Tracking the Travels. A review of Ogas & Gaddam *Journey of the Mind: How Thinking Emerged from Chaos*, Norton.

Review by
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In *Journey of the Mind: How Thinking Emerged from Chaos*, Ogi Ogas and Sai Gaddam take the reader on a ride through the timeline of life on planet Earth. This kind of voyage has been presented before. Daniel Dennett gave his, Darwinian inspired volume *From Bacteria to Bach and Back* in 2017 and, more recently, Joseph LeDoux published *The Deep History of Ourselves*, a version that focused on the neurocognitive elements (LeDoux, 2019). Ogas and Gaddam's account differs from these others in emphasis and style, though like Dennett and LeDoux, they begin at the beginning with the appearance of the first living unicellular species archaea and bacteria, the prokaryotes.

I have several problems with the book, and they start with the sub-title. The approach to abiogenesis, or the origins of life, views the process as a measured, gradual transition in which organic molecules assembled into entities with cell membranes and capable of self-reproduction – not "chaotic" but orderly. Thus, the first living cells were remarkably finely tuned organisms with complex biomolecular functions. Even more problematical, from my perspective, is that "thinking" didn't "emerge" at some time in evolution. My Cellular Basis of Consciousness (CBC) model, developed in *The First Minds* (Reber, 2019), is grounded on the assumption that cognitive functions were there from the very beginnings, that life and sentience ("thinking" if you wish) are coterminous. Cognitive functions are inherent features of all life forms. Every organism is sentient, no matter how basic its biomolecular functions are. Every living cell experiences valenced perceptions, displays a variety of cognitive processes, learns, forms stable memories, and communicates with others. One that did not would have been a Darwinian dead end. It could not have survived in the (real) chaos that was its primal environment. This model has been developed and expanded. See Baluška, et al., (2021), Reber & Baluška (2020; in press) for extensions and elaborations of the CBC theory including identifying several biomechanisms that we consider to be candidates responsible for this *ur*-sentience. Current thinking is that the key biomolecular effect is the excitability of the cell membrane and the finding that all cells are sensitive to anesthetics.

Ogas and Gaddam seem, at first, to accept this framework as they do discuss many of these features of prokaryote life and as early as Page 3 they tell us that the housefly "marks ... nature's boundary between minds that are unquestionably non-conscious and those indisputably conscious." But, then in later chapters they dismiss both the prokaryotes and insects as not being truly reflective of consciousness, sentience − because a nervous system is required and consciousness had to await the evolution of vertebrates. The result is that the initial discussions of the great journey are muddled. In the first several chapters, beginning with their overview of archaea and bacteria, they refer to these prokaryotes as being the first "minds." In fact, they use the term "supermind" when referring to colonies of unicellular species. But later, after a description of prokaryotic learning, memorial functions, perception, guided locomotion, and communication, they state that "This is surely not consciousness, mind you" (p. 54). Well, it's not

human consciousness but I see no reason why Ogas and Gaddam don't consider these manifestly sentient behaviors as examples of consciousness. I see no reason why existential consciousness starts with vertebrates and not with prokaryotes − which they earlier seemed quite comfortable endowing with "minds." After a time I began to think that the real problem here just might be lexicographical. In their framework it is possible to have species with minds but without consciousness. From the point of view of the CBC, the first unicellular species were sentient, had minds, experiences, valenced perceptions, felt pain, learned, formed stable memories, and communicated both within and between colonies.

Ogas and Gaddam also mischaracterize aspects of the world of the unicellular. For example, they claim that the first cellular colonies were formed by amoebas (protists) and that communication began with slime molds. But bacteria form colonies and communicate both within and between the collectives − even when they are of different species (see discussions in Reber, 2019; Baluška & Reber, 2020). They maintain that "multitasking" didn't appear until multicellular eukaryote species such as *Hydra vulgaris* arguing that a species needs distinct parts to multitask. Again, unicellular bacteria multitask routinely. Prokaryotes defend against viruses (using CRISPR) while absorbing nutrients, locomoting, and communicating with others.

I worried that, being a cognitive psychologist who came to this area of scholarship late in my career, perhaps I had misunderstood Ogas and Gaddam's presentation. I contacted a respected cell biologist who'd read the book for an expert's analysis. The response fit with my understanding: their cell biology knowledge and expertise is wanting.

Ogas and Gaddam have also assumed a burden, dubbed the "emergentist's dilemma" − though they appear not to realize it. If the species that have true consciousness evolved from ones that were "dumb" biomechanical beings, then the biomechanism(s) that caused the transition to self-awareness, reflection, a true mind need to be identified. They state that when the neural functions reach a certain (but unspecified) level of complexity and interaction, consciousness is "ignited" − which isn't terribly helpful. They are, of course, not alone here. Many others who have charted the same evolutionary course have the same problem. And none of them seem to appreciate it either. See Damasio (2022), Dennett (2017), Ginsberg & Jablonka (2019), and LeDoux (2019) among others who assume that genuine consciousness requires a nervous system and that the experiences of species without them are somehow limited to preconscious conditions. None, however, tackle the issue of identifying the biomolecular processes involved in making the transition to sentience.

On the other hand, taking the CBC model and recognizing that sentience and life are coterminous changes the nature of the issue. There is still the need to discover the biomolecular causes here but the problem is a far more tractable one than trying to unpack what happened with the evolution of vertebrates.

I appreciate that, in the field of consciousness studies, the CBC model is the outlier while Ogas and Gaddam's stance reflects the standard paradigm. A number of recent books and articles (e.g., Damasio, 2022; Dennett, 2017, Feinberg & Mallatt, 2013; Ginsburg & Jablonka, 2019; Godfrey-Smith, 2016) also cover the behaviors of prokaryotes and conclude that, because they lack nervous systems, they are simply displaying what Dennett called "competence without

comprehension." Not surprisingly, there is little agreement among these authors as to when in evolution a genuine consciousness emerged. Some, like Ogas and Gaddam argue for vertebrates. Both Ginsburg and Jablonka and Feinberg and Mallatt put it at the beginnings of the Cambrian explosion -- although for different reasons. Godfrey-Smith maintains the first conscious species were the cephalopods. Others, such as Baron and Klein (2016), have argued for insects. Elsewhere (Reber, 2019; Reber, & Baluška, 2020), it was noted that there is an interesting pattern here. Each researcher identifies the appearance of sentience with the species they studied. The reason is, of course, because it was there all along.

From this point in the journey, Ogas and Gaddam's focus shifts and the framework becomes a "modular" approach where behaviors are characterized as due to the functions of modules that handle the Where, Why, When, and How of different circumstances. The presumed existence of these modules is based on the research and theories of neuroscientist Stephen Grossberg. Grossberg is generally regarded as one of the founders of the computational neurosciences and, along with Gail Carpenter, developer of Adaptive Resonance Theory (ART). ART is a feed-forward system that strives to simulate various functions from those of individual cells to coordinated, parallel and interactive cerebral modules. The model is based on neural nets and, using a variety of ART "Types" (depending on the task at hand), has been successful in simulating a number of perceptual and cognitive functions. The theory is provocative and influential (in sub-areas of the field) but hardly Newtonian in scope and impact (and, yes, Ogas and Gaddam liken him to Sir Isaac). I suspect Grossberg is pleased to know that his theory of mind is "the solution to one of the most boggling mysteries in science: how consciousness works and why consciousness exists at all" (p. 131) − but he would, I also suspect, demur on the grandiosity of such a claim.

Ogas and Gaddam use Grossberg's modules to describe how various species behave. For example, the chapter on the Tortoise Mind has a red-toed tortoise looking to eat a snail. Its What module handles the real-time input, matches visual patterns with memories of previously encountered snails, experiences "resonance" and engages the Where, When, and Why modules, etc. Unfortunately, there are no data and no empirical support for such a story. It's just a theoretical description based on the presumption that the tortoise mind can be thought of as a cluster of Grossbergian modules. Similar analyses are presented of the behaviors and minds of various species up to and including *Homo sapiens*.

I'm trying my best to be fair but I do not see how a modular framing of the story of the evolution of mind is an improvement on more conventional analyses. It doesn't advance the field simply because it doesn't bring any additional explanatory power. One could easily provide a very different story by, say, building the description around motivation, genetics, sociality, competition, ecology, mating. It wouldn't result in a simulation by a neural net but, to put it crudely, so what? Grossberg's quantitative approach to consciousness and cerebral functioning, based as it is on neural nets, lacks several features that are essential in understanding consciousness − of any species. There are no genetic mechanisms − a significant contributor to any species' functions. Neural nets lack social elements − we, and many other species including bacteria, are compellingly social. There are no embodied components − minds exist, not in vats but in bodies. Even more problematical, the modules have no developmental processes − they change over time with experience and feedback but those changes aren't based on any biological

growth and aging processes. In short, by tethering their approach to Grossberg, Ogas and Gaddam end up with a book that, while engaging at times, and informative at times, simply doesn't bring any new insights to the table.

A common rhetorical device is the reference to "superminds" and the term is used for any species that forms collectives, literally − as in species such as slime molds that aggregate into colonies, birds that form social groups and interact with each other, and humans in social groups; and figuratively − to refer to a presumed collective consciousness that emerges from groups of humans coordinating behaviors. Again, it's not clear what the gain is here but it does give them a platform for some lovely passages outlining the roles of thought and language, and extending the speculation to imagined futures with galaxy-wide consciousness.

Ogas and Gaddam write in an engaging style though they do assign a series of cutesy-pie names to the subjects of the discourse. An archaea is "Archie." "Sally" is the salmonella bacterium, and a roundworm is dubbed the "Duke of Dirt." They also jokingly caution us to never let a slime mold hear us call it that. Amusing I guess, but slime molds are routinely called that in the literature (e.g., Jabr, 2012). "Yuna and Conley" are stand-ins for the Union and the Confederacy − I have no idea what the point of this one was other than the possibility it was presented as an example of a collective supermind having a consciousness than transcended those of the ordinary humans either defending or being repulsed by slavery. I appreciate that Ogas and Gaddam were trying to make complex issues appear simple but it didn't work. It felt like they were trying to review the rich and complex evidence for the several billion-years of evolution for middle-schoolers.

The book jacket has positive blurbs from several highly respected scientists including Karl Friston, Stephen Kosslyn, and Philip Zimbardo − and most intriguingly my friend Annie Duke, at one time one of the best professional poker players in the world, currently a business consultant and, even more interestingly, an "almost" Ph.D. in psychology. Her mentor was the late, wonderful Lila Gleitman, another old friend. Interesting crossing of life's paths. Perhaps they, all of them, saw things in it that I didn't. My overall assessment is more modest: A bold but flawed effort.

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