

Research Essay

Vertical Growth of Intelligence versus Horizontal Growth of Consciousness

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Abstract

In this paper I explore consciousness and intelligence in the setting of conventional neuroscience and cognitive science. To be conscious is to be aware but awareness is not always intelligence. Intelligence is task driven, and comes at a later stage in development than consciousness. Consciousness and intelligence are sometimes interdependent on each other, but have always been known as separate entities; an attempt to associate them, results in a lot of debate. This paper hypothesises the growth of consciousness to be horizontal, while the growth of intelligence to be vertical during the progression of development. The horizontal growth of consciousness is completely dependent on cell division and cell differentiation, while the vertical growth of intelligence depends on the horizontal growth of consciousness and enhancement of neural systems. Consciousness is computed within the microtubular network of a single cell, which amplifies with multicellularity, while intelligence is related to the nervous system which matures with complexity.

Key Words: Consciousness, intelligence, growth, embryogenesis, cells.

Introduction

There always seems to be an invisible link between intelligence and consciousness due to the mystification that exists between these closely-knit terminologies. Consciousness as we know has been a topic of discussion in the fields of philosophy and science for many years and many have struggled to pin down its exact nature and possibilities. Many scientists are trying to understand this phenomenon from a top-down approach by studying this feature in an impaired state (Blumenfield 2012; Farzampour and Huguenard 2015; Demertzi et al 2013). There always lies a difference of opinion when it comes to consciousness; as for some it exists (Manzotti 2005; Tonneau 2004; Chalmers 1996; Block 2007; Hameroff and Chopra 2012) while for some it does not and is considered a falsely acclaimed feature (Blackmore 2002; Jackson 1982; Rey 1983). Introspection is a delivery of one's knowledge to one's mental life and has been linked by philosophers to consciousness (Dehaene 2013) but ultimately it's our mind that generates this thought, which leads to Descartes's problem of Cartesian duality in philosophy; which is a mind-body problem (Ryle 2009; Barrett 2006; Long 1969).

Such arguments though supportive cannot define some of the facts of consciousness, such as P-form of consciousness proposed by Ned Block (Block 2007) which according to David Chalmers is the "hard problem of consciousness" with A-form or access consciousness related to

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introspection that generates awareness (Chalmers 1995, 1996). Introspection is understanding, one's own thought and feeling in a conscious state of mind and can be compared to reasoning and memory which are ultimately forms of intelligence (Hixon and Swann 1993; Byrne 2005). Intelligence on the other hand, is the ability to perceive, store and retrieve knowledge of any information to be utilized when needed (Legg and Hutter 2007). In humans, intelligence has been understood as perception, consciousness and awareness (Hunt 2011) but does not assist animal, plant or microbial intelligence for the ability of an animal, plant or microbe to be intelligent is always questionable. Animal consciousness, cannot explain the problem of other minds due to the lack of expression of language as observed in humans (Searle 1994) which is a bigger problem with microbial intelligence.

A group of scientists, in the Cambridge conference on 'Consciousness in human and non-human animals' announced and signed a declaration stating, "Convergent evidence indicates that non-human animals have the neuroanatomical, neurochemical, and neurophysiological substrates of conscious states along with the capacity to exhibit intentional behaviors. Consequently, the weight of evidence indicates that humans are not unique in possessing the neurological substrates that generate consciousness. Non-human animals, including all mammals and birds, and many other creatures, including octopuses, also possess these neurological substrates" (Low 2012). The question is, are animals intelligent or are they conscious or both? Some animals and microorganisms do demonstrate behaviours that can be similar to humans but whether it is intelligence that drives this behaviour or is it a conscious need-based behaviour is difficult to judge. According to Stuart Hameroff, consciousness in lower organisms exists as a primitive form of consciousness which may have been the main cause for the Cambrian Explosion and its occurrence then, was likely to have accelerated evolution (Hameroff 1995).

Is intelligence related to consciousness or vice versa? Does being conscious resemble being intelligent or rather, do we need consciousness to be intelligent? These questions will never have a well defined answer, but this does not suggest that we cannot approach the problem. This paper attempts to hypothetically correlate consciousness and intelligence by hypothesizing the growth and formation of consciousness and intelligence as two separate entities that do overlap at some point, but take different paths during embryogenesis.

Horizontal growth of Consciousness

The growth of consciousness can be understood in the pretext of Hameroff-Penrose's Orch-OR theory of consciousness, that generates by way of computation in the microtubules (Hameroff and Penrose 2014). Quantum consciousness holds an important place in understanding the functioning and transmission of consciousness within the cytoskeletal network of a single cell (Pereira 2015). The body develops from a single cell; the zygote, which is a result of fusion of the sperm and ova. Is it intelligence that drives this process or is it consciousness that makes it happen? It is but, the intelligence of two human beings and the conscious moment generated within the two cells that makes this event possible. This phase can be hypothesised as the origination point of horizontal growth of consciousness; a form of consciousness that resides in every cell and guides it internally as well as externally.

During the process of embryogenesis, the zygote or fertilized egg undergoes cleavage or cell division to form the blastula; a group of similar cells which advances with cell differentiation, a significant change from unicellularity to multicellularity (Grosberg and Strathmann 2007). Cells differentiate in the gastrula stage of embryogenesis to form the three germ layers that gives rise to the various structures that form the body. Based on the hypothesis of quantum consciousness, microtubules present in the fertilized cell compute consciousness which help the cell divide and advance further through the various stages of embryogenesis. In comparison to the division that occurs in unicellular organism, here the computation of consciousness is at a much higher level due the complexity of microtubular network. Based on Hameroff-Penrose's Orch-OR computational model, it has been predicted that quantum super positions of the tubulin dimers in the microtubules create the moment (Hameroff and Penrose 2014) which may vary depending on the microtubule make-up in microorganisms or organisms without a brain (Pereira 2015).

Horizontal growth of consciousness progresses during cell division and cell differentiation in the blastula and gastrula stages of embryogenesis. Consciousness drives the organizing capability of these germ cells which differentiate further to form the numerous systems within the body. Development is a combined process and wholly depends on the differentiation patterns observed between the cells in the germ layers (Gardner 1982) which shapes the foundation for stem cell research (Gage 2000). With cells constantly dividing during the process of embryogenesis, a horizontal growth in generation of consciousness may be observed with an increase in the number of microtubule content as a result of increasing cell numbers. Cell differentiation on the other hand also contributes to the horizontal growth due to the increasing complexity in the microtubular structure which begins with the early growth of the brain cells. It can be further hypothesised, that cells differentiate to develop as neural cells, as the nervous cells are the only set of cells that can manage the "hard problem of consciousness" or phenomenal consciousness, which is not the case with the other cells in the body or even with microorganisms.

According to the horizontal growth hypothesis of consciousness, the capacity of a cell to compute consciousness depends wholly on the complexity of the microtubular structure and therefore can only grow horizontally with the advancement of cellular growth and differentiation during embryogenesis. In higher organisms, growth in complexity of the microtubular network within the neurons results in higher conductance and higher consciousness, which enhances the capability to demonstrate intelligence. In microorganisms, this growth is restricted to the microtubules present in the cell which is limited but since microorganisms live in communities they utilize their consciousness to build and survive which is represented horizontally.

Hypothesising the Vertical growth of Intelligence via the Horizontal growth of Consciousness

Intelligence augments with changes in plasticity of the brain from zygote to adult but size does not its level (Shaffer 2012). In humans the brain grows rapidly till the age of five, which reduces intensity but grows until 20 years of age which is considered to be the critical period of intellectual development wherein organization and reorganization of the neural pathways and the synaptic junction occurs (Linden 2007). Rapid growth of intelligence can be hypothesised as vertical growth of intelligence, which progresses with the development of the complex

connections and higher microtubular networking within the neural cells of the brain. The development of neural tissue occurs simultaneously during the stages of embryogenesis and as hypothesised, the horizontal growth of consciousness plays an important role during this stage. Intelligence is a process by which one can receive, store and retrieve information and is dependent on external factors but during the formation stages of embryogenesis, consciousness would help drive the cell to differentiate and divide to form the nervous system, which gives birth to actual intelligence. Based on the hypothesis, it can be suggested that vertical growth of intelligence due to the development of the neural system wholly depends on the horizontal growth of consciousness which initiates the differentiation process for formation of the neural system.

The vertical growth of intelligence comes with higher neural connectivity but the so-called intelligent behaviours observed in microorganisms are independent of neural systems, then how would they be termed intelligent? In several unicellular organisms, so-called intelligent behaviours have been observed which can be compared to human intelligence but does not equate its intelligence bearing capacity. Based on the current hypothesis, it can be hypothesized that, the so-called intelligence observed in unicellular microorganisms is highly primitive and is wholly based on consciousness generated within the microtubules of these cell. The unicellular microorganism is a single unit performing this function and therefore its ability to compute consciousness is limited or rather restricted to the microtubular network. This is one of the main reasons microorganisms demonstrate cooperative behaviours e.g. microbial mat formations, slime moulds, etc (Crespi 2001; Latty and Beekman 2010); a collective computation of consciousness occurs due to large cell numbers which perform activities that could be termed intelligent or could be compared to human intelligence. Based on the hypothesis it can be noted that, all types of cells and microorganisms have the capability of computing consciousness through their microtubules which could be the reason for demonstrating this so-called intelligence.

Hypothesised vertical growth of intelligence is rapid, because it is specific to the highly differentiated neural tissues of the brain which continues post embryogenesis right up to adulthood. All multicellular organisms are intelligent but the level of intelligence depends on the number of neural connections in the brain (Linden 2007). Consciousness in the brain depends on microtubule networks within the neural connections which in the human brain perform higher levels of consciousness in comparison to lower organisms. In unicellular organisms, the assembly or clustering of cells is somewhat like the cells of the brain or the neural network, wherein the increased microtubular networks in the colony generates consciousness that can be equated to a lower level of intelligence or so-called intelligence. In higher organisms, the vertical growth of intelligence wholly depends on the horizontal growth of consciousness during the stages of embryogenesis of higher multicellular organisms. In microorganisms and single cells, consciousness generated in the microtubular network generates a so-called primitive form of intelligence which is used collectively to perform several intelligent-based activities.

Conclusion

Consciousness and intelligence are independent in their existence but based on the current hypothesis, there is a strong correlation observed at the cellular level, dependent on the microtubular network within the cell. Based on the hypothesis, embryogenesis is wholly managed by the conscious decisions computed within the cells, making them aware of their capability to divide and differentiate but during this process the generation of the neural cells and tissue gives rise to intelligence and takes over from consciousness which results in the bifurcation of two unique entities. Consciousness computed within the microtubular network of cells can be considered as a primitive form of so-called intelligence, which helps microorganisms demonstrate behaviours, which in some cases may be comparable to human intelligence. In higher organisms, horizontal growth of consciousness definitely builds a solid platform for the vertical growth of intelligence to progress.

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