

AFTER PHRENOLOGY: NEURAL REUSE AND THE INTERACTIVE BRAIN

by Michael L. Anderson. MIT Press,
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After Phrenology by Michael L. Anderson is a unique and thought-provoking contribution to the current debate on how cognition interfaces with the environment and how we can move scientific studies of the brain forward. His theory of “neural reuse” is a proposal for how we may reframe the debate and fills in some of the gaps that exist now when we communicate about the mind, the brain and the environment. The basic idea is that, rather than seeing localized areas of brain activity as the way to define brain functionality, we should investigate the neural circuitry combinations that are employed to perform complex functions. Included in this notion is recognizing that our ways of doing things are both active and environmentally connected. For Anderson, “the Modern, Modular, cognitivist assumptions that have guided research during most of the last 50 years of cognitive neuroscience have not been borne out by the data this research produced” (pp. 301–302), and thus this book is a call

for a new kind of approach—neural reuse. He additionally offers a theoretical framework that claims to show how this design offers an evolutionarily informed framework, one that has the capacity to both explain brain functions and recognize our embeddedness in our environments.

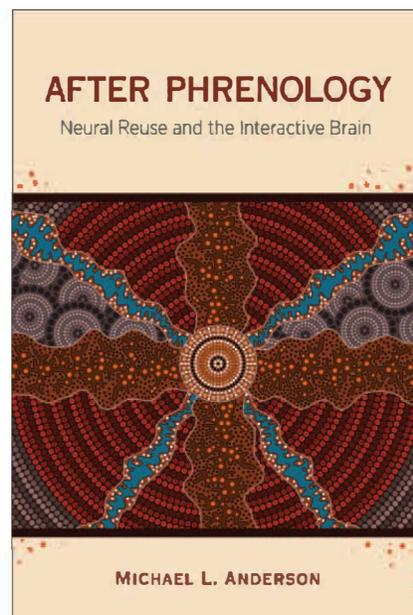
Anderson’s theoretical effort centers around the following concepts: (1) individual regions of the brain are functionally diverse and differentiated; (2) there is frequent functional overlap between different brain networks; (3) the brain is fundamentally action oriented and specializes in managing the organism’s interactions with the world; and (4) the brain achieves its functions by assembling the right functional coalitions between both neural and extraneural partners, supporting interaction with external artifacts—including symbolic ones—for cognitive ends. In making his points, Anderson asserts that contemporary cognitive neuroscience’s core view is that the brain is an informational processing device and studies too often rely on the notion of localization.

I suppose time will tell if “neural reuse” can aid in focusing discussions more on the use of local regions of the brain for multiple tasks across domains. Evidence Anderson points to includes examples like Broca’s area, which is fairly well established as a

language region despite the frequency with which it is activated in nonlanguage tasks. Since seeing neural reuse as a fundamental feature of the functional architecture of the brain would allow us to rethink how we speak of the architecture, the categories used and even the principles of brain evolution and development, this kind of framework would, according to Anderson, better convey that Broca’s area is not only a language region. Admittedly, at the end, I was never really clear as to why he calls his viewpoint “neural reuse,” although it seems the concept is intended to convey functional overlap.

The best sections of the book are at the beginning, where Anderson lays out the evidence showing that individual regions of the brain are functionally diverse and are used and reused in many different tasks across cognitive domains. His first major point is that achieving functional specificity is a matter of assembling the right coalition of neural partners to accomplish the task in question. With this underpinning, he argues that this kind of functional structure makes evolutionary sense in terms of the efficient use of metabolically expensive and relatively scarce neural resources. Following this overview, Anderson turns to the functional development of the brain. Rather than positioning himself in terms of a more traditional functional specialization approach, he develops an argument for interactive differentiation as the relevant operational concept controlling development.

Overall the book argues that the brain is best understood as an action controller, responsible for managing the values of salient organism-environment relationships (p. xxii). Thus, the multidimensional neural dispositions should be understood as the brain’s differential propensities to influence the organism’s response to the various features or affordances in its environment. In other words, each brain region is involved in multiple tasks, and coherent function is a matter of establishing the appropriate neural partnerships. Anderson



is quite focused on showing how the architectural theory works on language, because he sees it as such a powerful cultural tool. In addition, one of the book's strongest sections is the appendix, where Anderson outlines 23 open questions. This appendix is excellent on its own terms, and I am personally receptive to theories that point out their own limitations.

I really wanted to conclude that this book was breakthrough material, but I'm not entirely convinced. Although *After Phrenology* brings in many contemporary scientific publications, the end product is primarily a philosophical argument that reminded this reviewer of how difficult it is to explain the brain, the mind and the fullness of our lived experience in tandem. As I read, I increasingly thought to myself that it was strange Anderson did not mention consciousness, because the tenor of the book seemed to focus on consciousness-type conundrums. He explained this omission about a hundred pages in:

When neuroscientists start brandishing the “c” word, there are two predictable reactions: increased public interest and attention and increased scientific scrutiny and criticism. . . . Or, as one prominent neuroscientist put it to me recently, “It is such a fad. I kind of hate it” (p. 109).

Even if he doesn't express the ideas in terms of the “c” word, the philosophical underpinnings align with the symbolic/interpretive concerns of consciousness theorists. Anderson is trying to wrestle with the brain's intrinsic behavior in terms of the mind and its environment using as a point of entry “faculty psychology”—admittedly a term I was only vaguely familiar with before opening this book. Whereas the extensive citations of scientific studies make it appear the ideas have a firm evidentiary foundation, his bewildering reliance on characterizing localization in faculty psychology terms places the ideas within a trajectory that dates back to Thomas Aquinas and medieval scholasticism. While it is also said that

faculty psychology influenced Franz Joseph Gall's (1758–1828) phrenology, a pre-Darwinian idea, I am not convinced that faculty psychology has similarly influenced clinical and experimental neuroscience today or historically. I'm not even convinced that faculty psychology had a broad impact on psychology in the late 19th century. Thus, I find Anderson's taxonomy for this study ill conceived, leading to the conclusion that one major problem with the book is its title. Anderson's efforts to ground the interesting ideas about neural reuse within this kind of framework seemed off the mark and took credibility away from his efforts to move the contemporary theoretical discussion forward. A second problem was that this grounding didn't seem to include an accurate grasp of the contextual vocabularies for the historical views he wants to cast aside.

The problem in the way Anderson presents the story is that he doesn't seem to know much about the experimental trajectory. He mentions the importance of Broca, who made significant contributions in setting up the localization agenda. Then, after introducing Broca's work, Anderson tells us that faculty psychology has a long history:

As is well known, functional localization in the eighteenth and nineteenth centuries was heavily influenced by faculty psychology (Reid 2002), leading to the notion that individual capacities such as parental love or verbal memory might be supported by distinct, relatively circumscribed regions of the brain (p. 3).

I've never seen faculty psychology mentioned in any of the books I've read on the history of the neurosciences, nor do I recall reading about Thomas Reid, so I was baffled.

I now know that Reid (1710–1796), a Scottish philosopher and a critic of Hume, wrote his book *Essays on the Intellectual Powers of Man*, the book Anderson cites, in 1785, before Broca was born. It is also known, as mentioned above, that faculty psychology was connected with

scholasticism and other medieval philosophies and influenced Gall's ideas. The larger point in terms of *After Phrenology* is that my understanding of the contextual information that led to localization theories differs from the way Anderson frames the history. I know of Gall's localization ideas, while thinking of localization investigations, in terms of 19th-century researchers like John Hughlings Jackson (cerebral dominance), Eduard Hitzig and Gustav Fritsch (the motor cortex), David Ferrier (stimulation and lesion studies) and others who made compelling contributions to the localized areas of the brain story after Gall's case for localization was cast aside. There were also people like Jean Pierre Fourens (1794–1867), who opposed localization yet is often given credit for experiments that showed divisions and functions in areas of the brain. Since Anderson seems to place all the localization work (as well as imaging work today) under the phrenology umbrella—even as he points out that people were skeptical of phrenology—I was left with the question, How exactly does he think we got from there to here?

Anderson links it with the neuron doctrine, the concept that the nervous system is made up of discrete individual cells, a discovery that is generally aligned with the neuroanatomical work of Santiago Ramón y Cajal, although the name itself was coined in 1891 by Heinrich Wilhelm Gottfried Waldeyer-Hartz (1836–1921). I am inclined to think that whether or not Ramón y Cajal supported functionalism, it is not a good supporting frame for Anderson's neural reuse theory, since Ramón y Cajal was a neuroanatomist and structuralist and his neuroanatomical studies were based on what the evidence showed him. Indeed, positioning Ramón y Cajal is quite complicated. In 1906, when Camillo Golgi and Ramón y Cajal shared the Nobel Prize in Physiology or Medicine “in recognition of their work on the structure of the nervous system,” Golgi so strongly criticized the idea that each neuron is an independent cell that does not “anastomose” with surrounding cells

that Cajal called the occasion of their shared prize “a cruel irony of fate [to] pair, like Siamese twins united by the shoulders, scientific adversaries of such contrasting character!” [1] Anderson does mention William James and the divergent histories within the various approaches to psychology. He also mentions many 20th-century thinkers whose approaches are compatible with active and environmental approaches. For example, he integrates the ideas of John Dewey (1859–1952) and J.J. Gibson (1904–1979). As someone who is particularly fond of Gibson’s ideas about affordances and his ecological approach, and quite aware that both Dewey and Gibson worked decades before neuroimaging and after phrenology, these sections reminded of the scientists who have accused me of being out of date or behind the times when I have mentioned the ideas of these thinkers. In other words, I agree that their ideas seem to offer a good basis for assembling the right coalition of neural partners to accomplish the task in question.

In summary, Anderson wants us to focus on the idea that the brain is a collection, is fundamentally action oriented, and specializes in managing the organism’s interactions with the world. This focus makes sense to me particularly since I have increasingly found myself referring to brain imaging as the new phrenology, despite my initial enthusiasm for this kind of study. Early in the 21st century I was excited about the way scans, for example, allowed me to offer a visual analogy that seemed to explain that the brains of a specialist and a novice function differently. My enthusiasm dimmed as I watched scientists espouse theories that went far beyond what the data showed. As scientists began to support their theoretical musings by citing similar musings of their scientific colleagues, and popular culture further trivialized the results, I kept seeing the aura of phrenology when imaging studies were presented. As I read Anderson’s thoughtful study, and saw the liberties he took by ignoring contextual realities, I was disappointed that he

didn’t hit the nail on the head in a way that conforms more to my sense of the terrain. I was also once again reminded of how hard it is to move our minds in new directions.

That said, Anderson’s neural reuse program is an effort to reframe how we look at brain relationships, and thus I applaud it. Like the neuronal recycling hypothesis proposed by Stanislas Dehaene and ideas about brain plasticity, it is important to keep considering alternatives since we all know that we don’t have all the answers. While I often found this book perplexing, it does open an avenue for further communication. Indeed, as I read I found myself frequently thinking “yes and no.” Sometimes, when I said yes, it was because I agreed with the goal behind the ideas. Yet, as I tried to convince myself that the ideas were strikingly original and exciting, I also kept thinking that the material seemed skewed at times or was suggesting we add in ideas that are already a part of the debates (as I know them!). In the end, it was difficult to embrace the theoretical result to the degree I wanted to when I began the book. Anderson, to his credit, seems open to hearing disagreements and finding ways to work through conflicting ideas. Like him, I hope more of us will begin to ask if imaging data is now being used at times like phrenology and, if so, how we change this.

Reference

- 1 Nai-Shin Chu, “Centennial of the Nobel Prize for Golgi and Ramón y Cajal—Founding of Modern Neuroscience and Irony of Discovery,” *Acta Neurologica Taiwanica* 15, No. 3, 217–222 (2006).