Remote Learning Module for 6 April 2020

Lecture Notes on *Mind, Matter, and Mathematics* – Chapters 1 & 2

Last class we concluded our encounter with Hacking's *Rewriting the* Soul, and the problem of false consciousness when souls are rewritten. Today we'll begin raising a completely new set of applied philosophical questions concerning the relations between mind, matter and mathematics. Here we meet the neurobiologist, Jean-Pierre Changeux, and the mathematician, Alain Connes, as they engage in several lively disputes concerning the relation between math and science, the ontological status of mathematical objects, and justification of mathematical truths. You'll note that their dialogues were originally actual conversations (face-to-face; would that we were doing the same today, but enough of that).

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Chapter 1: Mathematics & The Brain.

(1) We begin with Changeux's introduction of his principal themes and interests. As a neurobiologist, he wants to think about how mathematics serves biology by providing an investigative tool for modeling brain function. He wonders how the brain creates mathematical objects, and arrives at mathematical truths; and he asks whether there is a role for mathematics to play in advancing moral philosophy. Alain Connes, on the other hand, argues that in order to understand the brain we must go beyond biology, and that by looking at the logic of mathematical proofs we discover a series of absolute, universal truths that are objective and independent of culture. As well see shortly, Connes is a staunch defender of a very old view about mathematical objects: Platonism.

(2) The first point of contention we encounter concerns the relation between math and science. We can see even here a pervasive tension between a theme and an anti-theme that will run throughout the subsequent dialogues. On the one hand, we have the Platonic theme that reappears in the works of Descartes and Leibniz: mathematics illuminates experience; it unifies knowledge, and is the highest science. On the other hand, we have the Skeptical theme that reappears in Diderot (mathematics *obscures* nature and adds nothing to experience) and Francis Bacon (math should always be seen as a servant to physics). Changeux takes the skeptical position, while Connes takes up the mantle of Platonism. By way of illustration, Connes offers a joke wherein a prospective patron mistakes a sign saying, "Dry Cleaning Here," for a description, when it is actually an exhibit, and who must be told: "We don't clean; we sell signs." His point is that words alone are never enough to fix reference, so that we must distinguish between mathematical and physical intuitions.

(3) This distinction between two types of intuition leads to a further metaphysical distinction between mathematical and physical objects. They consider the suggestion that one way to guarantee that radio signals from outer space are a form of extraterrestrial communication we would be better served using the language of mathematics than biology, since we can imagine that there may be beings with a radically different biology from our own, but with whom we might nevertheless communicate mathematically, by exchanging, for instance, subsets of the prime numbers in ascending order (since the sequence of primes, to the best of our knowledge, exists nowhere in nature). Connes argues that this makes sense, because mathematical objects exist independently of our discoveries and intuitions about them. This, in a nutshell, is the view we can call "Platonic Realism," or just plain, good, old-fashioned "Platonism." This Platonic view is sometimes also called "Logicism." Changeux opts for the rival philosophical view we can call "Constructionism." As we'll see a bit later on, Constructionism comes in two flavors, one called "Intuitionism," and the other, "Formalism."

On the one hand, Platonism embraces a form of metaphysical as well as epistemic dualism: mathematical ideas have a reality entirely distinct from the things of sensible, physical reality. Constructionism, on the other hand, is a materialist view: mathematical objects and ideas are "creatures of reason," and therefore exist only in brains. You'll note that Changeux cites the British Empiricists, Locke and Hume as supportive of this view (ideas are merely copies of sense impressions); this is not entirely fair: Hume famously held that the truths of math are known *analytic apriori* (that is, known by reason, independent of experience), while for Locke they are *acts of reflection* on counting operations. This is not be the first time French thinkers have oversimplified the thought of their cousins on the other side of the English Channel, nor have the English been immune from committing the same intellectual sin in the opposite direction; so let us be cautious.

(3) In defense of Realism, Connes offers an analogy between the work of the mathematician and the work of the geographer. Just as the geographer looks to provide accurate and complete maps of a given terrain or body of water, so too the mathematician looks to map mathematical relations, for example, those that pertain to finite fields. Finite fields are sets of numbers closed under the operations of addition and multiplication such that all their nonzero elements have a reciprocal. Changeux prefers a different analogy: the mathematician is rather more like a tool-maker than a geographer. We might simply call this view Anti-realism. He uses the example of pre-historic stone arrowheads as evidence of the emergence of logic and mathematics from tool-making. Connes, in turn, replies that Changeux has mistaken maps for map-makers. We must, in other words, distinguish between the objects of our mathematical knowledge and our manner of apprehending them. In short, he claims that the human brain has evolved to permit intuitions that don't arise from physical reality; we learn that there exists, quite inexplicably, a coherence in mathematics that is independent of sense perception.

(4) Because mathematics has a history, Changeux insists that mathematical truths are not tenseless—they are neither eternal nor immutable; instead, they are emergent historico-cultural artifacts, subject to evolution over time. What axiomatic methods uncover are the properties of constructed objects, fashioned in formal systems, not an external reality. Axioms are like the rules of a game, while proving theorems is like playing the game; what we uncover are properties of the rules, not external reality. The game *Monopoly* should not be mistaken for Wall Street. Connes will have none of this: for him mathematical and physical objects are on a par:

we posit them both on grounds of the coherence and permanence of our perceptions. Changeux ends the chapter by contending that Connes has confused concepts with percepts: calling an intuition an abstract perception is, moreover, a bad metaphor because it makes Realism into a self-interfering position. On the one hand, if Platonic Ideas are hyper-real, and therefore metaphysically immaterial, we must embrace *Idealism*; but on the other hand, if Platonic Analysis implies that being cannot be deduced from thought (or that there are, or can be, evidence-transcendent truths)—in other words, that the world is independent of how we think of it—then we must embrace *Anti-Idealism*.

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Chapter 2: Plato as Materialist

(1) Changeux defends his materialism and constructionism as derived from Spinoza's *emandatio intellectionis* (or healing of the intellect), whereby our metaphysical analyses should proceed ascetically, leading us away from the mythic residues of Platonism and other kinds of transcendental thought. We see again the thematic tension between Plato and Democritus as well. Besides Spinoza, Changeux also looks to J. T. Desanti for inspiration: the method of materialism is to seek out law-like regularities sufficient to explain how the brain generates mathematical objects. To this, Connes replies: yes, the brain generates all right, but what it generates are tools for investigating an independent reality. His point, of course, is that mathematical reality is wholly unaffected by empirical knowledge.

(2) Using an argument similar to Ian Hacking's treatment of the concept of multiplicity, Changeux opines that concepts are *generative*, and he cites the example of political *liberty*, an idea that had to be invented by human beings, not discovered in human nature. Connes agrees that the idea of liberty has a history, but that this history follows the course of looking to account for real features of human behavior. This makes knowledge acquisition hard to understand, Changeux counters: Why did it take so long for us to prove the existence of irrational real numbers, for example, if they were there all the time? Better, he claims, to understand mathematical objects as *memes* (in the old sense of this word, from Richard Dawkins, not what you might have found on your news-feed this morning): cultural representations that thrive, proliferate, and transmute from brain to brain. [Ok, I can't help but further analogize, much like the way viruses thrive, proliferate, and transmute from body to body.] Moreover, Changeux asserts, treating Platonic Realism as a "working hypothesis" is no better than pursuing psychoanalysis in order to help us figure out the mechanisms of cerebral function.

(3) We close the chapter with one of Changeux's major themes: the Darwinian evolution of mathematical objects. He thinks the geographer/discovery metaphor smuggles teleology in the back door. Biological evolution has no goal, no purpose; it is simply an instance of the law of effect (events that are rewarded are repeated). Instead of looking for Platonic/Aristotelian final causes, we should be looking for what Ernst Mayr called "next causes." For instance, we ask: How does/did DNA come to exhibit enzymatic activity sufficient to serve as the basis of heredity. Returning to Spinoza, Changeux cites him as having exposed the dangers of using teleological arguments when doing metaphysics, saying of Spinoza, the "rigor of his philosophical method stands as a model for us still."

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Next time, we'll look to Chapter 3: Nature Made to Order. Be well everyone, and remember: social distancing continues to save lives, which is presumably why we are still not in JUB 202 presently. I hope you and yours are all in good health as we make our way through these difficult times. It will not be easy, but we will make it through—with courage, dignity, and grace. And while we're at it, let us then ask of these concepts, courage, dignity, grace: have we invented or discovered them?