ABSTRACT
The article examines the role of the spontaneous activity of neurons, and therefore, of brain neural networks, in information processing. Analysis of the spontaneous activity of neural networks is based on data obtained during neurosurgical operations conducted by W. Penfield. The case of frequentative electrode stimulation of the human brain temporal cortex and the patient simultaneous interview were analyzed. Such a survey revealed that the irritation of a specific localization caused the actualization in a person memory of an episode of her past according to this localization. The analysis of the spontaneous activity of neural networks of the brain is based on comparing the conditions of conducting this experiment, in which the actualization of long-term memory occurs artificially that is, with the help of electrode stimulation of the corresponding neural networks (and therefore guaranteed not spontaneously), with the conditions for actualizing long-term memory during the natural processing information in neural networks of the brain.

This analysis made it possible to form a hypothesis and draw conclusions that, first, the spontaneous activity of neurons and neural networks of the brain is an indispensable condition for the actualization of long-term memory so that it is involved in the regulation of expedient human behavior; and, second, the phenomenon of spontaneous activity of neurons proved the impossibility of processing information in the brain without the participation of mental phenomena, at least representations that actualize personal experience (information) for further use.

Keywords: Spontaneity of Neuronal Networks, Neurosurgical Operation, “Shift” of Information from the Past to the Present by Mean of Spontaneity, Memory Fragments Actualization, Mental Representations, General (Holistic) Brain Information Activity.
INTRODUCTION

The collective bioelectrical activity of the brain recorded by the EEG is characterized by the fact that it is formed mainly based on the spontaneous activity of neuronal cells, that is, the activity that, in contrast to the induced bioelectrical activity, cannot be explained by external physical effects of the environment on the brain [1,2] in the “now” moment. In this regard, the study aim to answer how, due to the spontaneous activity of neuronal cells, and thereby due to the spontaneous activity of corresponding neural networks of the brain, information stored in them for a long time is actualized. (The ability of living beings to actualize long-term information and use it for regulating their behavior is fundamentally necessary for the general (holistic) information activity of the brain.) In addition, here we will formulate a hypothesis about how the phenomenon of spontaneity can, through the hierarchical management-controlled relations of neural networks of different brain structures among themselves, ensure the biological and/or social expediency of general information activity in it [3-6].

SEARCH METHODOLOGY

Solving this problem requires considering the critical importance of two facts, the first of which is one of the postulates of information science. It claims that any information has its own “carrier,” that is, some structure in which relevant information can be fixed (encoded). Neural networks of the brain as well, along with any informational devices and biologically functioning systems, implement this principle [7]. In our case, the “carriers” of information in the functioning of the brain are the neuronal networks themselves, which, depending on their spatial structure, temporal parameters of their activity, and on belonging to specific brain structures, can record (encode) relevant information that can be remembered during life by a living being.

CASE DESCRIPTION

The second of the aforementioned two facts, from which we have to start in order to point out the fundamental role of the phenomenon of spontaneity in the informational activity of the brain, is a fact that, in the middle of the last century, became known from the clinical practice of the Canadian neurosurgeon W. Penfield [8,9]. During brain surgery for epileptic seizures, Penfield discovered the following. He irritated a group of neurons in the temporal cortex, which is responsible for recording the experience accumulated by a person. Then, to the question “what do you feel now,” the person answers this question (such a dialogue is possible due to the absence of pain receptors in the nervous tissue). In the context of modern knowledge about the brain, the answer can explain how accumulated experience is actualized and can be applied. Here it should be taken into account that the operated person, focusing on what he feels ("sees"), forms his speech activity. The operated person, depending on the localization of the irritating electrode in cortical fields 20 and 21 (according to Brodman), “sees” (restores in memory) an episode of her (his) past life in the form of representations (dynamically changing mental images) and can describe it in detail.

For example, one of Penfield’s patients described, down to minor details, the episode of her first meeting with her father after his return from the Second World War [8,9], which took place several decades before the moment of this brain operation. Moreover, if the electrode was held in a given area of the cortex for a long enough time, irritating the same cells, then this dynamic of mental representations (mental images) was constantly interrupted at the same place of the episode and later repeated from the same place. This phenomenon indicated that the information about the past represented in this episode (sequences of mental images changing over time) was recorded precisely in the structure of neural networks of the brain, the elements of which were those nerve cells stimulated by the electrode. Here we can state that thanks to such “artificial” activity of these neural networks, there is a certain “shift” of information from the past to the present in order to use this information to regulate behavior (to answering the question). Another preliminary conclusion from this surgical practice should be that the bioelectric activity of neural networks of the brain, which fix in their structure the experience accumulated during life, is a direct physical factor that “reads” information from neural networks through mental representations.

DISCUSSION

Now we can conduct a more thorough analysis of this neuropsychological fact within a broader context that takes into account the “artificiality” and lack of biological (or social) expediency [3-6,10] of the actualization of the described episode in the conditions of the operation. Indeed, in natural conditions, a person usually restores in her memory primarily what is directly related to the solution of her immediate or long-term life problems, which have biological (or social) expediency within the framework of

1Due to the war in Ukraine and the impossibility of using his archives, the author in this reference cannot indicate the pages and provide the relevant quote from the books of W. Penfield and others, translated into Russian, with the patient’s explicit statements. The author is unsure which of the two specified books contains the described fragment. However, this episode was most likely described in both sources indicated here.
her subjective values [3-5,10]. At the same time, “artificial”
stimulation of the brain in this experiment actualizes a
memory fragment, which is not significant for the patient to
solve her immediate or long-term problems. In addition, we
must also consider the indisputable fact that the information
here is presented to the operated person in the dynamics of
mental representations (images).

Further, our last closing conclusion from this experiment is
as follows: it is unlikely that the patient could reasonably
answer the psychologist’s questions during the operation
if a sequence of mental representations (images) had not
been formed in her brain due to the “artificial” excitation
of the corresponding neural network, which allowed her
to restore in her memory (“see”) an episode from her past.
In this case, she would not have that informational context
that did not unexpectedly and arbitrarily appear “before
her” during the operation and which allowed her to answer
the question “with knowledge of the matter.” In other
words, she would not be able to skillfully orchestrate the
muscles of her tongue and larynx to answer the question
if she did not “see” the contents of the dynamics of the
representations in which information about her past was
presented to her. Furthermore, here we must consider that
such an informational process of behavior regulation based
on experience obviously cannot occur without the mediation
of mental phenomena, at least mental images.

Below, we will consider the role of spontaneous activity of
neural networks implementing the function of long-term
memory within the framework of the above-described
experiment and its interpretation. For this, we will need to
again compare the actualization of memory in the “artificial”
conditions of the described experiment with how it normally
occurs during informational activity in the brain. However,
first, let us point out the crucial point of how the phenomenon
of spontaneous activity of neural networks can occur in
the brain’s neuronal cells. Without going into details, let us recall
that for a spontaneous activity to occur in neural networks
of the brain, it is necessary that the relevant neurons in
them accumulate energy through the mediation of known
biochemical mechanisms [11] and then spontaneously
discharge it during bioelectric activity. Further, suppose that
neural networks functioning as “carriers” of information are
spontaneously excited in the brain (either by themselves or
due to the spontaneity of other neural networks). In that
case, according to the Penfield experiment, this bioelectrical
excitation should actualize the information fixed in them
in the form of the dynamics of mental representations
and thereby ensure its application for regulating the

Thus, this spontaneous activity of the neural “carrier” of
information forms a person’s ability to “see” an episode from
her past in the present. Moreover, it does not matter whether
this spontaneity will be realized by the neural network that is
the “carrier” of this experience or by other neural networks
of the brain that were able to initiate spontaneous activity
and thereby actualize the information fixed in another
neural network that is its “carrier.” (In Penfield’s experiment,
the “carrier” of information was excited by an object external
to the brain, namely, an electrode).

Further on, we should be interested not only in the
actualization of past experience in the present but also in the
context of this actualization of information about the past,
which should accompany any actualization of information
in the conditions of the natural functioning of the brain.
The need to actualize information is usually formed when a
person needs to use a particular experience fixed in his brain
(patient W. Penfield did not have such a need during her stay
on the operating table). In this case, we can now assume that
the actualization of information currently necessary for a
person and fixed in a certain “neuron carrier” can be carried
out through the mediation of other neural networks. These
networks, for example, might belong to neural structures of
the brain which can more effectively implement spontaneous
activity and, at the same time, implement other informational
functions related to the ability to evaluate the biological (or
social) significance of information [3,5], including evaluation
of fragments of personal experience.

Obviously, such neuronal structures of the brain should
not only be more capable of spontaneous activity but also
implement, in connection with this spontaneity, the function
of memory management and, in general, the information
process in the brain. Such spontaneous (intra-cerebral)
triggers of actualization of expedient information in the
brain during the information process can be neural networks
of brain structures, which, one way or another, according to
their functional potential, are related to the evaluation and
selection of information necessary for solving problems.
First of all, such brain cortical structures include the frontal
cortex, the cingulated cortex, and the insula [12]. Among the
subcortical structures, we can mention the hypothalamus,
the amygdala, and some large nuclei, in particular, the
adjacent nucleus, which are related to the realization of
mental phenomena that have an evaluative function, such as
feeling pain, experiencing pleasure or displeasure, fear, rage,
etc. In our works [3,5,10], these brain structures received
the status of management since, in our opinion, they are related
to the realization of the ability of living beings (including
humans) to subjectively evaluate the biological or the social
significance of information and decision-making, which
indicates their managerial function. The ability for subjective
evaluation can be realized in the brain through the already listed emotional manifestations, such as fear; the experience of pleasure or displeasure, disgust, and even aesthetic or ethical evaluations.

Now, taking into account the analysis of the clinical case carried out here, we will form a hypothesis that could explain the phenomenon of the spontaneity of neurons and the neural networks formed by them within the general informational activity of the brain. When actualizing long-term memory in natural conditions, the brain's neural networks that record information in their structure, should be optimally excited to prepare the information fixed in them for use. In other words, the bioelectric impulse is, as in the above experiment by W. Penfield, a factor of “reading” of the information encoded in the neural network, which includes the information that is “read” (actualized) to the general informational context that occurs in the brain. However, if, as a part of the experiment, this actualization was caused by the “artificial” irritation of the electrode from the outside, not only of the brain but also of the entire body, then in the conditions of the natural informational activity of the brain, such a reason is probably the spontaneous activity of neural networks of other brain structures, which, producing their spontaneous activity, “force” neural networks, which are “carriers” of information, to also perform a spontaneous activity together with them. Such managing neural networks should spontaneously actualize expedient information within the framework of the general information process currently taking place in the whole brain.

This hypothesis about at least one of the manifestations of the phenomenon of the spontaneity of neural networks of the brain during information processing, which ensures the information process through the actualization of information, is also indirectly confirmed by the following idea about the functional properties of neural networks of the brain. If we resort to the analysis of the activity of the most primitive neural networks of the brain, namely, those that can be called stimulus-reactive (or unconditioned reflex) networks, then it should be “obvious” to us that their informational activity, based on their functional opportunities, does not need spontaneity. (Here we can note that certain biochemical processes can internally only strengthen the external stimulus-reactive response trigger). Furthermore, they skillfully implement their function of transmitting information (signal) from the sensory input to the corresponding motor output through a bioelectric potassium-sodium “standing wave.”

The functional primitivism of such neural networks lies in the fact that they cannot accumulate new experiences during their lifetime, so they “use the services” of genetic experience only, being formed on its basis [3]. They are also unable to integrate (in the sense of G. Tononi’s Integrated Information Theory [13] this experience, genetically fixed in their structure, with other information fixed in other stimulus-reactive neural networks, no matter how complex their neural network structure may be. So, their generalized evolutionary “disadvantage” is that these neural networks cannot form new and biologically expedient motor acts in response to new external stimuli at their “motor end.” However, the main thing we must consider here is that they do not have to be spontaneous, as they function skillfully in response to routine “genetically programmed” stimuli, being activated exclusively from outside a local neuronal informational stimulus-reactive system.

At the same time, “mentally active neural networks” [3], with which we are dealing in the described above experiment by W. Penfield, in contrast to stimulus-reactive neural networks, are able, precisely due to spontaneity, to accumulate experience and use it in the orchestration of the muscular activity of a living being. This ability allows “mentally active” living beings (and most successfully humans) to form biologically or socially expedient behavior in response to external novelty in a probabilistic environment.

CONCLUSIONS

The hypothesis formed here, explaining the phenomenon of spontaneous activity of neurons and the neural networks formed from them within the framework of the general informational activity of the brain, implies if it is confirmed, the following conclusions:

1. Spontaneous activity of neural networks of the brain, as a physiological phenomenon, is functionally related to the purely informational phenomenon of access to information, long-term fixed in the corresponding cortical neural networks, to the possibility of its evaluation, processing, and application in regulating the behavior of living beings that have a mentally (psychically) functioning brain.

2. Another significant conclusion from the analysis of the experiment described here by W. Penfield is that, probably, during the processing of information in the neural networks of the brain, mental (psychic) phenomena play a much broader functional role than it could be predicted based on the analysis of the indicated the experiment of W. Penfield and what was pointed out here in point 1 of these conclusions (such a broader functionality of mental phenomena during information processing in the brain is described in detail in works [3,6,10].
DECLARATION OF CONFLICT OF INTERESTS

There is no conflict of interest due to the presence of only one author of the article.

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