Essay

A Conjecture Concerning the Physics of Consciousness

D. John Doyle*

Dept. of General Anesthesiology, Cleveland Clinic Foundation, Cleveland, Ohio, USA

Abstract

In this short essay, the following conjecture is offered: the phenomenon of consciousness is necessarily an energy consuming process. This conjecture, if true, implies that if a being is conscious, that being must have some form of physical existence.

Keywords: Consciousness, physics, conjecture, energy consumption, physical existence.

Introduction

From beginning of history philosophers and scientists have wondered about the relationship between the mind and the body and how mental events arise from a physical substrate such as the brain. In recent years, individuals interested in the problem of consciousness have identified a number of intriguing questions related to this complex issue: What are the necessary and sufficient conditions for the emergence of consciousness? Can the mind exist independently from the body? How is it that general anesthetics are capable of eliminating consciousness? Are conscious artificial beings possible?

In this brief communication a conjecture concerning consciousness is offered that, if true, would be fundamental to the study of consciousness and, possibly, helpful in answering questions such as the above.

Conjecture

The conjecture I offer is simply this: the phenomenon of consciousness is necessarily an energy consuming process.

*Correspondence: D. John Doyle, MD. PhD, Department of General Anesthesiology, Cleveland Clinic Foundation, 9500 Euclid Avenue - E31, Cleveland, Ohio, 44195, USA. E-mail: djdoyle@hotmail.com

Discussion

A conjecture is a proposition that is unproven, has not been disproven, and appears to be correct. The conjecture offered here - that consciousness is necessarily an energy consuming process - makes sense in the context of what is known biologically. For instance, it is well known that under conditions of profound hypothermia, consciousness vanishes concomitantly with a drop in organismal energy consumption, and that hypothermia therapy is sometimes used to reduce brain metabolism and improve neurologic outcomes in patients (Bernard 2005). Similarly, we also know that the energy for the brain's neuronal activity comes principally from the conversion of glucose into ATP (adenosine-5'-triphosphate) (in cellular mitochondria, via the citric acid cycle) and that conditions that result in a shortage of ATP in neurons (such as profound hypoxia) will lead to unconsciousness (Gnaiger & Kuznetsov 2002). Also, it is known that with a number of general anesthetics, brain energy consumption is diminished (Alkire & Miller 2005). These facts are all supportive of the proposed conjecture.

A final point worth noting is that this conjecture is compatible with Landauer's Principle, (Landauer 1961) which states that the minimum amount of energy required to irreversibly change one bit of information is kT ln 2, where k is the Boltzmann constant and T is the substrate temperature. This implies that energy is required to change encoded brain information, which is needed for memory and recall, and therefore also for consciousness.

The philosophical implications of the offered conjecture are two-fold. First, according to the conjecture, the operation of any artificial being (such as a conscious silicon-chip-based computer), would necessarily require the expenditure of energy (electrical energy, in the case of the computer example). Secondly, the notion of a conscious nonphysical soul released after physical death, a belief common to a number of religions, is incompatible with the conjecture.

References

Alkire, M.T. & Miller, J. (2005) General anesthesia and the neural correlates of consciousness. *Prog Brain Res.* **150**, pp.229-244.

Bernard, S.A. (2005) Hypothermia improves outcome from cardiac arrest. *Crit Care Resusc*. 2005 **7**(4), pp.:325-327.

Gnaiger, E & Kuznetsov, A.V. (2002) Mitochondrial respiration at low levels of oxygen and cytochrome c. *Biochem Soc Trans*. **30**(2), pp.252-258.

Landauer, R. (1961) Irreversibility and Heat Generation in the Computing Process. *IBM Journal of Research and Development*, **5**, pp. 183-191.