How subjective memories are realized in TGD inspired theory of consciousness?

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Abstract

We remember our conscious experiences, also as re-experiences, and not just as learned, often unconscious, behaviors that reduce to associations. In the standard ontology of quantum theory. The information of the conscious experience, if determined by the quantum jump, must be about the initial and the final states of the quantum jump and the transition between them. In the standard ontology of quantum theory, it cannot be represented by the final state of the quantum jump. According to the standard quantum theory, quantum states 3-D time=constant snapshots and do not remember anything about the previous quantum jumps.

In TGD, the zero energy ontology (ZEO) combined with holography = holomorphy vision suggests a universal mechanism of memory storage and recall. The slight non-determinism of the classical field equations, determining the space-time surface, implies that quantum states are superpositions of space-time surfaces analogous to 4-D Bohr orbits for 3-surfaces as particles. In standard ontology they would be superpositions of 3-surfaces.

State function reductions (SFRs) occur between these states and the information about the initial state (in 3-D sense) and about transition to the final state (in 3-D sense) is coded to the Bohr orbits associated with the final state (in 4-D sense). The slight on-determinism makes possible memory recall in ZEO. The proposed mechanism is universal and applies also to matter, which is usually regarded as "dead" (since it looks dead in the time scales of our perceptive abilities). This justifies the notion of the 4-dimensional brain.

In this article the notion of memory is discussed from the points of view of computer science and neuroscience, of quantum theories of consciousness, and of TGD inspired theory of consciousness.

Contents

1 Introduction

We remember our conscious experiences: also as re-experiences and not just as learned, often unconscious, behaviors that reduce to associations. In the following the notion of memory is discussed from the points of view of computer science and neuroscience, of quantum theories of consciousness, and of TGD inspired theory of consciousness.

1.1 Memory as challenge in computional and neuroscience approaches to consciousness

The notion of conscious memories is highly problematic in computional and neuroscience approaches to consciousness.

1. Computers completely lack subjective memory if they are what they are believed to be, that is to obey the Turing paradigm. Computers are also believed to be deterministic, either in the sense of classical physics or of statistical quantum mechanics. Since non-determinism is the basic aspect of conscious entities, computers are expected to lack conscious experiences. One can of course challenge the Turing paradigm and this is done in [L7].

2. In neuroscience, memories are often interpreted as mere learned behaviors. This view is a remnant of behaviorism. Associations provide a mechanism of memory and association is also the basic mechanism of the now fashionable large language models. This interpretation does not explain the episodic, experiential memories that we also have. Some of us have very intense sensory memories. All of us have dreams involving memories and the electric stimulation of the parietal lobes can induce lively sensory memories of the past events.

   Memories must be stored in some sense. In neuroscience, the finiteness of the memory space becomes a basic problem. If memories are "carved in stone", a large number of stones are needed and their number is increasing all the time. It might be necessary to give up some memories, most naturally the oldest ones. Computationalist would say that new data is written over the older data. What happens is just the opposite: the last memories to disappear are the childhood memories. The strong emotional content of these memories is certainly one reason for this. They are also remembered many times and this produces many copies of them, which makes it easier to recall them. This might be used as a neuroscience explanation for their stability.

   The understanding of the reading of memories, that is having a conscious experience providing information about the memory, remains an unsolved challenge in the neuroscience context: this would require a genuine theory of conscious experience.

1.2 Memory as a key challenge for quantum theories of consciousness

Any theory of consciousness, including quantum theories of consciousness, should be able to explain the basic mechanism of conscious memory. A basic element of subjective memory is its temporality. Its content is about events of the past.

1. An attractive idea is that, by their non-determinism which is a basic behavioral feature of conscious entities, quantum jumps determine the development of consciousness. Subjective memory recall should therefore represent information about the previous quantum jumps. The quantum states should contain information about what was experienced in the past.

2. The information of the conscious experience, if determined by the quantum jump, must be about the initial and the final states of the quantum jump and about the transition between them. It should be encoded into the final state of the quantum jump. In the standard ontology of quantum theory this is not possible. According to the standard quantum theory, quantum states 3-D time=constant snapshots and do not remember anything about the previous quantum jumps.

   Therefore, theories of consciousness based on standard quantum mechanics cannot explain subjective memory, which is from previous conscious experiences, i.e. quantum jumps. For some reason, this fact seems to have been overlooked.

The understanding of subjective memories is therefore a hard challenge for the theories of consciousness. There are some guide lines concerning the understanding of subjective memories.

1. If one accepts only the statistical view of quantum theory, a natural proposal would be that in some sense the characterization of quantum statistical time evolution corresponds to some kind of Markov chain. Stronger condition would be quantum states are replaced by sequences of 3-D quantum states. This would require a failure of strict determinism but standard quantum theory does not allow this.

2. The failure of strict classical determinism is however a valuable guideline and would mean that quantum states are in some sense "slightly" 4-dimensional so that also the brain would be "slightly" 4-dimensional. The zero energy ontology (ZEO) of TGD indeed predicts this. Quantum states are superpositions of 4-D classical time evolutions obeying almost deterministic holography so that they are not quite 3-dimensional.

3. In TGD, the zero energy ontology (ZEO) combined with holography = holomorphy vision suggests a universal mechanism of this kind. In the sequal the general TGD based mechanism of memory storage is discussed. By its universality, the proposed mechanism applies also to the matter which is usually regarded as "dead" (since it looks dead in the time scales of our perceptive abilities).

2 TGD view of subjective memory

We have memories about the conscious experiences of the past. How are these memories formed? How are they recalled? In TGD classical physics is an exact part of quantum physics. Zero energy ontology (ZEO) [L2] [K1] suggests a rather concrete model for the representations of the memories in terms of the geometry of the space-time surface.

2.1 ZEO briefly

Consider first a brief summary of ZEO.

1. The three basic notions of ZEO are causal diamond (CD), zero energy state, and state function reduction (SFR). Zero energy state be seen as a pair of ordinary 3-D quantum states at the light-like boundaries and as a superposition of space-time surfaces inside $CD = cd \times CP_2$ obeying holography [L8]. Here cd is the intersection of future and past-directed light-cones of M^4. There are two kinds of SFRs: "small" SFRs (SSFRs) and "big" SFRs (BSFRs).

2. A sequence of SSFRs is the TGD counterpart for a sequence of repeated measurements of the same observables: in wave mechanics they leave the state unaffected (Zeno effect). Already in quantum optics, one must loosen this assumption and one speaks of weak measurements. In ZEO, SSFRs do not affect the 3-D states at the "passive" boundary of CD but affect the 3-D states at the active boundary. This gives to the flow of consciousness and defines a self as a conscious entity. In the TGD framework, SSFRs give rise to a flow of consciousness, which defines self as a conscious entity. The quantum change is at the active boundary of the CD. Since the size of the CD increases, this increase gives rise to a flow of geometric time correlating with the subjective time as sequence of SSFRs.

3. BSFR is the counterpart of the ordinary SFR. In the BSFR the arrow of the geometric time changes. BSFR means death of self and to a reincarnation with an opposite arrow of geometric time. Death and birth as reincarnation with an opposite arrow of time are universal notions in the TGD Universe. Falling asleep and biological death are examples of BSFR. Since TGD predicts quantum coherence in arbitrarily long scales, the arrow of time can change in even cosmological scales.

2.2 The classical representation of the information of subjective memories

Consider now the classical representation of the information of subjective memories.

1. Zero energy states can be regarded as pairs of 3-D many-fermion states at the opposite light-like boundaries of the CD. Second view of zero energy state is as a superposition of space-time surfaces obeying holography and therefore analogous to Bohr orbits. This picture is made more complex by the hierarchy of CDs.

2. It is essential that the holography is almost deterministic. Holography = holomorphy principle allows the explicit construction of space-time surfaces as holomorphic minimal surfaces, and they are analogous to Bohr orbits when one interprets 3-surface as a generalization of a point-like particle. Already 2-D minimal surfaces fail to be completely deterministic (a given frame can span several minimal surfaces). This non-determinism forces ZEO: otherwise one would have ordinary ontology with 3-D objects as basic geometric entities.

   The failure of complete determinism makes 4-dimensional Bohr orbits dynamical objects by giving them additional discrete degrees of freedom. They are absolutely essential for the understanding of memory and one can speak of a 4-dimensional brain.

3. The restriction of the 3-D many-fermion states and of the wave function in WCW to to the space-of 3-surfaces defining the ends of Bohr orbits at the passive boundary of CD are unaffected by the sequence of SSFRs. This is the counterpart for the Zeno effect.

   This requires that a given SSFR corresponds to a measurement of observables commuting with the eigen observables at the passive boundary. The simplest option is that these observables are associated with the discrete degrees of freedom due to the classical non-determinism.

4. The 3-D states at the opposite, active, boundary of CD are however affected in SSFRs, and this gives rise to self and flow of consciousness. Also the size of CD increases in a statistical sense. The sequence of SSFRs gives rise to subjective time correlating with the increase of geometric time identifiable as the temporal distance between the tips of the CD. The arrow of time depends on which boundary of CD is passive and the time increases in the direction of the receding active boundary.

5. In TGD, ordinary SFRs correspond in TGD to BSFRs. Both BSFRs and SSFRs are possible in arbitrarily long scales since the h_{eff} hierarchy makes possible quantum coherence in arbitrary long scales.

   The new element is that the arrow of geometric time changes in BSFR since the roles of the active and passive boundaries of CD change. BSFR occurs when the set of observables measured at the active boundary no longer commutes with the set of observables associated with the passive boundary.

   The density matrix of the 3-D system characterizing the interaction of the 3-surface at the active boundary with its complement is a fundamental observable and if it ceases to commute with the eigen observables at the passive boundary, BSFR must take place.

   The degrees of freedom characterizing the classical non-determinism are crucial for memory. Since they commute with the eigen observables at the passive boundary, they naturally belong to the degrees of freedom measured in SSFRs.

2.3 The mechanism of memory recall in ZEO

Consider now what memory recall could mean in this framework.

1. The view has been that active memory recall requires what might be regarded as communications with the geometric past. This requires sending a signal to the geometric past propagating in the non-standard time direction and absorbed by a system representing the memory locus (part of the brain or of its magnetic/field body). The signal sould be generated in a BSFR of some subsystem. In ZEO this is possible since BSFRs change the arrow of the geometric time.

2. The signal must be received by a system of the geometric past representing the memory. The signal would be received at a quantum critical memory location by a resonance mechanism, and a second BSFR would occur, resulting in a response that would propagate to the future brain. This pair of BSFRs corresponds to the TGD counterpart of quantum tunnelling.

3. How are the memories coded geometrically? This can be understood by asking what happens in SSFR. What happens is that from a set of 3-D final states at the active boundary some state is selected. This means a localization in the "world of classical worlds" (WCW) as the space of Bohr orbits. The 3-D surfaces at the active boundary of the CD represent the outcome of quantum measurement. The final state as a zero energy state represents classically the quantum transition to the final state! This is not possible in the standard ontology.

4. The findings of Minev et al [L1] [L1] that in quantum optics quantum jumps correspond to smooth classical time evolutions leading from the initial state to the final state. This provides a direct support for the ZEO view. The interpretation works for SSFRs and also for the transitions of atoms as pairs of BSFRs having interpretation as quantum tunnelling events.

2.4 Is consious experience associated with SSFRs assignable to the classical non-determinism?

ZEO therefore gives a geometric representation of a subjective experience associated with the SSFR. One obtains conscious information of this representation either by passive or active memory recall by waking up the locus of non-determinism assignable to the original conscious event. The slight failure of determinism for BSFRS is necessary for this. The sequence of SSFRs is coded to a sequence of geometric representations of memories about conscious events.

This is how the Universe gradually could develop representations of its earlier quantum jumps to its own state, kind of Akashic records. Since the algebraic complexity of the Universe can only increase in a statistical sense the quantum hopping of the Universe in the quantum Platonia defined by the spinor fields of WCW implies evolution.

It is tempting to think that cognitive and sense-awareness, or at least memory, correspond to regions of the space-time surface (minimal surface), where quantum jumps between the different classical alternatives are possible. These "hot spots" would be analogous to the frames spanning the soap film and as quantum critical systems serve as seats of memories.

At least for SSFRs associated with remembering, classical non-determinism and quantum non-determinism would correspond to each. Could this be the case also for sensory and cognitive SSFRs, in fact all SSFRs? Could the classical-quantum correspondence fail only for BSFRs as counterparts of the "ordinary" SFRs. In these measurements the observables would not correspond to the classical non-determinism but correspond to "ordinary" observables.

2.5 Memory and TGD inspired quantum biology

Can one say anything more concrete?

1. TGD predicts that any system can have a self as a sequence of SSFRs. Therefore there is an entire hierarchy of systems, which can be conscious and the question is what level in the hierarchy biological consciousness corresponds to. In the case of the brain, the quantum critical slightly non-deterministic hotspots of the 4-D space-time surface representing the brain could be associated with DNA, microbuli, neurons, axons, and larger structures constructed from them.

2. Perhaps the most natural identification for the seat of our conscious experience is associated with the field bodies (magnetic and electric) of these systems. The reason is that they contain dark variants of the ordinary particles characterized by a very large value of effective Planck constant h_{eff}, which serves as a measure for algebraic complexity, representative capacity, and intelligence.

3. Gravitational Planck constant $\hbar_{gr}$ and electric Planck constant characterize the gravitational [L3, L4] electric bodies [L6, L9]. Both DNA, microtubuli, and DNA have large electric charges and the gravitational magnetic bodies of the Earth and Sun are excellent candidates for the field bodies involved.

   Water is an essential part of the living matter and expected to be crucial for our conscious experience. The proposal is that the monopole flux tubes accompanying the ordinary basic biomolecules carry sequences of dark protons providing a fundamental representation of the genetic code, which is universal and possible in all scales.

4. The notion of dark DNA leads to a proposal that the genetic code, realized in terms of a completely unique icosa tetrahedral tessellation of the hyperbolic 3-space H^3 [L5], would be crucial in the communications based on multi-resonance mechanism as selector of the receiver and frequency modulation as the way to represent information.

   This mechanism, associated with the EEG and its possible fractally scaled copies at longer and shorter time scales, would be essential also for the memory recall. Dark photons obtained from ordinary photons have period and wavelength scaled up by h_{eff}/h. Large values of h_{eff} long time scales. The larger the value of h_{eff} the longer the time span of the memory.

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