On the Rationality of the Appearance of Consciousness

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This paper tries to reveal the rationality of the appearance of consciousness in the evolution of the universe. Difficulties in understanding consciousness can be boiled down to two problems: the possibility of causality breaking and the origination of truth. By virtue of structural information from the neural networks, this paper gives a causality breaking description of the nervous system and promoted that the biological feelings can be abstracted as a mapping from the nervous system to the world of cognition. Cognition reflects the causality conserving experience, at the same time, it's also connected with the causality breaking expectations. The mathematical description of transformation law provides a proper definition of truth, which makes cognition possible and integrate the framework. The hole theory is consistent with structures of the nervous system and biological feelings, which makes it a scientific framework of understanding consciousness.

Keywords: consciousness, causality, feeling, neural networks, space-time, experience, truth, cognition

INTRODUCTION

Although physics has helped us understand a lot about the nature of the universe, we know quite little about the nature of ourselves. The appearance of conscious lives seems to break laws of the universe and our spirits felt like independent from the outside universe. With lots of reasonings and inductions, I believe all difficulties in the understand of consciousness essentially come down to two problems:

Problem 1 *The ability of thinking of a conscious life do not obey the causality of what happened in the universe.*

Problem 2 *A conscious life is capable of feeling the truth of things, where the truth is not simply a truth-value in a logic system.*

Expecting things is a kind of nature of a conscious life. Since thoughts do not obey the causality of what happened in the real world, if there is any "law" of consciousness, it must break causality of events in the expectation system. It is known to us that causality is survived in the relativity space-time with every thing moves slower than the speed of light. However if one wants to extend the theory describing a space-like particle, he/she will fail with a lot of problems.

Actually this failure is inevitable because of the wrong motivation. In the evolution of the universe, if any system contains a quantity constancy for the description of the system and "events" inside all take larger values of the quantity, it's possible that "events" in that system can be described as a kind of "superluminal" (fast-than-light) like theory, which breaks causality of the events inside. This possibility does exist in the system of human brain. With some observations of the physiological structures of the nervous system, I make a separation between mind state and time state in the mind, construct a space-time like description of the nervous system, where the event actions can be described as causality breaking transformations.

At the same time, we know that causality breaking cannot be just a description, it must be felt so that it comes into our mind. With the generation of feelings well understood biologically, the problem left to us turns out to be the understand of their reality. Since it is the biological functionalities of neural networks make feelings possible, we regard the feelings with their functions well implemented as real and see if it's possible to realize cognition. Taking this in mind, feelings can help form a map from the space-time system of the nervous system, or simply refered as the neural space-time, to the world of things we understand, the world of cognition. And what is important then, all the cognition and understand about things in the latter world can be felt as real, making it different with a imaginary world of logics.

In this paper, I first present a mathematical description of a causality breaking neural space-time. Then with the help of biologically feelings, I introduce a field picture describes the mapped world of cognition. Integrating the two parts together, I further illustrate the brain mechanism of cognition, showing that the causality breaking expectations and the causality conserving experience make the feeling of truth possible in the neural space-time. In the last section, I briefly review the theory and talk some interesting aspects.

THE CAUSALITY BREAKING EXPECTATIONS

The Central Nervous System (CNS) of mammals manipulate all mental feelings. It contains billions of neurons and trillions of synapses which form innumerable complex networks. The functionality of these webs are implemented through the transmission of neural stimuli, activating and deactivating specific functional proteins. It's worth noticing that structures of these neural networks contain much symmetrical information. One of the most attracting feature is the up-down inverse symmetry between the networks in the Primary Motor Cortex and the networks in bodies [1].

For understanding effects of this structural inverse

symmetry, we simplify the phenomenon into a toy model as shown in FIG.(1). First the model without inverse symmetry is constructed considering that networks in the brain and those in the limbs can be functionally connected. This is supported by the fact that typical neurons in the Reticular Formation (RF), which is an crucial structure connecting ascending neural stimuli and the descending ones, contain both axons extending up the other CNS structures and axons extending down to the spinal cord [2, 3], and studies have shown that not only these neurons are anatomically connected, but also the ascending/descending stimuli are functionally connected [2, 4]. If we represent the ascending stimuli outside the surface and the descending stimuli inside, this ring-like structure just indicates that both kinds of signals won't be logically connected after their creation. But if the symmetry is inverted, as shown in the right part, the Klein-bottle-like topology breaks down the inner-out separation and gives us reason to mathematically connect them.
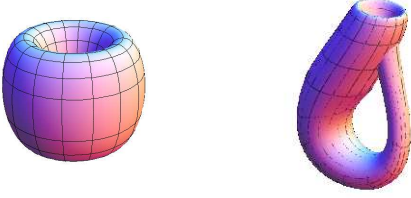

FIG. 1: Up-down neural network inverse symmetry of the CNS

Since our instant feelings of the outside environment come up with the same speed as the passing of time, while our expectations in mind don't, I separate treating these networks, calling those in brain as "mind states" and the ones in body as "time states". Then, if we represent an ascending activate mind state by ξ, a time state by ζ, and their descending state by $i\xi$, $i\zeta$, this inverse symmetry can be reflected by a sign difference in the metric tensor of $(\zeta, \xi_1, \xi_2, \xi_3)$ spanned space-time [5], that is,

$$g_{\mu\nu} = g^{\mu\nu} = diag\{1, -1, -1, -1\}. \quad (1)$$

Here I take the dimensions the same as space-time of real world considering that our understand of the real world can reflect the logical structures of our feelings. However, there is no difficulty if one tries extending to higher space dimension.

As just said, the ζ component takes a constant speed "c", if causality is broken, then the corresponding quantity for mind states should be larger so that expectations are possible. Then, a causality-breaking relativity space-time should satisfy the following postulates:

Postulate 1 *Constancy of the speed of time state.*

Postulate 2 *Cognitions are invariant for all subject observers.*

The "speed" here can be understand as a kind of "processing rate", the dual structure in FIG(3), which will be illustrate later, indicates that this "processing rate" of expectation can be faster than that of time state. And the "subject" here is quite similar to the "inertial" in usual special relativity. Considering properties of the neural networks, we give up isotropy of the space time but keep the homogeneity as an approximation. This means the loss of rotation invariance and therefore we just need to talk about the Lorentz boost. In this section, I first build a causality breaking description of the neural space-time system, making it consistent with the structures of the nervous system. But since cognition is involved with our understand, it must relate to the mapped world, I postpone the explain the invariance of cognition.

The mathematics is now quite similar to those so called "superluminal" analysis [6, 7]. Have in mind that only the "superluminal" scenario is considered, we have

$$\zeta^2 - \boldsymbol{\xi^2} = -(\zeta'^2 - \boldsymbol{\xi'^2}). \quad (2)$$

Then the coordinate transformation law from frame R to R$'$ (where R$'$ moves with u with respect to R) is:

$$\begin{aligned} \boldsymbol{\xi}' &= i\boldsymbol{\xi} + \rho(\boldsymbol{\beta} \cdot \boldsymbol{\xi})\boldsymbol{\beta} + \gamma\zeta\boldsymbol{\beta}, \quad (3) \\ \zeta' &= \gamma(\zeta + \boldsymbol{\beta} \cdot \boldsymbol{\xi}), \end{aligned}$$

where $\boldsymbol{\beta} = \dfrac{\boldsymbol{u}}{c} > 1, \gamma = \dfrac{\pm 1}{\sqrt{\beta^2 - 1}}$, and $\rho = \dfrac{\gamma - i}{\beta^2}$

The sign in front of the γ depends on the forward or backward direction of movement. A crucial problem of "superluminal" physics in space-time dimension higher than 2 is that the Lorentz boost takes coordinates of either along or perpendicular to its direction into imaginary. This is happening because the space-like dimension is different with the time-like dimension. But considering that all time states naturally come up with the same step, it's not reasonable extending the time-like dimensions. This difficulty in space-time universe turns out not a problem in the neural space-time. As in our definition, the imaginary component simply change its direction, which is quite possible happening in the real neural networks. Since the time state is always interacting with environment, in Eq.(3), I have made an substitution so that the time coordinate as well as the boosted coordinate keep real. What need to be aware of is the additional minus sign in compositions. For convenience of later use, I rewrite the Lorentz boost, or Expectation as following:

$$x'^\mu = L^\mu_{\ \nu}(\boldsymbol{\beta})x^\nu, \text{ where } x^\mu = (\zeta, \boldsymbol{\xi}),$$

$$L^\mu_{\ \nu} = \begin{bmatrix} \gamma & \gamma\beta_1 & \gamma\beta_2 & \gamma\beta_3 \\ \gamma\beta_1 & 1 + \rho\beta_1^2 & \rho\beta_1\beta_2 & \rho\beta_1\beta_3 \\ \gamma\beta_2 & \rho\beta_1\beta_2 & 1 + \rho\beta_2^2 & \rho\beta_2\beta_3 \\ \gamma\beta_3 & \rho\beta_1\beta_3 & \rho\beta_2\beta_3 & 1 + \rho\beta_3^2 \end{bmatrix},$$

and when there is no confusing, we simply write:

$$x' = Lx.$$

In quantum physics, since Lorentz transformation obeys causality, the transformation itself don't have any physical effects. However in the neural space-time, any Lorentz boost as an activity of mind has to be felt. This actually gives reason to our feelings of causality breaking expectations. Namely, a *Lorentz boost* in this paper actually represent a *Expectation*.

TRUTH AND COGNITION

The generation of feelings in the brain seems simply like the activation of neurons biologically. But this is just one side of feelings. The activation of independent neurons won't be connected with consciousness. To make a feeling come into ones mind, their effects must be known to each other. Therefore, a feeling in mind relies on collective effects of neurons. Since these effects depend on neural stimuli transmitted among neural networks, we can describe them as fields, which are themselves functions of the transmitted stimuli. In my framework, the movements of stimuli can be represented by a neural space-time point, so a field can hence be represented as $\phi(x)$. And since any of the feelings are invariant under the transmission of neural stimuli, the field $\phi(x)$ is also invariant under the transformation of x.

The process of cognition as an effect in our mind behaves as kind of feeling, hence it's also invariant. But at the same time, cognition is beyond a kind of feeling, events in the world of cognition are things that are causality related and the completion of a process of cognition also include the judgement of truth, which itself is another kind of feeling. Therefore to understand the cognition, we need to look into causality related events in our memories.

Remembering the generation of different tissues via selective expressions of genes in the morphogenesis, anatomical structures as well as main part of the network structures of the nervous system are determined during the grows of embryos. However, the proliferation, differentiation especially the synaptic structure have plasticity almost in the hole lifetime, except the plasticity decrease with the grow of a mature individual [1]. Therefore, the formation of the synaptic structure and expression of the functional protein help with the formation of memories, and this means that what our memories in the brain, although behave like events in the world of cognition, are basically sets of feelings in the neural space-time.

With this understand, we can regard any kind of field in the world of cognition as superposition of fields of feelings, invariance is therefore kept and fields in the world of cognition are causality connected. It is now interesting to investigate the cognition in the form of FIG.(2), where the mind states have been projected to the X-Y plane of the Cartesian coordinate system while the time state is represented by the Z-axis. Since memories of present things are recorded along with things happening in the real world, our experience about things obeys causality of the outside world. At the same time, because of the constant processing rate, all the experience is recorded on the surface of the cone. We name this cone the truth cone to reflect its causality conserving property. On the other hand, our expectations are capable of breaking causality, which take our feelings about one thing from a point on the surface of cone outside the cone.
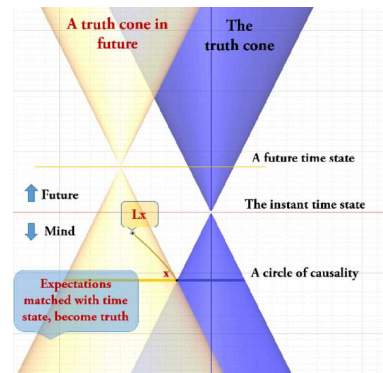

FIG. 2: Expectation can be experienced as truth in the future, giving a inverse transformation L^{-1} for Lx, turning it into real, and making the thought related with x causality connected to this future truth cone

Expectations take place all the time, but to complete the process of cognition, these expectations need to be felt as truth or fake. From the transformation law in Eq.(3), we see that the boost takes components perpendicular to its direction into imaginary, if we take the real component and imaginary component as different kind of feelings,[11] then we can define the feeling of truth by boosting backward to get a real quantity, enhancing the feeling of real components. And since we've take the time state as a real component, this also indicate that the process of cognition can help enhance our excitabilities.

With the truth proper defined, the framework is now integrated. Some examples can be helpful to understand this theory. We note that language as a window of our minds communicate with the outside world, can be very related with the process of cognition. However, when one tries to understand language phenomena with logics, the obscurity of words and the stringency of logics contradict with each other, generating a lot of problems. Here I take the sentence "The king of France is bald." as an example, which has been widely discussed [8, 9], reflecting the puzzle of the "Apparent reference to nonexistents", and try giving an explanation using this theory. Related properties of Human, King of France, Bald, will be represented with fields $\phi_H(x)$, $\phi_K(x)$, and $\phi_B(x)$ respectively.

Without expectation, firstly, cognition is possible though superposition of feelings with respect to the same space-time point. For example, when we think about: "The king of France is a human." the neural space-time point governed the thinking is true for both the field of $\phi_K(x)$ and $\phi_H(x)$. Therefore the truth of the logic is also known to us. This can be understood symbolically as:

$$\forall(x \in K)(\phi_K(x) \to \phi_H(x)). \tag{4}$$

Then if we think about nonexistents. Say, "The king of France is bald." This can be understand though the expectation taking a bald man the king of France.

$$\exists L(\exists(x \in B)(Lx \in K) \tag{5}$$
$$\to (\phi_B(x) \to (\phi_B(Lx) \land \phi_K(Lx)))).$$

Here because the $\phi_B(Lx)$ and $\phi_K(Lx)$ are both imaginary, we can think about them, but truth won't be felt from this expectation. Imagining that one day you have a journey to France and see a bald king of France in real, the time state then will recall this expectation, generate the inverse boost L^{-1} for this expectation and give you feeling of truth. Therefore, we see that our cognition here based on our experience of "France", "King", "Human", our expectation of experience, which is triggered by the time state of that you see the example sentence in my paper. And our knowledge of relationships among them is determined by fields, which is superposition of feelings, and invariance under boost. The process of cognition is complete but nothing new is understood by your mind since the expectation is not matched as truth.

ANATOMY OF COGNITION

I introduce the notion of filed with deduction, but our understanding of the cognition can also be supported by anatomical structure of the human brain. As shown in FIG(3), the thalamic in the center are connected with fibers down to the spinor cord while the cingulate cortex just connected within the brain. This forms a dual structure of the Limbic system, the larger one is a bit like the Papez circuit [10] illustrating the movement of emotions and the smaller one, in a degree duplicate the larger circle. Since the smaller circle is connected with the downward networks though the thalamic, the speed of a time state can be understood as the processing rate of neural stimuli in the smaller circle. At the same time, the size of the larger circle implies that the processing rate of mind states can be larger than that of time state, which is consistent with our causality breaking picture.

At the same time, if we take into account their connections to the cerebral cortex, where memories are stored, we can have an understanding of the anatomical structure of the cognition process. In FIG.(3) you see that the pathway of time state is clear in the hippocampus, while the pathways of expectations, although have a large multiplicity, meet an additional matching, determining if it can go into the hippocampus. The matching here happens between the time state and the expectation, which means it provide the part judging the reality of expectations. If we take the future time state in FIG.(2) to an instant time state, then the truth cone given by the time

state can provide inverse boosts to those expectations on it, generating causality relationships among those expected events. As a result, those expectations which are known as real will go though the matched pathway enhancing your excitability, while the unmatched ones will turn back and increasing your curiosities.
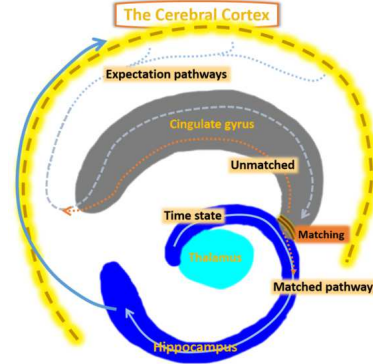

FIG. 3: The dual circle structure of the Limbic system, and a sketch map of the cognition process

SUMMARY

Understanding of the consciousness turns out composed of several parts in the framework. The causality breaking description of neural space-time, the mapping from the neural structure supported space-time to the world of cognition, and the feeling of truth in the process of cognition. "Superluminal" like description makes it possible to break causality and thus provide an explanation of expectations. The biological feelings in this theory are understood as maps. This crucial in that the mapping actually helps us separate functions of the neural networks and the biological implementation of feelings, theoretical works with the functions can then move forward along with experimental analysis of the implementation. And realizing the feeling of truth in the end complete our description of the cognition process, which makes it possible for an individual to understand things.

It is interesting that nature gets the property of self-similarity. We understand the space-time of the universe though our mind, and according to this theory, our minds turn out again space-time like. What's more, to understand ourselves, we construct a third time a space-time like theory. But be aware that the space-time is quite different from one another, all these thinkings should be rational with the causality breaking nature of expectations, as well as consistence with biological knowledge.

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[11] We've taken the ascending state as real and descending one as imaginary, but this is just for simplicity. One can take all of them as complex numbers and demonstrate the calculation, more interesting things will appear then.