

9.29.17

Charles, I will keep this email from you as a little treasure. With its humor and insights, the sheer sweetness of the writing and its steady focus on what is really important it is a portrait of the man I love. I found nothing in what you wrote that I would disagree with. I appreciated especially your comments on possible relevance of the research to our understanding of consciousness beyond the human variety. It was a pleasure to receive such a delightful epistle at the end of the day. It has been a good day but I was exhausted until I read your 'ramblings'. I always tell Bryn that our ramblings about ideas and literature are in fact more important than the prescribed work for the day. Take care of yourself and the love of your life!

Hugh,

I opened the article "The Brain's 7D Sandcastles could be the key to consciousness" but was blocked from reading the full review without subscribing. Knowing that almost anything of interest can be found publicly available on the web, I searched until I found the complete study: "Cliques of Neurons Bound into Cavities Provide a Missing Link between Structure and Function". The full article resides in the "Frontiers in Computational Neuroscience" site and others.

Many great novels begin with equally great sentences. This study begins with a delightfully concise description of the subject and the problem:

The lack of a formal link between neural network structure and its emergent function has hampered our understanding of how the brain processes information.

The second sentence is a tight description of their method:

We have now come closer to describing such a link by taking the direction of synaptic transmission into account, constructing graphs of a network that reflect the direction of information flow, and analyzing these directed graphs using algebraic topology.

When I read 2.1 *The Case for Directed Simplices*, I stopped dead in my tracks. Well, not really. What actually happened was that I was eating my usual breakfast (coffee, yoghurt, peanut butter), and read this:

*Networks of neurons connected by **electrical** synapses (gap junctions) can be represented as undirected graphs, where information can flow in **both directions**. Networks with **chemical** synapses, which impose a **single direction** of synaptic communication from the pre- to the postsynaptic neuron, are more accurately represented as directed graphs.*

While reading the above, I reached for the coffee pot to refill my cup—but, still reading, I poured the coffee directly into the open peanut butter jar instead. [In the process, I discovered that you can pour coffee back out of a peanut butter jar into your coffee cup without losing any of either.]

I have long understood that communication among neurons is electro/chemical, but had no idea that these were separately electrical & chemical and that they had discreet directionalities: two-way and one-way. This most certainly does amp up the possible complexities geometrically.

Algebraic topography seems to be a useful tool in examining these complexities, but it is both misleading and ingenuous to suggest that the discovery of massively complex structures of connection is a discovery of additional dimensions—breathtaking as these structures are. I would suggest that this is a somewhat careless use of the word *dimension*.

So also with the extravagant claims (not made by the writers of the paper) that these studies could be the “key to consciousness”—and yes, Searle is right about his weakness.

However, there are indeed implications for the study of consciousness. The Blue Brain Team found that the delightful roundworm *C. elegans* has the same neural structures and uni/bi-directional communication as higher orders of living things. You can look at neural structures from *C. elegans* up to ourselves, or begin with ourselves and exam brain structure and activity back down to the simplest living organisms. In doing this, I seem ineluctably drawn to the premise that the immense and complex web of life is one web. There is a wonder in both its simplicity and complexity, but the awesomeness of Life itself strikes us with a stunning blow. We know the constituent mineral components of life but not how or under what conditions they combine to be the phenomenon of Life. We will probably learn a great deal more about this—perhaps even satisfying explanation/understanding, or even conditions under which life can be artificially created. But I suggest that nothing will stop our jaw-dropping stupefaction at the pure Wonder of it All.

By the way, algebraic topography promises to reach greater and greater sophistication in mapping the structures and complexities of brain function in both *C. elegans* and *Homo Sapiens*, but questions that interest me much more—such as the transformation of an ordinary citizen into a terrorist, or, for that matter any other ideological conversion, would require not simply an examination of the disruption of complex neural interactions but also a direct, human, phenomenological observation and interaction with the subject of radical re-orientation of values and worldview.

Charles