Four-dimensional mind: a solution to the mind-body problem

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Keywords: The mind-body problem; Spacetime diagrams; The unconscious mind

Abstract: The mind-body problem is a topic debated by philosophers over centuries. With the rise of neural science, psychology, and various functional brain imaging techniques, some new solutions to this century-old problem are able to emerge based on multiple cutting-edge research. This work attempts to generate a new view on the mind-body problem by firstly incorporating spacetime diagram into the solution process. Each region of the combined spacetime diagram is then categorized by their unique features that were selected based on recent psychological and neural scientific discoveries. Finally, the potential problems solved by this perspective of the mind-body problem are discussed.

1. Spacetime diagrams

Spacetime diagrams are two or three-dimensional representations of events happening in the actual four-dimensional universe with the horizontal axis being space dimension and the vertical axis being time dimension. In Fig. 1, space is compressed into a planar, two-dimensional representation, the three-dimensional spacetime has been divided by two opposing cones named light cones. The light cone is constructed by multiple light rays originating from the origin labeled the observer, each individual path traveled by a photon is named lightline. Due to the invariance of light speed, the slope of each lightline is the light speed. The light cone resided on the positive side of the time axis is named the future light cone and the opposite light cone is called the past light cone. Inside the region bounded by the future and past light cones are a set of events that can be accessed by the observer when traveling less than the speed of light. Inside the future light cone region it is called absolute future and the opposite region absolute past. Because the observer at the origin has a smaller time value when compared to the events in absolute future, the observer can have a cause-and-effect relationship with any event within the boundary imposed by future light cone. Likewise, events in the absolute past region can also have this relationship with the observer (Penha, N., and Rothenstein, B). The rigorous mathematical formulation of the light cones and other prominent features of spacetime diagram are interesting topics but are beyond the scope of this work. The basic construction and understanding of the spacetime diagram are enough to initiate the discussion about the connection between the mind-body problem.

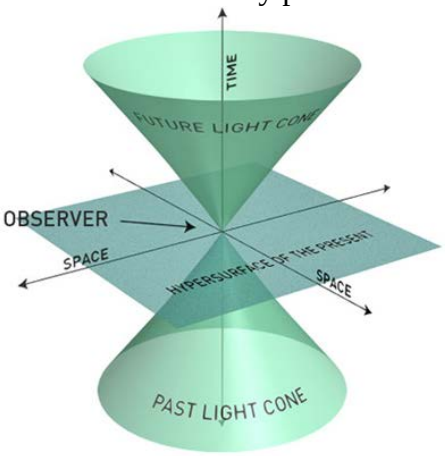

Fig.1 A three-dimensional spacetime diagram

  DOI: 10.25236/cstss.2019.043

2. The mind-body problem

The mind-body problem can be regarded fundamentally as the problem arising from the inconsistent properties of the physical world and the mental world. Humans are animals, with a physical body existing strictly as a three-dimensional object. We are capable of perceiving other physical properties such as weight, color, shape, etc through the medium of spacetime. On the other hand, we also possess an inner life, our subjective experience of emotion, intentionality, desires, and so on. The physical properties of the external world are objective, meaning that they can be perceived by everyone else. Mental properties, however, are purely subjective and can not be directly experienced by others. The distinction between the two realms of perception is the fundamental incongruity explored by the mind-body problem. There are mainly three types of view on this subject. The first view is named the materialist view. Materialists view this distinction as a false dichotomy because mental states are also a form of physical state. All the apparent non-physical properties of the mind can all be explained by physical processes. The second view is the idealist view, which states that the physical world is an empirical world and everything physical about the world arises from the collective mental states of all observers. Finally, there is the dualist point of view, which states that both aspects are essential perspectives making up the perceivable reality and they can not be reconciled consistently (Robinson, 2017). This article will take on the dualist perspective of the mind-body problem, referred to "interactionism" which is more precise due to its intuitive nature. Interactionism is a variety of dualism that stresses the interaction between the mental and physical realm. There are obvious counterarguments to this view such as how can the two drastically different properties influence each other? Many philosophers and physicists have gone to great lengths trying to offer a rebuttal with no definitive result. The technicalities of this point of view are beyond the scope of this article, rather, this work attempts to utilize this view of the mind-body problem to point out the fundamental discrepancy between the body and the mind and how spacetime diagrams might offer a solution to this conundrum.

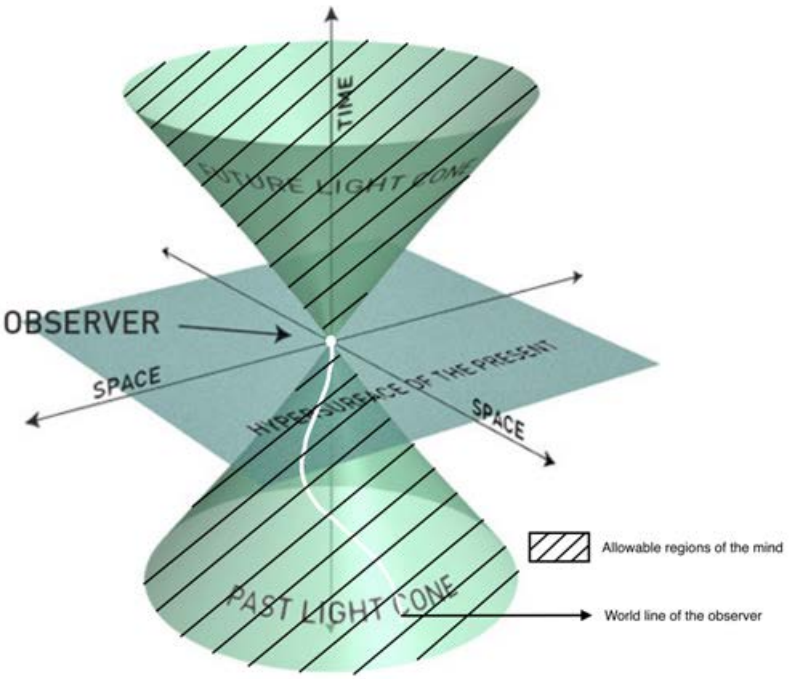

Fig.2 Mind and body inside a three-dimensional spacetime diagram

3. The body and the mind in a spacetime diagram

Based on the dualist perspective of the mind and the body, each portion can be analyzed separately. We can start by exploring the place of the body if we were to place it inside a spacetime diagram. The body is considered to be a material object, in other words, a strictly three-dimensional

object with one but constantly evolving temporal coordinate. This places the body alongside with other objective physical objects in our universe and is consistent with the illustration in Fig. 1 with the body being the origin.

According to our daily experience, we constantly engage in mental activities such as daydreaming, mind-wandering, etc when we are not focused on a specific task. The root cause of this subjective yet ubiquitous experience has not been officially discovered until functional brain imaging techniques have become widely available. The paper announcing the discovery of the brain's default mode network (DMN) was first published in 1997. Shulman et al investigated the subjects' brain activity by subtracting the task scans from the resting-state scans. What they have discovered is that the brain is constantly involved in activities yet to be categorized while no stimulus has been given to the subject (Shulman et al., 1997). Since then, the activities that are involved with the activation of the DMN has been systematically categorized based on the anatomical structures of the network and their resulting behaviors. To summarize, the mental activities related with the DMN are primarily: emotional processing, self-referential activity, recollection of prior experiences, and spontaneous cognition, including daydreaming, mind-wandering, thoughts about one's past and future (Raichle, 2015). Furthermore, the brain weighing 2% of an adult's body mass consumes 20% of the body's energy, but less than 5% of its energy consumption is altered when the brain is dealing with task-evoked activities (Bargh, J. A., and Morsella, E., 2008). How could controlled thoughts require less energy to process when compared to uncontrolled mind-wandering? More counterintuitive results appear when we examine the work done by Benjamin Libet.

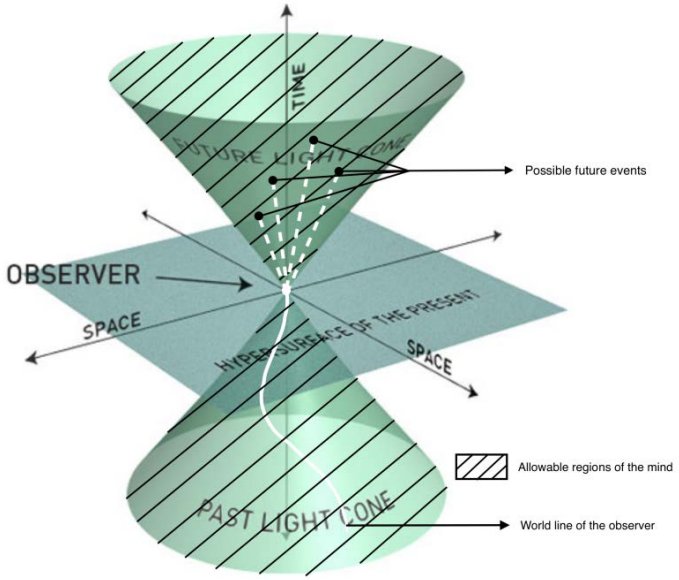

Fig. 3. Mind and body inside a three-dimensional spacetime diagram with foreseeable future events.

In Libet's experiments, the subjects are asked to perform some simple motor tasks such as button pressing based on visual cue, the time between the volition of action and the actual action is recorded. While the subjects are performing the actions, EEG electrodes are also used to monitor and record the subjects' brain activity when performing the tasks. Then, the time interval between the reported intention and the action is compared with the EEG recording of the same action. The surprising result after comparing the two time intervals is that the brain's signal of the activity, later known as readiness potential (RP), precedes the actual action by around 200ms, raising multiple problems regarding determinism and the existence of free will (Libet et al., 1993). Since the original experiment, multiple studies have been conducted to further understand the nature of RP. Libet originally theorized that RP is a precursor for definitive action to execute. However, using a modified version of Libet's original experiments, more up-to-date studies have shown that RP does not necessarily signify execution. It has been shown that despite the accumulation of RP to an apparent point of no return, the action can still be canceled willingly by the subjects (Fifel, 2018).

With these unusual temporal characteristics of the mind, when attempting to plot the mind inside a spacetime diagram, we have to consider all the possible regions that the mind may reside regardless of whether we are consciously aware of its perceived temporal location.

4. Causality and the mind inside the future light cone

In our normal understanding of causality, only events from a prior time coordinate are capable of influencing events in the present. Likewise, only events from the present can influence events in the future. This forward causation has been the most intuitive and understood relationship between casualty and time. Such form of causation is also applied to the understanding that the mind and the body both exists in the present: when we see danger, the mind tells us to avoid it by walking away; when we cut our hand in the present, it will bleed in the near future. This view of the place the mind and the body occupy in a spacetime diagram, however, becomes questionable when we consider the problems introduced earlier. This perspective is also inconsistent with Fig. 2 when we try to plot the body and the mind separately because they will simply overlap. As a result, the interaction between the mind and the body and the nature of the mind have to be reconsidered.

When we examine the possible residing place of the mind in the context of Fig. 2, it becomes obvious that since the mind occupies regions inside a spacetime diagram, the mind can then be defined as a subjective four-dimensional object with the present mind being its three-dimensional time slice. In other words, in the present, the mind would have access to the past and the possible future of its subjective world line and is allowed to travel between them. This ability corresponds to the DMN's activities such as future planning, self-reflection, and memory processing. Terms such as possible future and future planning are used because this work does not embrace deterministic ideas such as the block universe theory or superdeterminism, rather, supports the non-deterministic view of the growing block universe where the future does not exist while the present and the past do. But if this is the case, natural questions arise from this four-dimensional mind perspective such as if the future does not exist, how can the mind be allowed there? How can a three-dimensional body give rise to a four-dimensional mind? How do a four-dimensional mind and a three-dimensional body interact? This work will not be able to answer all of the potential questions that may arise from this perspective but will attempt to solve some of the more tracTable ones.

One of the problems this article aims to solve is how do the mind and the body interact on a theoretical level. If we were to graph the mental process of future planning, it would look similar to Fig. 3. In Fig. 3, the black dots inside the future light cone are possible events that are casually related to the present. It is worth noting that some future events may not appear to be consciously known but are still perceivable by the unconscious mind. As the three-dimensional observer travel along the time axis, regardless of it being a conscious or unconscious choice, the mind has to actively select one single future event for the body to experience. In other words, the mind selects what future event will become the present based on the information given by the present and the mind's ability to gain insight into the future. When such choice is made, the mind guides the body through spacetime so it will experience the selected future event and other unselected future events fail to be an integral part of the observer's world line and become imagination when the temporal value of the observer becomes greater than the events' just like previously defined. For most of our daily experience, the mind appears to be an excellent guide to our daily routine: we know to go to the grocery store when we run out of eggs, we know to arrive at the scheduled location on time for a meeting, etc. These activities that involve in active conscious preplanning and information gathering can be defined as foreseeable future events because the mind in the future is influenced by the present. On the other hand, there are countless instances when our mind tells us the decision of choosing certain events in the future rather than the others without our conscious awareness, these instances are often named "gut feelings", "instinct", etc. Whether instinct chooses an event that has a "good" or "bad" outcome is not the concern, but rather, the action of selecting certain events over the others unconsciously can be then defined as the process of selecting unforeseeable future events.

5. The fight for control

The relationship between the conscious and the unconscious mind is a complex topic explored by many in the field of psychology. In cognitive psychology, the unconscious mind has been equated with subliminal information processing. In social psychology, the focus has been the mental processes that the subject is unaware and their resulting influence. Some of the more recent view of the subject points to a behavioral mechanism guided not by the conscious mind, but rather, the unconscious mind. Our unconscious mind not only adapt us to the present, it also acts as a guide to our future behaviors (Bargh, J. A., and Morsella, E., 2008). This action is congruent with the "hierarchical prediction machine" approach where the mind is consistently seeking to unify its incoming sensory input information with its predictions (Clark, 2013). This view of the mind would also solve the problems generated by Libet's experiments and later versions of the original experiment. The core discrepancy generated by these experiments is the temporal mismatch between the RP and the conscious decision. In the perspective of the four-dimensional mind, preceding RP is the unconscious mind giving instructions to the three-dimensional body. However, the conscious mind may sometimes dominate the unconscious mind just like in more recent versions of Libet's experiments, after the RP has reached an execution threshold, the action is nonetheless canceled by the conscious decision.

In the four-dimensional mind perspective, the entirety of the mind can be defined by the two regions in the future and past light cones plus the present. The conscious portion of the mind include the past world line, the present, and all foreseeable future events. The rest of the region where the mind may exist can be subsequently defined as the unconscious mind. In this view, the conscious mind can no longer be defined as the counterpart of the unconscious mind, but instead, the "discovered" portion of the unconscious mind. This view, however, generates natural question such as if the conscious mind and the unconscious mind are the same, how can there be a conflict between them? This question can be answered by analyzing from the perspective of the conscious mind. The conscious mind has been considering the unconscious mind as a separate and inferior subliminal version of itself based on the past erroneous definition of the unconscious process. Past definition has been defining unconscious as stimulus processing one is not aware, but it should be defined as the result and influence of such stimulus processing unaware by the individual (Bargh, J. A., and Morsella, E., 2008). This view of the unconscious not only drastically boosts its credibility and importance in the decision-making process, but it also allows conflict between the conscious and the unconscious to be resolved. Before this view, an individual would quickly dismiss any influence exerted by the unconscious, leading to the dominance of the conscious mind. However, when one is aware of the importance of the unconscious, the conscious will be able to resolve this conflict by combining the conscious and the unconscious mind, leading to a unified mind overall.

This view would also explain the energy consumption of the mind at resting state and the little change of the mind during stimulus processing. According to the spotlight model of attention, we can only be consciously aware of one event or activity at a time. When we examine the spacetime digram, this model would translate to the conscious mind being multiple single points inside the diagram while the unconscious mind being the majority of the region. It naturally requires little energy change for the conscious mind to "navigate and discover" what is already there.

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