Subjective Perception of Time and a Progressive Present Moment: The Neurobiological Key to Unlocking Consciousness

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The conclusion of physics, within both a historical and more recent context, that an objectively progressive time and present moment are derivative notions without actual physical foundation in nature, illustrate that these perceived chronological features originate from subjective conscious experience and the neurobiological processes underlying it. Using this conclusion as a stepping stone, it is posited that the phenomena of an in-built subjective conception of a progressive present moment in time and that of conscious awareness are actually one and the same thing, and as such, are also the outcome of the same neurobiological processes. A possible explanation as to how this might be achieved by the brain through employing the neuronal induced nonconscious cognitive manipulation of a small interval of time is proposed. The CIP phenomenon, elucidated within the context of this study is also then discussed.

Time, present moment, consciousness, nonconscious, self-awareness, cognition, phi phenomenon, CIP phenomenon, memory.

Introduction

The Collins Concise Dictionary defines consciousness as "denoting a part of the human mind that is aware of a person's self, environment and mental activity and that to a certain extent determines his choice of actions." Although this definition would appear useful, just by stating it, it would also seem to raise more questions than it actually addresses. For example, are humans the only species capable of consciousness? One look at a chimpanzee, and in particular, if one is allowed to inspect and play with a mirror (Oakley, 1985), would suggest that this is not actually the case. Furthermore, the definition also makes the generally widespread mistaken distinction between self-awareness, and awareness of environmental stimuli and introspective mental activity. It should be understood that all conscious cognition involves self-awareness. To be aware of ones environmental surrounding is obviously also to be aware of ones subjective phenomenal mental experience. Any form of conscious awareness thus also necessarily demands *self-reference* and that one is consciously self-aware. This does not imply however that all conscious cognition involves awareness of ones "self-construct" or "self model". Rather, that by virtue of logical necessity, all conscious aware cognition requires *self-reference*.

In his book "Consciousness Explained" (1991), Daniel Dennett attempts a much more stripped down definition by asserting that conscious awareness is the not the historically widespread notion of the presentation of data to a mythical subject (the mind), but is rather the sum total of all data streams taken together. Although in a different way, this description would also appear useful, particularly in its possible consistent relation to Temporal Binding (see for example, Crick. 1994; Engel, Fries, König, Brecht & Singer, 1999; Newman & Grace, 1999), this explanation would not appear much more helpful, as it might be describing the inner workings of a computer: a technology based solely on the processing of a purely syntactical set of operations and algorithms, and which at present, indeed is not capable of consciousness. Furthermore, it arguably never will be. This will not bother Dennett however, as he then goes on to assert in a strong form of behaviorism, that due to the first person perspective of awareness, that subjective qualitative mental experience and consciousness do not exist either. Like too many accounts on the topic, both definitions avoid the most fundamental questions of what consciousness actually is and how it might be achieved. In Dennett's case, as with rocks in 18th century sceptical philosophy, by denying its existence in the first place. Like the Chimpanzee in the previous scenario, one need only look at a computer, or a rock for that matter, to realise both explanations fall short. Unfortunately, the possible facilitory and causal relationship of Temporal Binding (Crick, 1994; Engel et al., 1999; Newman et al., 1999) to consciousness, as distinct from possibly being an integrative feature of awareness in the same way that a lens integrates and merges together an already existent vision, inevitably also falls short for the same reason.

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Recently tenable and insightful work on the subject by individuals such as Francis Crick (for example, see Crick, 1994), David Chalmers (see Chalmers, 1996), Gerald Edelman (see Edelman, 1989, 1992), Thomas Metzinger (see Metzinger, 2000), Roger Penrose (see Penrose, 1989, 1994, 1997), Israel Rosenfield (see Rosenfield, 1993), John Searle (see Searle, 1992, 1998), and a large host of others, has certainly advanced the topic and helped to promote and establish the study of consciousness in itself as a rigorous and multidisciplinary science, but frustratingly, it is instead often a myriad of related peripheral issues that are addressed, while the main question of what actually makes consciousness possible in the first instance is inevitably left for future (presumably more scientifically knowledgeable) generations to try to answer. With the benefit of recent advances in physics and philosophy however, and in particular, in our understanding of the nature of time, it appears as though this is about to change.

New, and not so new, Perspectives in Physics

The idea that our seemingly innate subjective conception of a flowing progressive time may be related to mental faculties and the neurobiological processing of information in the brain is not a new one, and speculation in relation to the actual reality of time dates back to the ancient Greeks. Centuries of philosophical attention since however, has not generally advanced the topic a great deal, and despite it historically being one of the most written about subjects in academia, the same basic questions asked by the Greeks 2500 years ago, are often the same still asked (and argued about) today. Recently however, physics and philosophy have helped to extend and solidify this notion by illustrating in more concrete terms that time is indeed a derivative notion. There is not a precise static instant and physical progression of time paralleling events throughout the universe, facilitating physical continuity as it proceeds. To the contrary, and rather paradoxically, it is exactly due to nature's exclusion of a time as a fundamental physical quantity, that time as it is measured in physics (relative interval as indicated by a clock), and as such, motion and physical continuity are indeed possible in the first place (Lynds, 2003).

To those familiar with Albert Einstein's two theories, Special and General Relativity, the absence of a “present moment” or “now” underlying a dynamical physical process will also not come as a great surprise. Einstein has shown us that there is not a universal “now” in time holding sway throughout the entire universe. Judgments of simultaneity or of a now do not always necessarily agree, but instead are relative: relative to ones state of motion and spatial proximity in relation to gravity. Furthermore, relativity's mathematical formalisation has seen the introduction of a “block” universe in which events do not “take place” as such, as we subjectively seem to perceive them, but are all “mapped out” together in a four dimensional space-time in which nothing particularly “happens” at all. Events are just there, mixed together, sharing equal temporal status, having neither happened in the past, nor happening at present, or about to happen in the future (for a more detailed discussion, see for example, Davies, 1995). In addition to this, recall that it is precisely due to there not being a precise static instant or present moment in time underlying a dynamical physical process, that motion, physical continuity and time (relative interval) are indeed possible in the first instance (Lynds, 2003). The message is clear, if somewhat counter-intuitive: a “flowing” time and progressive present moment are the products of our subjective perceptions and underlying neurobiology, without actual physical foundation in nature.

> “There exists, therefore, for the individual, an I-time, or subjective time. This in itself is not measurable.” -- Albert Einstein.

In the past various hypotheses have been tentatively offered in an attempt to explain the cause of this obviously extremely deeply seated subjective experience. Most typically, (i) that the phenomenon is the outcome of a type of “mental backdoor” in which a sense of a flowing, progressive time somehow subconsciously enters (Eddington, 1929), (ii) that the phenomenon is related to a sense of personal identity (Davies, 1995), or (iii) that it has its foundations in the subatomic world of the electron, being irreducibly quantum mechanical in nature and related to quantum uncertainty and randomness (Penrose, 1989; Davies, 1995). In his book “The Emperors New Mind” (1989), Roger Penrose contemplates the origins of such subjective experience.

> “It seems to me that there are severe discrepancies between what we consciously feel, concerning the flow of time, and what out (marvelously accurate) theories assert about the reality of the

> physical world. These discrepancies must surely be telling us something deep about the physics that presumably must actually underlie our conscious perceptions."

While some of the fore mentioned explanations would certainly appear useful, and in the case of a subjective sense of a flowing time possibly entering subconsciously through a mental back door as Penrose eludes to above, no doubt correct in a certain theoretical sense, it would appear that the correct explanation has been waiting for us at a more basic (and once realised, rather obvious) level.

The Neurobiological Key to Consciousness

When properly considered, it becomes apparent that there is an irreducible connection between our seemingly innate perception of a flowing time and progressive present moment and the phenomenon of conscious awareness. Without an in-built conception of a present moment in time, conscious cognition would not be possible, and would mirror that of computation i.e. not consciously aware. This can be illustrated by the impossibility of a hypothetical subject to be aware of any information that were in a constant state of flux in respect to time, unless the mental content of that information (for example, the representation of an image) were momentarily held static and frozen, if only for a small matter of milliseconds, while in awareness. If it were not, it obviously wouldn't be possible for a subject to be aware of it. Conscious awareness thus necessarily demands that mental content is held in awareness for a certain interval of time, however brief. Furthermore, as yet, a computer doesn't have such a capacity. Conversely, without conscious awareness, awareness of a progressive present moment is not possible. This is logically self evident, as if the first is lost, naturally the second is also. As such, with reference to our hypothetical subject with an in-built conception of a progressive present moment in time facilitating conscious awareness, it becomes apparent that both phenomenon are actually one and the same thing, and as such, must also be the result of the same neurobiological processes.

The question of how the brain might achieve this on the other hand is obviously much more difficult. It may still be some time before we understand enough about the workings of the brain so that we are able to address this question in a fully rigorous manner, but at this point I think conceptualised theoretical attempts at addressing the problem may at least be useful for providing a starting point for further investigation. On these grounds, in what follows an explanation is firstly proposed, and subsequently discussed.

How the Brain Might Achieve This: A Heuristic Hypothesis

To achieve both, conscious self awareness and an in built conception of a progressive present moment in time, I would suggest that that there would necessarily need to be some form of neuronal induced nonconscious cognitive process within the brain to facilitate a form of temporal *interplay* between nonconscious cognitive data steams. That is, possibly a millisecond level relative difference in respect to the timing of different parallel data streams, or alternatively, to *some* of the data within singular streams, so that the timing of *all* data within those streams is not perfectly synchronised. More specifically again, some form of in-built "self-referencing" mechanism, by which through the process of some cognitive data streams, or a certain amount of data within streams, "looping back" on itself, conscious awareness could be facilitated by the brain.

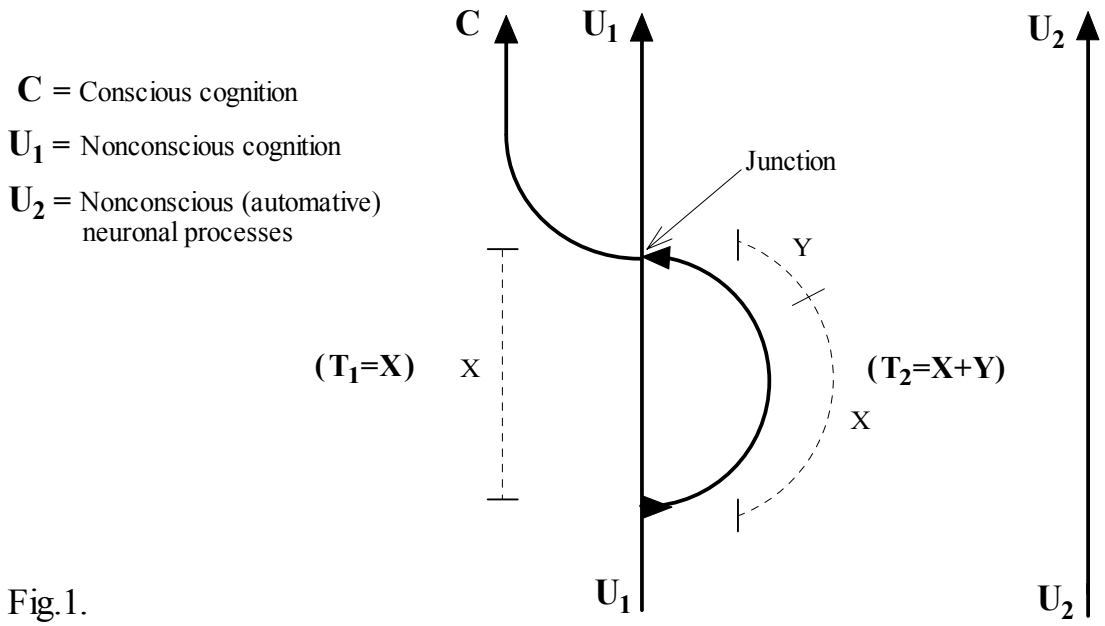

Fig.1.

A. Difference in relative timing (T) of data flow facilitates self-reference mechanism.
B. Difference in relative timing of data flow causes nonconscious cognition to always temporally proceed (previously nonconsciously self-referenced) conscious cognition in relation to the same original neuronal data stream(s).

From this viewpoint, awareness would involve the neuronal induced nonconscious cognitive manipulation of a small interval of time through the fore mentioned self-referencing mechanism caused by a difference in the relative timing of data flow, at which point the subject would continually become aware of "self-referenced" information as it passed through such a junction (see above). Other nonconscious cognition not involved with this process (presumably a large percentage when considering the sum total of all nonconscious cognition) would remain nonconscious, unless it were firstly stored in short term and working memory, and then subsequently went through the same "self-referencing" process once retrieved. Very recent nonconscious cognition of this kind, as distinct from automative nonconscious processes in the brain, would be readily accessible to awareness. This is an important and rather counter intuitive point. Much of what is often assumed to be conscious cognition, actually is not, as a subject cannot have any awareness of such recent content until it is *firstly* retrieved from short-term memory. Until then, it remains nonconscious. Thus, in respect to causality, it would be nonconscious cognition that is the result of neuronal processes in the brain that causes consciousness: consciousness would be an *emergent property* of neuronal activity. Furthermore, as all cognition would originate from nonconscious neuronal processes, consciousness would have no causal relationship to further conscious cognition.

As has already been outlined, as it is not possible for a hypothetical subject to be aware of any information that is in a constant state of flux in respect to time, we would also necessarily consciously think within the context of a progressing static instant and perceived present moment in time, during the millisecond time scale interval such information were momentarily held "static" and "frozen" in awareness. However, rather than this continuous stream of static information being consciously perceived as broken and disjointed in respect to time by jumping from one static frame to the next from moment to moment, the extremely small time intervals involved between new data entering awareness and replacing previous mental content, would guarantee that the perception would be a of relatively smooth continuous informational stream, similar to that experienced when observing a continuous sequence of static movie frames in quick unison (commonly 24 frames per second), with no joins being observed. Naturally, the phi phenomenon would support this view.

1. The CIP Phenomenon

Another example that would appear to support this model of consciousness is the incapability of a subject to mentally picture an object in relative motion without it also having a precisely defined position in respect to another object in that mental picture. I have called this the CIP position paradox. To illustrate it, I find it can be helpful to think of a train in motion relative to the tracks beneath. The only way for a subject to achieve awareness of any information (in this case, a moving train), is if that subjective mental image is static and momentarily frozen, if only for a few milliseconds, while in awareness. The paradox arises because this is regardless of whether an object is in relative motion or not. If it is, its position is constantly changing in respect to time and so does not have a defined relative position at all (Lynds, 2003). Indeed, the ancient motion paradoxes of Zeno of Elea that have baffled people for century's since their original conception almost 2500 years ago, in many ways were so baffling for this very reason: we consciously think within the context of a continuous sequence of perceived present static instants in time, in much the same way as a continuous stream of static movie frames projected in quick unison appear to us as being smooth and continuous, and we are not aware of any discontinuity. What's more, we assign and project this subjective chronological feature on the environment around us, as is the case with the example of the moving train. I have termed this the CIP (Conscious, Instant, and Phi) phenomenon. Without such a mental feature, conscious awareness would not be possible.

Conclusion

We can conclude that the phenomena of an in built conception of a progressive present moment in time and that of conscious awareness are actually the same thing, and as a consequence, it appears that we also necessarily consciously think within the context of a continuous sequence of static instants and perceived present moments in time i.e. the CIP phenomenon. From this, we can then further elucidate that the underlying neurobiological processes involved must also be the same. Possible ways the brain might achieve this that have been proposed on the other hand, are highly speculative and introduce mechanisms that are not empirically within our grasp at present, and as a result, are relatively heuristic. Furthermore, as is the extremely difficult nature of the study of consciousness and subjective qualitative experience, this may never change. It is also worth noting that other considerations not discussed here in relation to brain and time will also factor prominently in a full scientific picture of consciousness. It is evident that memory also plays an important role in awareness (Edelman, 1989, 1992; Rosenfield, 1993; Schacter, 1998; Newman et. al., 1999). In addition, the thalamus and the Temporal Binding of data would also appear to be important factors in aiding coherent and unified conscious experience (Crick, 1994), if not causally related. These things considered however, as a broad theoretical proposal, it would appear suggestive. It agrees with experience, and also seems to be consistent with what is already known about consciousness and the neurobiology of the brain i.e. self-reference, the prefrontal cortex etc. Lastly, it also holds a good deal of logical and philosophical appeal. As such, as a broad and general model, I would suggest it as being deserving of further investigation. The study of disorders of consciousness including stupor and coma, the vegetative state, akinetic mutism, absence and partial complex seizures, delirium, dementia and the more recently defined state of hyperkinetic mutism (Plum, 1991), as well as the pathophysiological study of psychiatric disorders such as Schizophrenia, would appear as perhaps one of the most salient areas for possible future research in relation to this model.

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