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Physics of Consciousness

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ABSTRACT

Conscious experience is an experience, i.e. a particular activation of mammalian system. Mental events are stable reverberations of sets of neural cell assemblies. Dynamical models based on this assumption allow to explain a large body of empirical evidence, such as the content of consciousness in dynamical situations and subjective ordering of events in experiments with short-time direct stimulation of neocortex.

1 Introduction

Great progress in understanding of biochemical and neurological mechanisms has not yet led to the comparable progress in understanding of higher cognitive functions of the mind. So far only very few attempts that aim at a unified theory of cognition have been made. They came from the artificial intelligence perspective. Probably the first was John Anderson's ACT model developed in the past 20 years. The model has three types of memories: declarative, procedural and working memory, and although it is just a formal model, with no ambitions for biological justifiability, it is quite successful in modelling a variety of high level cognitive phenomena, such as memory effects, priming, or even learning simple programming techniques and theorem proving. Another project, Model Human Processor (MHP), was started at Xerox PARC company as a model to design human-machine interfaces. Allen Newell, a co-author of the MHP project, wrote a book "Unified theories of cognition" [1] promoting the view that there is enough empirical evidence from cognitive psychology and neuropsychology to create many alternative unified theories of cognition. His own attempt was based on an expert system called SOAR, a system using production rules and symbol processing, certainly rather implausible as a model of mammalian activity.

Computational neuroscience provides a better path for understanding the brain/mind functions. Attempts to link theoretical computer simulations with experimental approaches have been quite successful but somehow restricted to lower level cognition (cf. [2,3]). First books on the theory of dynamical systems applied to the early stages of human development appeared recently (cf. [4]). A very interesting attempt based on modular neural networks applied to categorization and learning has been published by Murrie [5]. His CALM (Categorization And Learning Modula) networks, inspired by the cortical microcolumns, are one of the first successful attempts at cognitive modelling with some biological justification. Such cognitive models (cf. [6]) are concerned with many interesting psychological phenomena, such as various memory effects, recognition, priming, lateral inhibition, conditioning, categorization, learning, attention, reinforcement, optimization or motoric control. Quite recently consciousness became a popular subject (cf. [7-10]) but the discussion of this elusive phenomenon has been kept on a rather philosophical level. A few notable exceptions include the "global workspace" model of Baars [11], Theory of Neuronal Group Selection [12] and a relational theory of mind [13].

In this paper I will try to stay firmly grounded in empirical evidence. The non-"consciousness" does not refer to anything in particular, it is not a thing we can talk about, it is rather an experience or many different experiences that we label as "consciousness". The first problem in the research on consciousness is to clearly define what the real problem is. What should we explain?

2 Understanding Consciousness

Some physicists think that a unified theory of everything (TUE) will explain consciousness together with everything else (cf. Penrose [14] writing on consciousness, quantum gravity and unified field theories), but since they do not define what they want to explain (Penrose writes that "consciousness is indeed something") it is not clear

# CONSCIOUSNESS AND THE COMPUTATIONAL MIND

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