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# What Can Neuroscience Explain?

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Horgan's perceptive discussion of Freudian psychology, Prozac and evolutionary biology cannot mitigate the problems that seriously weaken his book (Horgan, 1999). While he certainly manages to deflate some of the more outrageous hype surrounding the scientific and often not-so-scientific study of the mind, his criticism of the brain and behavioral sciences contains a number of flaws, some of which I will address below. My response focuses on his discussion of neuroscience. As we shall see, the three mysteries that Horgan believes cripple neuroscience are certainly not as serious as he insists.

Neuroscience is fascinating, as Horgan reminds us, because it's about us. Few can fail to be attracted by the idea of a science that helps us to understand the material basis of human consciousness, and indeed it's the prospect of discovering the solution to the mind-body problem that draws researchers into the field in the first place. And yet, nowadays most young scientists find themselves driven, early in their careers, into the data-rich corners of scientific specialization and far from grander problems like the nature of consciousness and the solution to the mind-body problem. Consequently, for Horgan, once we get behind the exciting rhetoric, the workaday reality of contemporary neuroscience is something of a disappointment. The funny thing about this book is that Horgan actually seems happy that neuroscience isn't going to live up to the more extreme hype anytime soon. When it comes to the mind, Horgan is a lover of mystery and in fact argues that neuroscience is destined to fail by dint of insurmountable conceptual and practical obstacles.

According to Horgan, three major obstacles face neuroscience. The most significant of these is Levine's famous explanatory gap (Levine, 1983). The other two, the binding problem and the differences found between individual brains, play a subsidiary role in his argument. Let's dispense with the two subsidiary points from the outset.

## 1. Variability

Horgan calls the variability of minds and brains "a fundamental obstacle to progress in neuroscience" (1999, p. 32). Any attempt to uncover the functional anatomy of the brain will fail, according to Horgan, since the plasticity of the nervous system means that our unique life histories leave each of us with a unique brain. That no two brains are identical is certainly not a genuine objection to neuroscience. To begin with, generalization and averaging are part of every science. Surely neuroscience, like physics won't totter simply because no two objects, events or experiments are identical. To give content to his objection, Horgan needs to show that there are no genuine generalizations in neuroscience. He cannot do so, and the catalog of well-supported results in functional localization speaks for itself. Nevertheless, there are important technical problems in contemporary neuroscience that do, in fact, result from anatomical variability. Horgan could certainly apply his variability argument to many of the results supposedly derived from imaging technologies like fMRI and PET. As Joe Dumit argues (forthcoming) neural imaging often gives rise to problematic results as a consequence of the difficulties that emerge from having to average over anatomically diverse sets of brains. While Horgan's criticisms might have some merit in the context of imaging, these problems are technical rather than "fundamental." While generalizations from the results of imaging technologies must always be treated warily, the situation here is not qualitatively different from that of any other science.

In any event, most work conducted in contemporary neuroscience is devoted to the study of relatively homogenous cellular and subcellular phenomena. It is therefore unaffected by the variability argument. The overwhelming majority of workers in mainstream neuroscience are engaged in an investigation of the ground floor level of brain and behavior. As John Bickle has recently noted, a brief "perusal of this year's Society for Neuroscience Abstracts volume (cataloguing the 13,000+ slide and poster presentations at the year's meeting) reflects how intracellular, molecular, and biochemical mainstream neuroscience has become" (forthcoming, ms. 4).

While our knowledge of the details is steadily improving, critics often contend (in part because of issues like variability) that neuroscience is a theory-poor science. This charge is unfair. If we consider Horgan's variability argument, it could be argued that scientists like Changeaux, Deacon, Edelman, Freeman and others have presented an array of theories that could plausibly provide the general principles according to which dynamic nervous systems take the varying forms they do. Edelman's neural Darwinism is certainly an eminently reasonable candidate for such a theory.

## 2. Binding

The binding problem is a genuine problem for neuroscience. However, readers should be alert to the way the problem is presented in Horgan's book: "the binding problem – the Humpty Dumpty dilemma, to use my term – remains very much unsolved" (1999, p. 43). Horgan's formulation of the binding problem suffers from the common flaw of assuming that all neural discriminations must end up united in a single representational space in the mind-brain. This assumption is connected to Horgan's views on consciousness and the explanatory gap to which I will return below. As philosophers like Dennett frequently point out, incautious formulations of "the binding problem" often presuppose that there must be some single representational space in the brain (smaller than the whole brain) where something like Horgan's Humpty Dumpty comes together again (see Dennett, 1991, p. 357). For Horgan, binding is a matter of "construct[ing] pictures of the world from many disparate pieces" (1999, p. 43). At this point in the history of the subject, everyone agrees that there is no single point in the brain reminiscent of Descrates' pineal gland, where the representational Humpty Dumpty *can* come together again (see, e.g., Minsky, 1985). When Kandel comments, in his interview with Horgan, that the brain "decomposes the image, it decomposes all sensation, and then reconstructs it" (1999, p. 43). It should not be assumed that this reconstruction rebuilds the original image that jiggles around on the back of the retina.

Researchers recognize that there are multiple processing streams dedicated to the discrimination of different sets of perceptual contents. So in visual processing, distinct neural processes respond to color, orientation, contour etc. (e.g., Zeki, 1992). Vision researchers hypothesize that stimuli are processed simultaneously by numerous mechanisms, each of which is tuned to one or more of a cluster of salient features in the visual scene.

Explaining the way this multi-tracking process can allow us to understand a perceptual scene containing *multiple* objects give rise to a number of technical and conceptual difficulties. In their *Memory Amnesia and the Hippocampal System* Eichenbaum and Cohen present a crisp description of the puzzle that has come to be known as the binding problem:

> If there are multiple objects in a given scene, each activating the appropriate feature values of different maps, the problem emerges of how the overall system can keep track of which activations across the maps belong to the same object. That is, if the scene contains several different cars, people, trees and buildings of various types, then there will be multiple feature values activated in each of the (color, contour, orientation, etc.) maps; that being the case, how can the overall system tell which color and which contour went with which orientation in the scene? (1993, p. 287)

The first point to note is that while there are no agreed solutions to the various binding problems that arise in perception and memory, there is no shortage of plausible solutions. In the case of the perceptual modalities, reasonable solutions include serial application of selective attention (Triesmann, 1969, 1988). For years, scientists like Stephen Grossberg have presented computational solutions to binding-style problems and have offered hypotheses with respect to the kinds of mechanisms in the brain might be responsible for their implementation (Grossberg, 1982), Ultimately, the binding problem will be solved either through the discovery of mechanisms that perform the computational tasks involved in binding informational contents, or alternatively through the realization that significantly less binding takes place in the brain than our folk psychological perspective might lead us to believe.

The binding problem is not a Humpty Dumpty dilemma in the sense that Horgan needs to claim in order for his objection to stick. The binding problem doesn't pose the same kind of fundamental barrier to neuroscience that something like Levine's explanatory gap might.

## 3. Explanatory Gaps

Horgan follows a slew of recent philosophers who have claimed that science will always be unable to explain consciousness in any meaningful way. The core of Horgan's criticism of neuroscience rests on the so-called explanatory gap. Levine originally introduced the term in his discussion of the irreducibility of qualia (1983), however, Horgan mistakenly believes that Levine's argument can be applied to "mental functions such as perception, memory, reasoning, and emotion – and to human behavior" (1999, p. 16). There are no grounds for this extension of Levine's original use of the term. The explanatory gap applies narrowly to qualia and not to perception, memory, reasoning, emotion and behavior. Few philosophers would deny that each of these topics is approachable to a certain point by the ordinary methods of scientific investigation. The Maginot Line for the mysterians is human consciousness. They argue that there is no way to reduce our conscious experience; our pains, tickles, sense of self, imagination, pride and desire to a pattern of neural activity or to the theoretical construction of an interpreter? Faith in the reality of qualia poses the greatest obstacle to the scientific explanation of the mind. And yet, it's difficult to do much more with qualia than to insist on their importance and express our confidence in their existence. When we try to fix on something definite that a quale could be, we inevitably return to the realm of ordinary and very unmysterious scientific inquiry.

If our questions about qualia are to find answers, they will have to come from somewhere other than our ordinary prejudices. Even the most ordinary questions about qualia will lead us back into the realm of normal scientific inquiry. So, for instance, to take an example from Dennett's *Consciousness Explained*, many of us enjoy the taste of beer. However, for almost everybody, the first taste of beer is not an especially pleasant experience. We come to enjoy the taste of beer over time and yet, Dennett wonders, what precisely is the taste that we are now enjoying? The phenomenological difference between our first beer and our thousandth is clear, but what can we say has changed between beer number one and beer number one thousand. The two alternatives that the lover of qualia will propose are either:

(A) The way beer tastes to us gradually changes
(B) It's the same taste, but drinkers gradually come to enjoy the taste that formerly nauseated them.

There is nothing in our experience of beer that will allow us to determine whether A or B is true. However, in order for qualia talk to be coherent, one of these choices must be true. In order to determine which is true, it will be necessary to go behind phenomenology to the "actual happenings in the head to see whether there is a truth-preserving (if "strained") interpretation of the beer drinkers' claims." (1991, p. 396) However, if there is something in the head that makes either A or B true, it will only be because we have decided to identify "the way beer tastes" with some set of neural processes or another (see also Dennett, 1988). So, Dennett concludes, given the phenomenological indeterminacy that inevitably arises in such cases, "[w]e would have to "destroy" qualia in order to "save" them" (1991, p. 396). Hence, the existence of qualia, at least in the sense intended by the mysterians, seems to have been disproved.

## 4. Ethical and Aesthetic Concerns

Horgan's, title; *The Undiscovered Mind: How the Brain Defies Replication, Medication and Explanation,* is curiously ambivalent. While he is critical, of the neuroscientific project Horgan's title implies that one very contentious metaphysical point is already settled, specifically that the terms "mind" and "brain" are roughly interchangeable. As such, he would seem to be a friend of the most hard-nosed materialists. Of course, this impression would be mistaken. Horgan counts himself among the new mysterians (1999, pp. 248–250) and consequently much of his book is devoted to pointing out the conceptual and practical obstacles to a scientific explanation of the mind. For Horgan, the criticism of neuroscience has a moral component insofar as he is eager to resist what he sees as the reductionist devaluation of human life. He warns that "subtle harm can come from the suggestions of prominent researchers that we humans are *just* a pack of neurons or *just* vehicles for propagating genes or *just* machines. This kind of reductionism does a disservice to both humans and science" (1999, p. 13).

Such worries place Horgan in a long tradition of commentators who argue that the scientific worldview has demystified and thereby devalued human life and the natural world. Of course this inference is unwarranted. While science may have destroyed any basis for the belief in a "spirit" understood as some kind of "essential self" that exists apart from human biology, this is only because a view of human nature that depends the existence of a disembodied self is almost certainly false. However, it is a mistake to infer that human life or the natural world is meaningless simply because we have no reason to believe in supernatural forces and disembodied souls.

There can be little doubt that we are complex biological machines with some amazing emergent properties. Just as certain is the fact that some of these properties will resist straightforward reduction to biology, let alone chemistry or physics. However, no matter what these emergent properties might be, it seems reasonable to assume that all of them are the result of events that are governed by the laws of physics and which have taken place over the course of natural history. As such, the conditions governing their emergence are open to scientific investigation.

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