



Review of "The Cooperative Neuron. Cellular Foundations of Mental Life" by William A. Phillips.

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The Cooperative Neuron. Cellular Foundations of Mental Life. By William A. Phillips. Oxford: Oxford University Press. 2023. 384 pp. £49.95 (Hardcover – UK publication 20th April 2023), \$65.00 (Hardcover – USA publication 30th June 2023).

The December 2022 issue of *Zygon* (vol. 57, issue 4) contained a set of 6 articles on artificial intelligence (AI) and its current and future interface with issues in theology, philosophy and the study of consciousness. Fortuitously, this has now been followed by the publication of William Phillips' "The Cooperative Neuron". This new volume is *not* about AI, but it reviews recent developments in our understanding of nerve cells – in particular the pyramidal neurons of the neocortex - that are apposite, not just to the issues explored recently in the pages of *Zygon*, but to cognitive science as a whole.

20th century advances in neurophysiology led to a model of the nervous system as a network of electrically connected nodes. Signals arrived at synapses and were conveyed to the neuron cell body via the dendrites. Depending on the balance of excitatory and inhibitory signals, that cell body might or might not activate its own axon, sending a signal onward to further synapses and other neurons. Of course, neurophysiologists and cytologists were always aware of the many subtleties and complexities surrounding these events, but the simplicity of the underlying model was so appealing that such things tended to be forgotten in an accumulating rush of metaphors of the nervous system as a digital network object. From early images of the brain as a telephone exchange through eventually to the brain as ultra-parallel-processing computer, such notions in their turn inspired a late 20th century flourishing of various models of consciousness, individuality, free will and emotion – all the things that philosopher Roger Scruton insisted on encapsulating as "the soul" – as an emergent property of that network. The human computer/brain just happened to be instantiated in the delicate filigree of billions of connected neurons but could potentially be realised in any informational architecture that displayed an equivalent degree of complexity. Scruton's soul thus became a set of software procedures, a way in which the hyper-complex informational network could monitor and regulate itself over infinitesimally fleeting timescales.

Now, two decades into the 21st century, William Phillips shows that it is time for that underlying model to be replaced. The present century is beginning to reveal that the nervous system is much more than, indeed perhaps rather more firmly *not*, the kind of computational architecture the computer scientists misleadingly term (although through no fault of their own, given what much of 20th century neuroscience implied) a "neural network". Over 10 chapters, Phillips lays out the new landscape of neurophysiology, showing that the key novel concepts are those of cooperation and context-sensitivity. The first three chapters review the latest findings in the organization of the neocortex, showing how functionally fluid its operations may be. Chapters 4 to 7 then show how this new realization of the internally cooperative nature of the brain has implications for all areas of investigation into the mind, covering everything from sleep, anaesthesia and moods to conscious awareness, emotions, cognition, memory and more. If the book simply ended there, one might categorize it as a devastating critique of overly simplistic conceptions of the workings of the brain that have led to potentially equally flawed models of mind. But Phillips is not quite finished at that point. Chapter 8 takes the lessons of the new cooperative context-sensitive neurophysiology or the neocortex and asks what it can give back to the field of computation. If the brain is far less like a digital computer than 20th century scientists hoped, then perhaps it is for computing science to take up the challenge of designing computers that are more like brains, and Phillips has a few suggestions how. Chapters 9 and 10 summarise and explore the likely difficulties still to be encountered in this

new field of “cellular psychology”, as Phillips describes it. “The Cooperative Neuron” is a dense but satisfying requisite read for all who are interested in what goes on in our heads.

This review began with AI. Phillips only touches briefly on this issue and this, I think, is a weakness of the book, given what he could potentially have said. The cognitive scientists and neurophilosophers of the 20th century may not have known what Roger Scruton’s soul actually was, but they knew that the only convincing instances of souls were manifested in biological entities, and even then perhaps only in the most neuronally endowed of those entities such as ourselves. Now, in the 21st century, we must face the prospect that we may soon create artificial intelligences greater than our own. Will they have souls? Phillips’ thesis perhaps suggests, at least to me, that the answer may well be “no”. This is not because they are insufficiently intelligent – quite the contrary, once quantum computing solves its technical issues and joins the party - but rather because they are insufficiently “biological”. I mean this not, of course, in the trivially literal sense that they are instantiated *in silico*, but rather in that the architecture of their intelligence(s), by virtue of being fundamentally a 20th century computer (albeit, one might say, on 21st century steroids), does not embody the cooperative, context-sensitive nature, the cellular psychology, that Phillips argues so convincingly is a part of the architecture of our brains. Phillips still cannot answer the philosophers’ question about what the soul is, but by making the case for a fundamental difference between true neural networks and their simplified *in silico* equivalents, however sophisticated, he implies that AI, whatever its future triumphs in problem solving, won’t be engineering any new souls any time soon.