time to SI (Sensory Input of the Brain of Person A), symbolise moments of the past in which the person has stored information in their brain and can integrate it in the process of forming informational models of their "future" interaction with the physical environment. A "fan" of dotted arrows starting from coloured circle A symbolises the range of possibilities of a person to choose goals, forming plans, motor acts aimed at achieving these goals, etc. Thus, we can say that the causal features of processes in the physical world determine the functional characteristics of the informational activity of the brain through mental activity.

Indeed, everything that was stated in the previous sections about mental activity and about the factor of *subjective assessment* functioning in the psychic sphere as an information-processing factor testifies to the fact that the psyche is a virtual sphere, in which future physical interactions of living beings with the physical world are formed within the frameworks of biological and social existence. That is why human motor acts are in most cases (excluding cases with deep psychiatric pathologies) either biologically or socially expedient. This happens because *subjective assessment* is a factor of choice on the continuum of information stored in the brain, precisely that information that turns out to be useful for the life process in the biological or social sense. This understanding of *freedom of choice* as a key aspect of information processing in the brain carried out in the *sphere of psyche* clearly supports the well-known "*free energy principle*" (Friston, 2012). Indeed, the mechanism of *free choice*, so understood in this way, is precisely the mechanism for maintaining non-equilibrium stable states through the selection and combination in the *sphere of psyche* of that information and those behavioural acts that provide this dynamic stability with the external world.

However, if all the above really characterises the informational activity of the brain, we must assume the following. All informational interactions of the NNs of the brain in the top-down direction by means of mental phenomena, within which the integrated information is used, must in some way restructure the bioelectrical activity of the neuronal networks (and most likely their synapses (Soloviov, 2015) of subordinate structures. Otherwise, the controlled NNs will not be recipients of the managerial information-based influences of control NNs and structures. This restructuring should manifest itself precisely in the "spontaneous" interruption of "old" (formed in the past, see Figure 2) bioelectric activity and in the formation of a new structure of bioelectric activity.

This restructuring of neural activity in the brain is especially evident in the fact that, depending on what goal the person sets and when the person decides to carry out motor acts aimed at achieving this goal, the entire flow of bioelectricity from the brain to the muscles must be systemically restructured (Cohen et al., 2020) precisely for the formation of the corresponding motor acts. The structure of the motor cortex of the brain is such a neural network capable of providing this restructuring (Velliste et al., 2008). We symbolically displayed this systemic restructuring of bioelectric flows in controlled NNs with the graphic content of figure B, which is a symbolic image of a fragment of some neuronal columns (see Figure 2, B (1, 2, 3, 4, 5, 6)). These neuronal columns, being physically independent of each other, systemically change their bioelectric activity in accordance with the integrated information fixed in the managerial mental contents formed in the managerial NNs. We see that this "spontaneous" systemic (informationally organised) restructuring of bioelectric flows in controlled NNs is taking place only on the line of the present (see Figure 2, fragment B).

The process of restructuring bioelectric activity here consists in the fact that on the front line of the present, some NNs cease to demonstrate the optimal frequency for performing their information functions, while others, on the contrary, begin to demonstrate it. The "spontaneous" interruption of the previous optimal bioelectrical activity and the "spontaneous" emergence (formation) of a new optimal bioelectrical activity in the future are symbolised here by the interruption and emergence on the

present timeline of coloured lines accompanying the solid lines that symbolise neural pathways. The dotted coloured lines symbolise the future bioelectric activity in the NNs of the controlled structures of the brain, which can be changed through integrated information formed in control NNs. Such interruption of past bioelectric activities and formation of new ones in NNs of the brain should be carried out systemically. In other words, all bioelectrical impulses that "spontaneously" (Soloviov, 2023) arise in subordinate NNs must be systematised and orchestrated by that "mental product" (for example, a dynamics sequence of changes in mental images or thought) of the activity of control NNs, which use already integrated information fixed in this "mental product".

In general, the sense of this change in the trajectories of physical cause-and-effect lines (trajectories of bioelectric streams) in the neuronal tissue of subordinate NNs at the moment "now" lies in the total regulation by the mind in the brain. Thus, now we have a mechanism by which we can explain how the physical activity of NNs in a brain becomes biologically (or socially) meaningful. The most illustrative example here will be the following: the formation in the motor cortex of the structure of bioelectric currents spreading into the motor (muscular) system of the human body should be based on a person's subjective values and the integration of their personal experience. Mental constructs of integrated personal experience must be embodied in the mental construct of the goal as a vector in the "space of the probabilistic future" (see symbol V) which directs bioelectric activity in the motor fields of the brain. Such cortical motor fields activity, in turn, organises informationally well-endowed, systemic muscle movements (see symbol MO(V). This can be understood in the context of that bioelectricity, which spreads from the motor areas of the cortex and determines the dynamics of voluntary human movements, should be formed under the influence of a person’s subjective values of a person and the experience integrated in their brain. This integration may take place, in our opinion, only in the control networks of the brain (primarily the frontal and cingulate cortex, see Figure 1).

In the same way as in the motor structures of the brain, the regulation of physically active processes can occur in NNs that realise the functions of perception and memory processing due to their controlled, subordinate nature. In the first case, the control of physical processes through mental phenomena can regulate the focus of attention in NNs that implement perception. In the second case, mental phenomena form and change the structure and activity of NNs that perform the function of "carriers" of information during the fixation and consolidation of new experience (Soloviev, 2015).

Next, we will consider one important nuance that can help us to more deeply understand the essence of including mental phenomena in information processing in the brain and to establish objective studies of the functioning of NNs, considering their ability and necessity to implement mental phenomena. In objectively conducted observations of the bioelectrical activity of NNs of controlled structures (for example, motor fields of the cortex), such activity should indeed appear spontaneous (Soloviov, 2023). However, within our concept of top-down hierarchical regulation of NNs controlled by mental phenomena, this change in bioelectrical activity must be caused by systemic regulation through their mediation. This occurs because it is exactly in the framework of mental phenomena (mental images, thoughts) functioning that integrated information must demonstrate its integrative ability and causal function. Nevertheless, objective studies simply cannot observe, record (“see”, fix) this subjectively implemented systemic organisational influence of control NNs on the physically implemented activity of controlled NNs through their subjective, non-physical nature. However, we can indirectly see such systemic effects of control networks on controlled brain networks through mental phenomena in fMRI and other studies -for example, the effects of the structures of the frontal cortex on the motor areas (Cohen et al., 2020). The most revealing, in our opinion, are the studies of Nicolelis et al., (2022), which demonstrate, within the experimentally formed interface "monkey brain - AI", the monkey's regulation of its behaviour and the "behaviour" of the computer through the activity of the motor cortex.

Of course, the most acceptable candidate, through which it is possible to systemically regulate the NNs of the controlled structures of the brain by means of mental influence, is the synapse. Having accepted this point of view, firstly, about the organising nature of mental phenomena and, secondly, about their informational mediation in the interactions of NNs of the brain, we, of course, must admit

that the nature of this organising entity cannot be reduced only to simple signal transmission of information through bioelectric signalling. This is something that, while not directly using the services of physical causation, nevertheless functions on the basis of physical energy already accumulated in NNs, simultaneously and systemically interrupts past bioelectric activity and forms new activity through the influence of integrated information.

Summarising this subsection, we can assume that the Bottom-Up & Top-Down mechanism described here functions due to the mutual ability of the bioelectrical activity of the brain's NNs to actualise integrated information through mental images, and the ability of such mental phenomena to "force" NNs to act systemically and biologically or socially expediently. In addition, there are two possibilities for interpreting psyche (consciousness) in the framework of its involvement in the informational activity of the brain. First, the psyche should be a kind of informational "language" of communication between networks under conditions in which these physically active NNs are by themselves unable to operate within the framework of biological or social expediency. Secondly, this "language of communication" of brain networks appears to be the permanent processing of information through a person's subjective values. And it cannot appear to a human person as something else. Because a person's (agent's, self's) subjective values principally can keep this information processing "in own person's hands".

Counterarguments, limitations, proposals for future work. In modern brain science, there is quite a lot of literature that claims to form certain generalised ideas about the functioning of the brain. We consider two of them to be the most authoritative. These are Integrated Information Theory (Tononi, 2008) and the Free-Energy Principle (Friston, 2012). We rely on the first of these, using the term "integrated information." However, the author of this theory, based on the physicalist-oriented methodology of his research, does not explain, and cannot explain, how integrated information can be formed in the NNs of the brain based on past experience. Therefore, using a different research methodology, we consider the key limitation of IIT to be neglect of mental phenomena. On the other hand, we have no disagreements with K. Friston's theory, especially when he uses the terms "uncertainty" and "information deficit". We also consider his attempts to introduce the concept of "faith" into the mathematical apparatus to be extremely useful, although they are not based on the most essential functional characteristics of mental phenomena.

The next stage of the research aims to study the bioelectric activity of the primary motor cortex of the human brain through high-tech EEG experiments. These studies should reveal objective systemic changes in the activity of this cortical field, which, according to the hypothesis of this study, should be formed through integrated information recorded in the corresponding mental images of voluntary motor activity, previously formed in the psyche of the subjects during the creation of new movements.

3.2. From the Subjectively Active Human Brain to a Totally Physical AI

In the previous chapter, we showed that through the mechanism of Bottom-Up & Top-Down information integration, a mentally functioning sphere of information integration, which we call the psyche (or consciousness), is formed in the human brain, such that it ensures causal independence from the surrounding world. In the "boundaries" of this virtual area of information processing in the brain, it is possible to integrate the information received by a living being in different periods of its life span, using the mental phenomena of subjective evaluation and free choice of information. As a result, one of the fundamental evolutionary consequences of the integration of information through the mediation of the psyche is the possibility for living beings to separate subjectively significant patterns from fragments of experience that were somewhat similar in the past, which, being true in the past, could be useful in the future as well. Such allocation and isolation of regularities and generalisations can occur only in the sphere of the psyche, because it is within its "framework" that the subject (agent) can simultaneously keep in memory and "view" several relevant fragments of the past, actualising them through acts of free choice on the continuum of one's own memory. According to this, the psychic mechanism of integrating information, which acts though subjective assessment, serves to

select exactly the information needed to solve existing and future problems. Thus, precisely because of the psyche operating in the NNs of the brain, living beings acquire the ability to obtain new, more general knowledge about the surrounding world. A living being becomes able to respond to the external pressure of uncertainty, lack of information and environmental novelty with its own, biologically or socially appropriate novelty and creativity.

Now we are ready to return to the question we raised at the beginning of the study. So why is AI, being a purely physical entity, with all its "wires", boards, circuits, "electricity", chemical processes, and even "quantum-mechanical" technologies, not having specialised networks that carry out the function of subjective evaluation, nevertheless, "paradoxically" processes information in a biologically or socially expediently?". Why is AI able to answer our questions, new to it (that is, asked to it for the first time), with its "own" novelty and "creativity"? Does AI, in this case, remain an automaton that "obediently" finds algorithms potentially embedded in its technical and software architecture as a continuum of its computational capabilities limited by this architecture? Can it, in an unknown emergent way, with the increase of its computational capabilities and information capacity, automatically acquire all those evolutionary privileges that living beings were able to obtain only at the value of a rigid selection of an endless series of successful mutations that occurred over billions of years? It is unlikely. This is not only because the ideas and mathematical calculations of R. Penrose have long insisted on this. Our argument, different from that of Penrose (1989), is that physical processes and physical causality have not changed over these billions of years. They did not lose their "negative" property of not being able to implement information processes by themselves during this time. They themselves, in principle, “are not yet” capable of organising a causally autonomous information process that unfolds in a living brain on the matrix of its physically active NNs of enormous information capacity due to the action of subjective value in them and the free manipulation of information functionally related to subjectivity. After all, they are physical. That is, they exist only in the present and cannot , by themselves, be informationally effective, simply because they cannot reflect the past and the probable future without using semiotic "tools" of a mental nature (of mental images, for example) (Soloviov, 2008). This occurs because, in purely physical processes, it is not possible to signify objects of reality for the creation of information about these objects, that is free from its material (physical) carrier for inclusion of this information in the free processing. We refer to this argument against AI as an autonomous intelligent system as the “argument of the non-semiotic nature of physical processes by themselves”.

Here we must recall that in this work we are not, and should not be, interested in specific machine technologies. We should be interested in the most conceptually fundamental properties of humans and machines for performing intellectual operations. We associate these properties, first, with the types of causality that provide information processing in the brain and in machines. While information, as opposed to a physical process, is a phenomenon that appeals to the past and to the probable future, because the experience of the past, being actualised through the corresponding mental phenomena, allows a person to form and integrate an idea of the desired future, which should become the desired present through arbitrary motor acts. This becomes possible precisely, because in our brain, some neural structures and networks, through the corresponding (managerial) mental phenomena integrating information, manage and control, through this integrated information, NNs of controlled levels, making their activity biologically or socially expedient. However, in this case, we are faced with the problem of why, even a personal computer, not to mention ChatGPT, for some reason, "paradoxically" processes information in a socially or biologically expedient way. The answer to this question should be trivial: this is because any brain-artificial intelligence interface assumes that, through a keyboard (or some other device), it is possible implicitly to enter content that is required only by human values themselves. The developer embeds their values into the architecture of the machine, and the programmer embeds theirs. Finally, the user, with their questions and narratives, cuts off all unnecessary possibilities on the continuum of possible probabilistically correct network paths from the input to the corresponding output in the machine.

Any AI device, being totally physical, no matter how much memory it uses, no matter what tasks it solves, does so solely because of its inherent ability to find one of the probabilistically correct network paths from the corresponding input to the corresponding output, potentially built into its structure for "solving" tasks. Even when AI is designed and programmed considering the ability to "generate its own new values within itself", these values are still human values, which as a causal force work precisely in the human brain, but do not work in the internal architecture of a machine, which always works as a search engine of one of the “algorithms” possible in its physical architectonics and software limitations.In this case, we can assume that the machine—most notably a large language model (LLM)—does not “consider” information in the same way humans typically process it when consistently generating text. Instead, the AI machine “considers” the formal characteristics of words (syntax) (Khan, 2025), and not semantics-pragmatics, which are, by and large, concern subjectively significant information, as happens in the human brain (see Subsection 3.1). This mechanism can be well demonstrated both on modern chess-playing machines and on machines that implement LLM capabilities.Such a demonstration, due to its volume, requires a separate text. Here we can only add that in LLM technologies, syntactic rules for sentence formation work well for forming correct answers, just as in chess machines, the "limitless" memory of the machine is effectively used, turning to world chess experience as a request for a "hint" for the next move.

But if a computer is viewed only as a huge potential continuum of electrical paths and "nodes" of intersection of these paths, which extend from the input of signals into it and the output of signals from it, and in which physical causality totally "reigns", then where does the "passion" for human values come from in an LLM? To specify this “conformist passion,” we can call it an “obsessive” adaptation to dialogue with a specific person with whom this dialogue is being conducted. This, in our opinion, can give out a machine in the machine - even if we do not consider the possibility of artificial introduction of this "conformism" into the information activity of the machine. And this criterion of "unintelligence of the machine" seems not to have been known to Turing yet.

The solution to the nature of this “conformism” of the LLM-machine, in our opinion, lies in the fundamental impossibility of “pushing” into its total physicality a stable “feeling” of either “own identity” or, at least, the values of a particular person. In addition, their absence in the LLM-machine is also due to the total syntactic way of “processing information” in it. Instead, the information process in the NNs of the brain operates, if we use the language of semiotics, within the framework of the semantic-pragmatic (Soloviov, 2008) mode of functioning. In the brain it is information (semantics) that is operated. And it is processed precisely in the sphere of the psyche, which, by its nature, is the sphere of informational-value (semantic-pragmatic) functioning. Instead, an LLM machine, by its technology, is a machine that operates on software that takes into account only the syntactic aspect of human language practice (Khan, 2025). In the brain, it is precisely through the mentally implemented simultaneous actualisation of the entire continuum of information, which is associatively connected with a certain unit of coding of experience in the NNs of the brain, that correspondingly complete, even multimodal information is actualised. Just as, for example, information is represented in mental images, which include both visual and auditory experiences in their structure. If the brain used such syntactic technology, that is, relied not on information-valued, but on syntactic units of analysis, then it would have to encounter an insurmountable problem. This problem would be that such an "information process" would fundamentally not be able to be an information process but would remain simply a series of bioelectric impulses in the nervous tissue, which would be "not loaded" with an information function.

An LLM, in this situation of inability to manipulate information itself, but possessing the ability to combine "carriers" of information, that is, words as only "signs" of relevant information, can nevertheless function by applying vast specialised experience, which allows it to consistently form answers and comments in dialogue with a person. In this case, large memory arrays about the syntactic appropriateness of certain words in certain sentences and the speed of manipulating such "signs" that denote entire information complexes, in our opinion, allow the machine to be adequate even in quite complex dialogues with a person. It is necessary to consider that the appeal to such a mechanism

cannot help knowledge of dictionaries, because here too the LLM machine deals not with information, as it does in the brain of a person using a dictionary, but with its “carriers”. Rotating in the circle of continuous terminology (syntax) and its constructs imposed on the LLM machine by a specific dialogue, it does not have much opportunity to meaningfully, and especially value-wise, violate the boundaries of this specific dialogue.

Consider the process in which an LLM consistently forms, word by word and grammatically correctly,sentences and texts in dialogues with a human. A huge array of experience constantly imposes on the machine some value priorities regarding certain connections between words in sentences against the background of purely grammatical rules, allowing it to arrange words not only syntactically correct, but also in a value-engaged manner. This,, nevertheless, looks like outright "conformism", and such "conformism" that only works "here and now", because in the following dialogues the "conformist essence" of the machine will already be manifested in relation to another, not this value position. In a person's statements and denials, one can always programmatically find a subjective orientation.

Here we can draw a rather banal conclusion that such an LLM process is not an information process, at least one that occurs through the mentally active NNs of the brain. It is a combination of syntactic units - words - which are only "carriers" of information to which LLM-machines have no direct access, even through dictionaries. The huge array of texts that are the "experience" of LLM-machines is used by it only as a source of direct "hints", which allows it to add the next word according to grammatical rules and the high frequency of use of this word in this array of texts. The LLM machine is incapable of changing its “decision” after the announced result. This may also be evidence of its lack of freedom to manipulate information. Whereas a person is often in doubt about the products of their thinking, they can also stimulate themselves through the mental phenomenon of willpower to obtain a better result of intellectual activity. Although the modelling of artificial NNs, since the time of the McCulloch-Pitts “neuron”, sometimes attempts to introduce into their activity factors of non-algorithmicity, unpredictability, variability, randomness,and bias (Lin et al., 2024) it remains unjustified to expect from them what can be called “causality-from-within-itself” (Soloviov, 2020), which manifests itself in the freedom of information manipulation.

Thus, the essence of the mechanism of the "intellectual" work of the LLM machine, as the most obvious modern contender for possessing intelligence, is as follows. It is able, firstly, to to arrange words grammatically correctly in sentences and texts. Secondly, it quickly selects the necessary words, mainly those that are most often found in the corresponding word combinations and sentences. Since the correctly arranged words somehow contain relevant information, the text unfolds for a person with both its informational content and its value engagement. But only for a person, not for an LLM machine. Finally, it remains to consider the limitation of this technology of “thinking” without real thinking. This limitation lies in the fact that the LLM works without errors, “guessing” relatively correct reactions in a dialogue with a person only if it possesses the appropriate speech and linguistic patterns for exactly such action.

In our investigation the factor of the value of information revealed through the subjectivity of living beings is considered as something that determines both the behaviour of mentally active living beings, and the “behaviours” of intellectual technical devices, clearly hinting at the fact that the mental does control, orchestrate the *physical*. Thus, the term "information processing operator" means any structure or process in a system that has the function of management, control and determination, ensuring the systemically coordinated and purposeful activity of all other elements of the system. In English-language literature, the phenomenon of the information processing operator can be associated with the phenomena "agent", "subject" and "self", which, as we believe, have a poly-structural subjective nature. Here, too, we are talking about subjective assessment, but in a much more complex form.

In the future, our research will be devoted to LLM (Dyachenko et al., 2025) in order to clarify the mechanisms of their informational activity, using ideas that have strengthened their informational

capabilities over the past years, taking into account certain features of the information process in the brain through mental phenomena (e.g., Vaswani et al., 2023).

4. Conclusions

1. The process that directly operates information in the brain is a psychic process. It is provided by the bioelectrical activity of the brain's NNs, on the structure of which it unfolds. This psychic process is characterised by the fact that the operator of information processing within it is the factor of subjective valuation of information about objects and phenomena of the surrounding world. This operator "forces" physical processes in the brain and then in the organism to act in a biologically or socially appropriate way in accordance with their subjective situational cost through corresponding mental phenomena. Thus, this procedural feature of information processing in the brain, which provides manipulation of information in it free from direct external and internal physical influences, is a key difference from «information processing» in LLM devices.
2. Any modern AI device, being totally physical, no matter how much information it uses and no matter what tasks it successfully solves, does so solely through its ability to instantly find one of the most probabilistically correct outputs ("answers", "decisions") on the continuum of its network structural opportunities embedded in its network structure. Such a mechanism requires neither the psyche, nor the freedom to manipulate information, nor subjective assessment.
3. Informational causality, which has gained autonomy in the brain from external physical influences, ensures the influence of information on physiological (physical) processes in it. However, this influence can be carried out only within the framework of the hierarchical mechanism of Bottom - Up & Top - Down flows of information described here, which occur in the brain through the ability of the brain's NNs to realise mental phenomena. It is through this mechanism that the physical processes of the brain's NNs "obey" the logic of the information process. Based on this, we can say that in the brain, for it to process information, cooperation between the corresponding physical processes and mental processes occurs.
4. Any physical process, by itself (including physiological processes that are physical in their essence, in the brain), cannot form the experience of subjective value. So, AI, if only physical causality operates in it, will not be able to form its own values, and therefore, independently integrate new information.

5. The functional and causal relationships between the brain and subjective phenomena that invariably accompany its information activity remain almost unexplored (if not to say, mysterious). However, comparing the functional capabilities of a mentally active brain and a totally physically active AI, we can argue that AI can generate new generalised information through its structure, which provides a multitude of potential network paths from inputs to outputs that are "hardwired" into the computer. The solutions to the problems are found in the process of searching for the most likely appropriate network paths by provoking the information activity of the device with a user question and a programme. Therefore, the "logic" of information processing in AI is fundamentally different from human subjectively functioning thinking. It follows that modern AI cannot have its own information process drivers, which are implemented in the natural brain due to the factor of subjective evaluation. However, given the sometimes surprisingly witty responses of AI in extremely complex dialogues with highly educated humans, modern science cannot insist on the ultimate correctness of research that focuses only on the inability or ability of modern AI to have its own values (Plevrakis, 2024).

Acknowledgments

The authors are sincerely grateful to D. Vasilenko, O. Boroviecki, O. Yeriomenko, O. Kokun, A. Shevtsov, I. Shevchenko, R. Myronenko and A. Vasylchenko for advice and dialogues that allowed developing the ideas presented in this study.

Conflict of Interest

Each of the authors declares no conflict of interests that could affect the objectivity of the results of this study.

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