ogy"), contra Fodor and Piattelli-Palmarini, requires an explanation of its origin.

The diversity of organism-environment relationships reflects the principle that the fitness of phenotypes is highly context-dependent. Thus, the authors argue, there cannot be a universal theory of natural selection, for no general relationship of phenotype to fitness can be specified. But the same might be said of many other research programs. For example, the effect of an enzyme is highly context-dependent, so Fodor and Piattelli-Palmarini presumably would not expect any successful theory in biochemistry. In any case, evolutionary biologists have developed many causal theories, or models, of natural selection on particular classes of traits. We have highly developed theories of the evolution of life history traits, sex ratio, certain principles of form and function, and much more.

These theories of natural selection work: they successfully predict research outcomes. John Werren predicted and experimentally confirmed that the first of two female parasitic wasps who lay eggs in a host insect lays a more female-biased brood than the second (*2*). No such prediction could be made without selection theory. Among countless other examples, the pattern of variation in DNA sequences that betokens a "selective sweep" of an advantageous mutation was predicted years before such data could be obtained. Natural selection theory makes successful predictions across a huge range of biological phenomena, and it inspires countless fruitful research programs. What more can one ask of a theory? Contrast that with the ludicrous analogy with which Fodor and Piattelli-Palmarini end: "organisms 'catch' their phenotypes from their ecologies in something like the way that they catch their colds from their ecologies." They helpfully explain that the similarity consists of there being both environmental and endogenous instrumental variables. I look forward to reading about the research that this formulation will inspire.

Mayr once wrote that "Evolution seems to be a subject on which everybody thinks he is qualified to express an expert opinion" (*3*). Fodor and Piattelli-Palmarini show little familiarity with the vast literature on genetic variation, experimental analyses of natural selection, or other topics on which they philosophically expound. They are blithely agnostic about the causes of evolution and apparently uninterested in fostering any program of research. Because they are prominent in their own fields, some readers may suppose that they are authorities on evolution who have written a profound and important book. They aren't, and it isn't.

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NEUROSCIENCE

Meaning-Making Neurons

Michael Shermer

The Brain and the Meaning of Life

by Paul Thagard

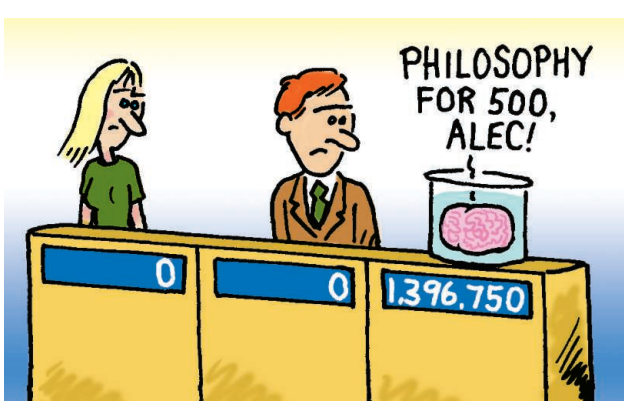
Princeton University Press, Princeton, NJ, 2010. 292 pp. $29.95. ISBN 9780691142722.

Twice I have spoken at the TED (Technology, Entertainment, Design) conference. Twice I have begrudgingly agreed to the strictly enforced 18-minute talk format—grumbling that "ideas worth spreading" (the TED motto) could not possibly be conveyed in such a constrained format. And twice have I been proven wrong. With discipline and diligence you really can say something of substance in a tight space, and more than 200 million downloads of endlessly entertaining and educational videos (*1*) prove the principle of pithiness.

In *The Brain and the Meaning of Life*, philosopher, psychologist, and computer scientist Paul Thagard (University of Waterloo) has elegantly employed the pithiness principle. He offers a tightly reasoned, often humorous, and original contribution to the emerging practice of applying science to areas heretofore the province of philosophers, theologians, ethicists, and politicians: What is reality and how can we know it? Are mind and brain one or two? What is the source of the sense of self? What is love? What is the difference between right and wrong, and how can we know it? What is the most legitimate form of government? What is the meaning of life, and how can we find happiness in it? Thagard employs the latest tools and findings of science in his attempts to answer these (and additional) questions. He briefly reviews how others have addressed them in the past. And he discusses how a scientific worldview can inform one's analysis and in some cases fully answer the questions—at least to the satisfaction of those of us who take a strictly materialist and naturalist perspective.

Yes, there is a point of view here, and well there should be. When Henry Fawcett commented to Charles Darwin that some scientists found Darwin too theoretical and believed that he should just let the facts speak for themselves, Darwin responded: "How odd it is that anyone should not see that all observation must be for or against some view if it is to be of any service" (*2*). Thagard's perspective is that of cognitive neuroscience. He wants to bore into the brain to add a layer of more objective analysis.

Take love, as Thagard does in a concise six pages. He notes that when you gaze upon the face of your lover, the ventral tegmental area and the nucleus accumbens—both rich in dopamine receptors and associated with extremely positive feelings similar to those in cocaine addiction—become quite active. He remarks how the hormone oxytocin increases feelings of attachment between people. These findings and numerous others that he mentions support his model of emotional consciousness, "emocon" (*3*). That conceptual model sketches how different areas of the brain "interact to produce emotions as the result of both cognitive appraisal and bodily perception." In it, external stimuli (such as the sight of



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your loved one) are input through the senses (sight, smells, touch) to the thalamus, which in turn stimulates both brain states and bodily states (increased heart rate and blood pressure, rapid breathing and flushed skin, and so forth). A network of mutual interactions among the amygdala, the insula, and various parts of the prefrontal cortex integrates bodily perceptions and cognitive appraisal. Thus, the base emotions from the amygdala (lusty passion) are linked to the higher cognitive functions of the cerebral cortex (assessment of the relationship).

How does all this get coordinated into a single feeling that we call love? Our dualistic intuitions tell us that there must be a mind that knows what the brain is doing, or some brain module that coordinates all processes into a single self, or some sort of central processing homunculus that sits at a neural switchboard. Not so, says Thagard: "There is no central processor that coordinates all the results and yields a decision. Rather, the brain's reaction to a scary face or other sensory stimulus comes about through the dynamic interaction of external sensory perception, internal sensory perception, cognitive appraisal, and positive and negative valuation." But from where does the sense of a single entity arise? Reciprocal feedback systems: "Note that the connections between brain areas in the … model are reciprocal, based on neural evidence that there is extensive feedback between neural populations in each pair of regions."

Whether or not reciprocal feedback systems can properly account for such subjective qualia states as love (or for the "self") is highly debatable. Still, Thagard is to be commended for proposing a testable hypothesis and providing evidence in support of it that can be easily accessed by both scientists and general readers. On the subjective feeling of happiness, for example, he cites data gathered by social psychologist Sonja Lyubomirsky on what makes people happy (*4*). Many things do, among them: expressing gratitude, cultivating optimism, avoiding overthinking and social comparison, practicing acts of kindness, nurturing social relationships, developing strategies for coping, learning to forgive, increasing flow experiences (in which one is absorbed in an activity), savoring life's joys, committing to your goals, practicing religion and spirituality, and taking care of your body through physical activity. Thagard is mildly dismissive of religion and spirituality, but he need not be—just broaden the category to include any activity that generates a sense of awe and transcendence. (For me, that comes from visiting astronomical observatories, fossil quarries, or geological formations, all of which lead to the contemplation of deep time and the humbling sense of insignificance before the vastness of the cosmos.)

Toward the end of *The Brain and the Meaning of Life*, Thagard dares to employ an objective standard to answer the question "What kind of government should countries have?" Because he gives the topic less than three full pages, political scientists will certainly feel that their field has been shortchanged. And while I agree with his conclusion that the current form of government most likely to satisfy human needs is "a liberal democracy operating in a capitalist economic system," I take issue with his subsequent qualification, "with substantial state support for education, health care, and other egalitarian social requirements." Nonetheless, I applaud Thagard's approach of bringing to bear on the question two data sets: the United Nations Human Development Index (*5*) (which rates 177 countries on how well they provide their citizens with "a long and healthy life, education, and a decent standard of living") and yearly surveys, since 1981, of subjective well-being (happiness) (*6*). Iceland, Canada, Ireland, the Netherlands, and Switzerland appeared near the top in both lists. It is true that two data sets do not a political science make, but Thagard's concluding remarks in this section are a model of scientific caution and skepticism: "We should also not rule out the possibility that some form of government not currently practiced might actually be better for meeting vital human needs than those now in operation. Perhaps future social experiments will find creative new ways of governing states that will be more effective than those now observed." Although we cannot implement such experiments in the name of science, if they do happen, scientists should be the first in to record the results.

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BROWSINGS

Caral: La Primera Civilización de América/The First Civilization in the Americas.
Ruth Shady; photographs by Christopher Kleihege. CK Photo (distributed by the University of Chicago Press), Chicago, 2010. 168 pp. $125, £81. ISBN 9789972337925.
Nearly 5000 years ago, a complex society developed in the desert valleys of the central Peruvian coast. At Caral, comprehensive excavations directed by Shady have uncovered a 65-ha complex of pyramids, smaller platforms, sunken semicircular plazas, public buildings, and residences. This large-format volume presents nearly 200 color photos by Kleihege that depict the site, structures, surrounding landscapes, clay statuettes, and crafted objects (below, stone monolith in front of Pyramid Galería).

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