an informal and relaxed way to gain insight into Peirce's semiotic and its profound and far-reaching implications for the philosophy of mind.

Notes

[1]Editor's Note: See Lammens, Johan M. (1994), Review of Lakoff 1980, *Minds and Machines* 4, pp. 115–122.

[2]Editor's Note: For an analysis of Peirce's notion of triadicity, see Hayes, Patrick (1995), Review of Burch 1991, *Minds and Machines* 5, pp. 454–465.

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William H. Calvin, *How Brains Think: Evolving Intelligence, Then and Now*, Science Masters Series, New York: Basic Books, 1996, vii + 184 pp., $20.00 (cloth), ISBN 0-465-07277-1.

According to the publisher's dust-jacket blurb, the Science Masters Series aims to "enable a broad audience to attain scientific literacy . . . in a range of disciplines." But, despite the fact that the current and projected Science Masters authors are established luminaries in their fields, the item under review falls short of meeting the series' announced objective.

What is Calvin's book about? Although the title presumably points the way, only Chapter 6 ("Evolution on-the-Fly") and Chapter 7 ("Shaping Up an Intelligent

Act from Humble Origins") (of eight chapters altogether) show a clear focus, and both of them concentrate on evolution "now" rather than "then"; i.e., on (1) how current intelligence might be supported by an ongoing, Darwinian sort of evolution in each individual brain, rather than (2) how intelligent brains evolved. The remaining chapters read like an impressionistic pastiche: arrays of short sections, often interesting in and of themselves, but too often lacking any clear connection with the surrounding material. Readers should come prepared to create their own hyperlinks.

The book begins by canvassing, and in some cases rejecting, various accounts of intelligence. Calvin's own account emphasizes problem-solving in novel situations – "evolving a good guess", or "evolution on the fly" as he calls it. But his attitude toward studying the relationship between intelligence and *consciousness* is strangely ambivalent. On the one hand,

> Your intelligent mental life is a fluctuating view of your inner and outer worlds. It's partly under your control, partly hidden from your introspection, even capricious . . . . This book tries to fathom how this inner life evolves from one second to the next . . . . (p. 2.)

From this, it would appear that the explanation of "how brains think" will provide some illumination about how brains give rise to subjective conscious experience. However, Chapter 3 ("Evolving a Good Guess") which begins and ends with epigrams about consciousness, announces a different objective:

> One reason that I'm going to hereafter [i.e., after Chapter 3] avoid a discussion of consciousness in favor of intelligence underpinnings is that considerations of consciousness quickly lead to a passive observer as the end point, rather than someone who explores, who adventures within the world. (p. 29.)

All well and good, perhaps, despite the fact that the "avoidance" doesn't really get under way until the book is nearly one-third completed. But Calvin apparently can't quite give up on the topic, for he optimistically suggests near the end of the book that we have been given an account by which

> the reader might be able to imagine a process *that could result in consciousness* and could operate fast enough to constitute a quick intelligence, good at guessing. (p. 147; emphasis added.)

Despite this confusion, the overall project is clear enough. Like many other researchers in cognitive science, Calvin seeks to provide an explanatory account of mind that is situated between the "lower" levels of brain function and the "higher" level of intelligence (conscious experience?). The aim of this middle ground is to afford a perspective that can be coherently connected downward to the brain's hardware and upward to a variety of cognitive functions. From such a middle ground, Calvin thinks, it may be possible to avoid the "Janitor's Dream" of (mistakenly) trying to comprehend simultaneously every level involved in cognition, from brain molecules up to consciousness, and declaring in the face of failure to do so that the mind is ultimately unfathomable. This type of "middle ground" analysis has been

particularly favored by researchers who invoke the "mind:brain:software:hardware" analogy, and, while Calvin does not push that analogy very hard, his own account is perfectly congenial to it.

Calvin's middle level consists of spatiotemporal patterns of neural activity in the brain, alternatively described as "cerebral codes". These codes or representative connection-patterns are presumably set up through causal transactions with the environment, although this leaves unanswered questions about the reference of abstract concepts and representations of fictional characters. Memory is explained as "simply reconstituting such a pattern of activity" (p. 108). The Darwinian element in intelligent brain activity

> appears to be a whole suite of features: distinctive patterns, copying them, establishing variants via errors (with most of the variants coming from the most successful), competition, and the biasing of copying competitions by a multifaceted environment. (p. 106.)

The theme of pattern-copying is essential to this account. Various patterns clone themselves and compete with one another for a given "work space":

> As you try to decide whether to pick an apple or a banana from the fruit bowl (so my theory goes), the cerebral code for apple may be having a cloning competition with the one for banana. When one code has enough active copies to trip the action circuits, you might reach for the apple. . . . But the banana codes need not vanish; they could linger in the background as subconscious thoughts. . . . Our conscious thought may only be the currently dominant pattern in the copying competition . . . . (p. 111.)

Unfortunately, metaphors like this dominate the book, and it is difficult to see how such writing will enable anyone to reach the goal of scientific literacy. Readers who seek a deeper grasp of how brains think may wish to resort to Chapter 7, which, according to the author, is dispensable "in the sense that many people could skip [it] . . . without realizing that something was missing" (p. 113). Nevertheless, Chapter 7 is the only place in the book that offers some neurophysiological detail concerning Calvin's major theme of pattern-propagation.

Calvin emphasizes that the question of how brains think calls for an investigation of both proximate and ultimate causes. Whereas neural Darwinism (mentioned above) supplies the former, long-term Darwinian evolution supplies the latter. A key development, of course, was the development of a brain "wired" for syntactic structures, although Calvin makes the interesting suggestion that syntax might reflect a more basic sequencing ability, a "core facility of the brain, useful for language, story-telling, planning ahead, games, and ethics" (p. 95). Moreover, the same brain structures might be tied to various manual tasks, which, Calvin observes, was a possibility noted by Darwin himself in his observation that people using scissors often tend to move their jaws in concert with their cutting motions. But, in describing evolutionary development, Calvin loses his focus to reports of personal travel and lengthy accounts of glacial processes. Even he seems to realize that the digression calls for an explanation.

> I tell you all this to point out that there is an enormous asymmetry between the buildup of ice and its subsequent meltdown; this is not at all like the exchange of energy involved in freezing and melting a tray of ice cubes. (p. 54.)

Lest the reader remain bewildered, he adds a paragraph later:

> That's what this chapter is really about: how the evolutionary crank is turned to yield our kind of versatility – wide repertoires and good guessing get a special kind of boost from a series of climatic instabilities. (p. 54.)

Very well, but Calvin cannot resist devoting approximately four of the chapter's remaining six pages to further details of glaciation, its connection to planetary orbits, and concerns about a future melt-off of Greenland's ice cores. As indicated earlier, much of this is interesting in its own right, but it proves highly distracting to anyone seeking an answer to the question of "how the evolutionary crank is turned to yield our kind of versatility." And it turns out that climatic change is only part of the story anyway.

The book's final chapter ("Prospects for a Superhuman Intelligence") offers speculations on the development of superhuman intelligence. Based on principles from the neurosciences, Calvin thinks, it will be possible eventually to construct a "first-order workalike" computer that could "reason, categorize, and understand speech"; such a machine, he believes, would be conscious "and likely as self-centered as we are" (p. 156). Later generations will display "intelligent consciousness", and eventually we will be confronted with "superhuman intelligence". Calvin shows little patience for "those tiresome debates in which one philosopher tries to hog-tie another philosopher ... over the issue of whether a machine can ever truly understand anything, whether they will ever be able to have our kind of consciousness" (p. 149). Instead, he focuses on three special challenges in developing future-generation computers:

1. Fitting them into our human environment: more sophisticated, intelligent computers threaten more job displacement, but they also introduce the possible benefit of patient, robotic teachers.
2. Instilling them with appropriate values: this may take some time and will likely "require a lot of star-pupil cloning, a process not unlike the domestication of the dog" (p. 159).
3. Coping with human anxieties: Calvin suggests that "machines could be required to speak in a characteristic voice", that new models could be subjected to evaluation procedures akin to the FDA's testing of new medical devices, and that superhuman computers "might require stringent licensing to use the Internet or telephone networks", or that their output might be subject to a "one-day-delay rule" for distribution (pp. 160–161).

In the face of these rather Pollyannaish ideas, Calvin does ask the question: Why should the goal of building superhuman intelligence be pursued? His three brief answers: (1) Because it's there. (2) Because if we don't do it, somebody else will. (3) Because environmental threats to our civilization can better be addressed with the aid of advanced computer modeling.

These visions of the future – and our responsibility toward it – have a pretty familiar ring, and for the most part they also sound pretty naive. Fortunately, there is a growing abundance of sophisticated literature on computers and society, and anyone wishing to address that topic in some depth will profit from consulting it. Good entry points are Johnson and Nissenbaum 1995[1] and Kling 1996.[2]

As for how brains think, a better starting place than this book is William Calvin's Web page (http://weber.u.washington.edu/~wcalvin). It's well done, and it's free.

Notes

[1]Editor's Note: See Kling, Rob (forthcoming), Review of Johnson and Nissenbaum 1995, *Minds and Machines*.

[2]Editor's Note: See Nissenbaum, Helen (1997), Review of Kling 1996, *Minds and Machines* 7, pp. 152–155.

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Jules Davidoff, *Cognition through Color*, Issues in the Biology of Language and Cognition Series, Cambridge, MA: MIT Press, 1991, xiv + 217 pp., $32.50 (cloth), ISBN 0-262-04115-4

and

Jonathan Westphal, *Colour: A Philosophical Introduction, 2nd edition*, Aristotelian Society Series, Vol. 7, Cambridge, MA: Basil Blackwell, 1991, viii + 166 pp., $21.95 (paper), ISBN 0-631-17934-8.

Jonathan Westphal, a philosopher and the author of *Colour: A Philosophical Introduction*, and Jules Davidoff, a neuropsychologist and the author of *Cognition through Color*, chase the demons of their own – and of each other's – disciplines. Davidoff's stated topic is the sometimes supposed "modularity" of the color-vision system. The concept of modularity is most closely associated with the work of the philosopher Jerry Fodor (1983). To ask if there is a color module is, in Fodor's