Research Essay

Window to the Past: The Role of Quantum Entanglement in Memory

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Abstract

This paper suggests that the static nature of time-space, a discovery in physics, implies that quantum communication plays a role in memory. The illusion of the flow of time and the nature of quantum entanglement are discussed. Arguments are given for a non-reductionist alternative to the standard model of cognition in which memory is stored in time-space. In this view the neural machinery of the brain receives and interprets information states embedded in time-space.

Key Words: quantum entanglement, memory, past, experience, cognition.

When we look at images of neural network (clipartbest.com), we are reminded of TV antenna (tvtechnology.com). The neurons appear more like collection mechanisms for radiating energies than chambers for storage. Perhaps the similarity between brain structures and antenna is more than analogous, especially when we consider the discoveries of physics about the nature of time. Neuroscientist admit that the standard model of memory is incomplete and constantly in revision (Parry 1). Only recently have the discoveries of quantum mechanics been applied to how the mind works, introducing the field of quantum cognition (Schwartz, Stapp, & Beauregard). New understandings of the flow of time may require re-thinking the nature of memory.

What if memories are not stored in the brain exactly? What if neural electro-chemical traces in synapses are connecting devices for the mind to access non-local states that exist in the past? Cosmologists tell us that our experience of moving along the arrow of time is an illusion. We think that we exist in the present and are moving towards a future from the past. The truth is, we are more like characters in a book who are bound by the sequences of words in the novel's sentences, even though the book exists as a whole. Characters are free to act in any way that they choose, but the story from the author's perspective has already been told. The "book" of the cosmos is a static whole. As theoretical mathematician Roger Penrose says,

> The way in which time is treated in modern physics is not essentially different from the way in which space is treated and the 'time' of physical descriptions does not really 'flow' at all; we just have a static-looking fixed 'space-time' in which the events of our universe are laid out (574).

Likewise, cosmologist Paul Davies explains that:

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> Our senses tell us that time flows: namely, that the past is fixed, the future is undetermined, and reality lives in the present. Yet various physical and philosophical arguments suggest otherwise. The passage of time is probably an illusion. Consciousness may involve either thermodynamic or quantum processes that lend the impression of living moment by moment. From the fixed past to the tangible present to the undecided future, it feels as though time flows inexorably on. But that is an illusion.

Cornell University physicists recently confirmed that because of our interaction with the strange quantum principle of entanglement, time is an emergent property of perception. They showed that from a perspective outside our universe all events would appear as static points. According to a summary of the Cornell paper, time "exists only for observers inside the universe. Any god-like observer outside sees a static, unchanging universe…" (Moreva).

Einstein confirmed that what we think of time is relative to our speed and position. In other words, what we experience as "happening now" would not be shared by an observer on a distant planet whose "now" would differ entirely. At the edges of the universe our present moment might be 100,000 years. If we could travel at the speed of light our mass would equal the entire universe and time would freeze into a static singularity like the center of a spinning wheel. Due to the linguistic basis of thinking, we experience the world as a sequence of events with physical reality only existing in the present moment as we watch the past fleeting away into nothingness. Yet, physics would say that we are inseparable from the past. It continues to exist as part of the static whole. The thoughts we had five minutes ago, or actions we took years ago, remain embedded in the fabric of time-space.

If time flowing is an illusion and if all of our past experiences are enduring realities, then memory could be understood as our effort to step out of the current of time to observe the prior events that remain as fixed features of time-space.

Instead of simply replaying neural-chemical representations in the brain like magnetic tape, chemically stored information may be acting like a catalyst that permits the mind to access past entangled states. In other words, entangled photons in a person's brain grant a sort of window to the past.

Quantum entanglement is the phenomena proven by experiments that show that two particles can come to share the same reality even though separated. If an experimenter changes the polarity of one particle, the other pair will change its polarity even if millions of miles apart. This change occurs instantaneously -- faster than the speed of light. When two objects come in contact with each other as part of the same system they are physically entangled forever. Just as stepping into a pool of water creates ripples, interactions between entangled objects have a lasting impact that changes both no matter how far they might become separated. The electron spins of both objects are connected "non-locally". "Non-locally" means that the particles share an existence regardless of location. All matter that interacts becomes entangled. Biologists are beginning to see quantum affects in living systems, such as photosynthesis (Lloyd, Saravar).

Quantum physics is contributing to the understanding of mental processes in the new field of "quantum neurology." Experiments show that the brain is able to sense quantum states (NeuroQuantology.com). Likewise, quantum cognition is a field that applies quantum principles to how the mind functions (Schwartz, Stapp, & Beauregard).

Contributor to the field of quantum cognition; computer scientist Subhash Kak, studied the role of quantum physics in human memory and concluded that "memories should be viewed as assemblages of quantum particles" (Kak).

Physicists are providing more evidence for the pervasiveness of entanglement in our universe, as this article explains:

> Quantum entanglement is a strange and non-intuitive aspect of the quantum theory of matter, which has puzzled and intrigued physicists since the earliest days of the quantum theory," said [physicist] Leon Balents, senior author of a recent paper on this topic published in the journal Nature Physics…. Quantum entanglement represents the extent to which measurement of one part of a system affects the state of another; for example, measurement of one electron influences the state of another that may be far away, explained Balents. In recent years, scientists have realized that entanglement of electrons is present in varying degrees in solid materials. Taking this notion to the extreme is the "quantum spin liquid," a state of matter in which every electron spin is entangled with another (Balents).

Just as entangled protons are shown to interact when separated by vast distances in space, I wonder if a kind of temporal entanglement exists in which the mind is able to interact with events separated by vast periods of time. Since to an observer outside the universe entangled connections between objects would appear as static points, we know that entanglement transcends the flow of time as well as space. Or put otherwise, entangled objects are connected non-temporally as well as non-locally. Moreover, since what is happening "now" is an illusion, it would follow that past information states in the brain continue to exist as enduring realities in the universe. Everything that you have ever done still exists as a physical reality. It is considered "past" only because of our illusory perspective (Mohan, Ishizaki, Fleming & Whaley).

To clarify, since the atoms in my brain today are connected with who I was five minutes ago, yesterday or even last year we would expect to find that there is some kind of quantum communication in addition to classical neural communication. Therefor we should take seriously the possibility that memory involves accessing entangled states that remain non-local realities in time and space.

An analogy between the brain and radio reception could be useful. Instead of "replaying of a tape", as the standard cognitive model would imply, perhaps the brain is receiving a quantum energy signal from the past. Rather than viewing memory as the accessing of information stored in neural-chemical traces, the quantum mind uses the technology of the brain to direct us to information patterns stored in entangled electrons produced by past interactions. Neural pathways could be thought of as literal pathways that point us to past information states that remain enduring realities in time-space.

The plasticity of memory is an argument against the "tape recorder" perspective of memory. If memory is a "chemical recording" then we should be surprised to see such a rate of errors. How often do our music recordings change each time they are played? The memory process is more like poor cell phone reception or a small ham radio receiver scanning the atmosphere trying to pick up fleeting signals. In such technological cases we expect to find flaws in reception -- exactly as we do whenever we discover that biological memory fails us. If the information is in the brain, why can't we immediately "replay" it?

Like most analogies the radio signal comparison isn't perfect since quantum entanglement lacks the characteristics of electromagnetic radiation. It can't be blocked by matter or loses strength at a distance. The connection between entangled particles gives each one a shared existence non-locally unlike radio signals. Therefore, the noise that degrades the effectiveness of quantum memory must be caused by limited reception ability of an individual's neural machinery.

If it is true that information about our experiences is stored in the structure of time and space -- rather than the hardware of our brain -- an analogy to cloud computing is natural. Brain synapses are like routing software in a personal computer that accesses information stored "in the cloud". Weaknesses and errors in our memory are caused by limited capacity or "bugs" in the software of the personal computer of our mind. All the information is safely stored in the super computer of the cosmos if we can properly access it.

Like a hacker trying to fix a computer bug, humans rely on language and culture to compensate for noise. Writing down documents that capture historical events or express the values of philosophy or teachings of religion, guide our minds in experiencing the past, narrowing the gap of ignorance toward universal knowledge. Literature permits us to share the memories of other people and gain a collective viewpoint. In this way culture invites us to (as Einstein said) "think the thoughts of God." Language is a tool we use to seize past entangled states that still exist non-locally in the fourth dimension of time past. Language and culture like a signal amplifier broaden human consciousness, moving us toward accurate understanding.

Moreover, highly emotional experiences could enhance the connection to quantum states of the past. It could be that the awareness of an emotion boosts the signal of the enduring reality of the past. Intense experiences of joy, love, grief, happiness, sentiment or aesthetic appreciation produce stronger entangled patterns that increase the potentiality of transmission between the past and the present viewer. The emotion serves as a “red flag” marking the quantum pathway in our minds, making access to it later easier.

An entanglement view of memory is intuitive. We feel entangled with past events and people in our lives. When we remember events in the past it feels like we are experiencing them again. What if we really are experiencing them? Imperfectly, often clouded and weak, but sometimes in vivid ways, especially when we remember an intense event. In fact "hindsight" may help us experience the past better than the first time we experienced it. Our memory may be redeemed by a more mature perceptive gained through acquired wisdom. We might say, "You know that experience I had as a child, it wasn't as bad as I thought. In fact, it helped me."

In this way a mature looking back may produce a "backward in time" effect which changes the experience, exactly like the observation of subatomic properties causes the collapse of superpositions, making the particle or wave a reality both now but also backward in time. Once observed in an uncontaminated state, the particle or wave has *always been* a particle or wave. This is the "quantum enigma" -- that conscious observation creates what we observe as physical reality (Rosenblum).

A quantum theory of memory may explain the evidence better than the traditional model of cognitive science. Why is it that brain damaged people can recover memories, even when whole parts of the brain are removed? While traditional neuroscience may offer plausible theories, if the information of the memory exists embedded in time and space and the brain is merely accessing that information, then the person recovering from brain damage may be re-learning how to pick up the signal from the past that exists independently from their brain.

This view may also contribute to the study of near death experiences when patients clinically shown to be brain dead are revived with memories of events that were objectively observed in the hospital room. If the brain is a receiver of signals produced by quantum entangled states in the past -- and not merely a recording devise -- then life after death becomes plausible (Greyson). A quantum mechanical view of memory is therefore intuitive. Just as radio waves are still being transmitted regardless of whether or not a radio is present, so after the brain has been destroyed, the reality of the person's life remains. Or again, cloud stored information is safe even if your personal computer crashes.

Playwright Thornton Wilder seems to have anticipated that human experience transcends the body and lives on in eternity. In his imagination he suggests that memory literally takes us back to events in the past.

In the final act of *Our Town*, Emily dies and discovers that she can "return" to observe major life events. Emily chooses to observe her mother making breakfast for the family on an inconsequential day in her past. She finds that the memory is too beautiful to endure. Emily concludes with a question to the Stage Manager:

> Emily: Oh, Mama, look at me one minute as though you really saw me. Mama, fourteen years have gone by. I'm dead. You're a grandmother, Mama! Wally's dead, too. His appendix burst on a camping trip to North Conway. We felt just terrible about it - don't you remember? But, just for a moment now we're all together.
>
> Mama, just for a moment we're happy. Let's really look at one another!...I can't. I can't go on. It goes so fast. We don't have time to look at one another.
>
> I didn't realize. So all that was going on and we never noticed.
>
> Take me back -- up the hill -- to my grave.
>
> But first: Wait! One more look. Good-bye, Good-bye world. Good-bye, Grover's Corners....Mama and Papa. Good-bye to clocks ticking....and Mama's sunflowers. And

> food and coffee. And new ironed dresses and hot baths....and sleeping and waking up. Oh, earth, you are too wonderful for anybody to realize you. Do any human beings ever realize life while they live it -- every, every minute?
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> Stage Manager: No. (pause) The saints and poets, maybe they do some" (Wilder.)

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