The Relationship between Brain Structure and Function and "Ultra Complex Brain Developments"

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Abstract

The "brain as a computer metaphor"-based technical reconstructions versus efforts to comprehend how the brain links the informational structure with its phenomenal constructs, such as perception, cognition, consciousness, agency, and free will—have all become increasingly important some years after the start of these programs. On the one hand, an engineering demonstration is in opposition to a more solidly founded scientific and philosophica undertaking. In all vertebrate animals, as well as the majority of invertebrate ones, the brain functions as the hub of the nervous system. It is situated inside the head, typically close to the sensory structures that support senses like vision. It is the most intricate organ in the body of a vertebrate. The cerebral cortex of an adult human has 14–16 billion neurons.

Introduction

Once more, despite the tremendous effort and technological accomplishments behind this research, concerns have been expressed about whether the findings can illuminate the potential role of this portion of the sensory cortex. Although the functioning of each individual brain cell is now very well understood, the mystery surrounding how millions of them work together remains. Modern neuroscience's most recent models consider the brain as a biological computer, quite different from an electronic computer in terms of its workings but comparable in that it gathers information from the environment, stores it, and processes it in various ways.

The issue of structure-function relationships in the brain is undoubtedly more complex than a purely technical reconstruction would suggest. The work behind very big brain projects may eventually lead to models of the human and rodent connectome (i.e., the brain's wiring pattern). But does this also apply to our understanding of how the brain works? Is the brain's wiring and cell signaling structure a perfect representation of its function? To be clear, I do not intend to criticize the VLPS's coordinated efforts nor do I wish to downplay any potential advancement that should be anticipated given the investments made.

The issue I do want to bring up here is that approaches that merely focus on the "informational structure"—the information that lies beneath the brain's wiring pattern—are lacking something. The "meaning" underlying this data is what's lacking. The phenomenology of experience is combined with information-based qualities in the brain. The relationship between this unique organ's structure and function connects several seemingly incompatible traits.

A key functional concept that has to be the focus of brain research is how the brain can genuinely integrate two conflicting traits, bridging the Rubicon dividing two magnitudes that are mutually incompatible. This topic merits additional thought because it has been largely disregarded. In the 19th and 20th centuries, neuroscience the anti-localizationist holistic tradition adopted cortical localizations, and vice versa. The combination of the two eventually produced the widely accepted theory of today, according to which cortical segregation and functional dispersion provide the substrate for the construction of Conscious Perception (cPS). We now know that dissociations in perception, from unconscious and subliminal to fully aware states, map well onto the spatio-temporal variation of the underlying neuronal firing pattern with the aid of non-invasive brain activity measurements, such as fMRI or EEG. The paradox of these results lies, once more, in the contrast between the statistical nature of information-based observations on the one hand, and the "expectation" offered by the structure of a perceptive brain, as described by Friston's "free-energy principle" model. The permanent architecture of the brain contains a vast functional repertoire. We must eventually find answers to various issues that are specific to the characteristics of the brain in order to understand the relationship between the structural connectivity of the brain (referred to as "the one") and the complexity of its function (referred to as "the many"). For instance, the organization of cells and their pre- and postsynaptic periphery is marked by a tremendous amount of intricacy. A single cell's "functional volume," which includes all of its peripheral in- and output relations, may actually span the full geometry of its reference structure, such as the entire brain.

Only the brain can experience this condition. We must take it a step farther in order to understand the one-to-many relationship between structure and function. According to me, research limited to the reconstruction of the "information processing domain" at a single scale (the cell-scale, the macro- and microcircuits of connections) cannot provide light on this particular link. Instead, such an endeavor will necessitate the use of numerous action orders of physical scales, from the level of the entire brain down to the molecular and sub molecular (atomic) level. Additionally, a unique sort of dynamics that underlies the many scaled neuronal architecture begins to assume a crucial function.

To ultimately gain a deeper understanding of how the brain models the environment, we must move beyond the kind of network reconstructions that are at the core of the extremely large brain projects.

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