Mental Evolution: A Review of Daniel Dennett's *From Bacteria to Bach and Back*

July 28, 2017

Abstract

From Bacteria To Bach and Back is an ambitious book that attempts to integrate a theory about the evolution of the human mind with another theory about the evolution of human culture. It is advertised as a defense of memes, but conceptualizes memes more liberally than has been done before. It is also advertised as a defense of the proposal that natural selection operates on culture, but conceptualizes natural selection as a process in which nearly all interesting parameters are free to vary. This liberal conception of key concepts creates space for philosophical innovation, but occasionally makes the empirical content of the theory difficult to pin down. Nevertheless, the book is full of scientific insight, wit, and humor. It will undoubtedly become a cause of both controversy and inspiration for those interested in naturalistic theories of human culture.

1 Introduction

Dennett's new book is a captivating, lively, and expansive account of the evolution of the human mind. It is a grand tour that begins with the origins of organisms, ascends to the heights of human culture, and ends with vistas of a future in which algorithms have begun to replace people as generators of cultural novelty.

Although the book is about the evolution of the human mind, it is not a work of evolutionary psychology. Dennett wastes little ink speculating about the Pleistocene conditions that may have prompted domain-specific cognitive adaptations. The opening lines of the book pose a pair of questions that provide a more accurate indication of its focus: "How come there are minds?" and "How

is it possible for minds to ask and answer this question?" The scope of these questions is unwieldy, and, as usual, Dennett ignores disciplinary boundaries in his attempt to supply an answer. The book weaves together a dumbfounding range of science, but also a significant range of Dennett's own philosophical oeuvre. This gives it the feel of a magnum opus. This book shows us, more transparently than do his previous works, how Dennett's ideas about matter, life, mind, and culture all hang together.

So how do they all hang together? We can start to answer that question by identifying two unifying themes that figure as prominently in Dennett's past books as they do in this one. The first theme is the explanatory power of natural selection. On Dennett's view, natural selection is not only responsible for generating the diversity of life; it is also responsible, by way of memes, for generating the diversity of human culture. The second theme is an injunction against the kind of magical thinking that often seduces those who contemplate major evolutionary transitions. How did simple minds emerge from replicating molecules? Cooperative minds from non-cooperative ones? Language-wielding minds from non-linguistic ones? The more miraculous these transitions appear to be, the more they invite magical thinking. Dennett's project is to break them down into theoretically manageable steps. The hopeful thought behind the book seems to be that if we can demonstrate how life, mind, and culture evolved gradually from less complex precursors, we can lay the groundwork for a compelling naturalistic worldview.

Gaps and tensions are inevitable in a book with such ambitious scope. But these are costs worth paying. The ambitious scope of this book provides a unique vantage point from which we can assess the coherence of a package of ideas that is, like the curvature of the earth, too vast to be visible under normal conditions.

2 Competence Without Comprehension

After an introduction and a brief chapter arguing for relatively mild claims about the importance of adaptationist reasoning in biology, the narrative grows bolder. The third chapter, entitled, "The Evolution of Reasons" begins by arguing that natural selection itself evolved from a precursor phenomenon called *differential persistence*. Some kinds of physical structure stick around longer than others. This fact - which Dennett calls differential persistence - can lead

to interesting patterns in nature even in the absence of selection and design processes. For example, the phenomenon of patterned ground, a process in which regular geometric patterns of stones appear on a dirt surface without any human or animal intervention, can be explained in terms of freeze-thaw cycles. Ice forms between the dirt and the stones, and when it melts, it releases some materials at a faster rate than others. If the ground is not perfectly level, this differential release rate acts as a sorting mechanism that is capable of generating interesting geometrical patterns.

The discussion of patterned ground serves two purposes that stand in mild tension with one another. The first purpose is to show that the process of natural selection has precursors; it did not appear out of thin air. The second purpose is to show that, despite the existence of those precursors, natural selection itself introduced a radical change in the manner in which complex systems come to be. On the one hand, Dennett wants to emphasize the continuity between genuine natural selection and other quasi-selective processes. On the other hand, he maintains that genuine natural selection ushers in a unique and novel kind of explanatory power. In Part I, this tension between novelty and continuity remains mild. I mention it because a similar tension can be discerned in the structure of the larger project, specifically with respect to Dennett's embrace of the "meme" label for his theory of cultural evolution. I'll return to this criticism in the conclusion.

So what is the radical change that natural selection is supposed to have brought into being? Once replicating molecules emerge and natural selection gets underway, *reasons* come into existence. For the first time, there is a distinction in nature between good and bad design. Natural selection magnifies and refines that distinction. Thereafter, it becomes possible to say that a property was selected for a reason, or an end. One might wonder whether Dennett is simply equivocating on the term *reason*. Surely our reasons - the rational principles underlying intelligence - are quite unlike the principles underlying those features of the biological world that emerged without the benefit of rational foresight.

Dennett avoids the charge of equivocation by emphasizing the distinction between the existence of a reason and its representation in the mind of an organism. He illustrates the point with a comparison between an elaborate termite castle and Gaudi's *La Sagrada Familia*, which have a superficially but surprisingly similar outer form. There are reasons behind the elaborate shapes in each case, and in each case, those reasons drive the behavior of the relevant

artificer. The difference between the two cases is that, in addition to his capacity to be moved by reasons, Gaudi had the power to represent, reflect upon, and refine his reasons.

Dennett's way of talking about reasons is more of a recommendation than it is the conclusion of an argument. There is, however, a closely related claim which serves as the primary thesis in Part I, and which Dennett defends explicitly. It is the claim that *cognitive competence does not require comprehension.* According to Dennett, this claim stands at the core of an intellectual revolution that was instigated by Darwin, reinforced by Turing, and is still taking place today. Where Darwin showed that there can be biological design without a designer, Turing showed that there can be computation without a (human) computer. Both insights are expressions of the more general claim that there can be - and very often is - competence without comprehension.

What do these terms mean? By "comprehension," Dennett means something like human understanding - the ability to appreciate the principles that explain why a thing is the way it is. "Competence" simply refers to an organism's ability to achieve a goal - to find food, impress a mate, or solve an equation.

It is tempting to impute comprehension to non-human animals engaging in goal-directed behavior. But experimental manipulation reveals that often, there isn't much comprehension there at all. Niko Tinbergen's work on supernormal stimuli is a good example. Chicks seem quite clever when they pester their mothers for food, but Tinbergen showed that this behavior is a disappointingly inflexible instinct, governed by perceptual encounters with anything roughly the size and shape of its mother's beak (Tinbergen, 1953).

This, of course, is not news. But when we move toward impressing a mate or solving an equation, the claim that comprehension is not required becomes controversial. When an expert mathematician solves an equation, we are impressed with her understanding of mathematical principles. But when Wolfram Alpha does it, we are not tempted to infer understanding. Dennett's claim is controversial because he wants to suggest that lots of our rational competencies are just like the competency of Wolfram Alfa. They emerge, without antecedent understanding, from a range of relatively mundane competencies.

Thus far, the book might be described as an attempt to extend Morgan's Cannon to anthropology. It is as if Dennett wants to declare, "in no case is human activity to be interpreted in terms of higher psychological processes, if it can be fairly interpreted in terms of processes which stand lower in the scale of

psychological evolution and development."[1] This is only partially right. One of the tasks of the book is to do justice to those aspects of culture that are shaped by rational insight, while simultaneously demonstrating that much of our culture was shaped by a blind and gradual evolutionary process. The obvious question raised by this juxtaposition is this: how do you get from mere behavioral competencies, like that of Tinbergen's chicks, to intellectual comprehension, like that of a skilled mathematician, by way of a gradual process?

3 On the Gradual Accumulation of Culture

The key to Dennett's gradualism is his defense of cultural evolution in general, and memetic theory in particular. Memes are units of cultural replication. Purportedly, they constitute the structure that underlies cultural inheritance, just as genes constitute the structure that underlies biological inheritance. Genes, however, are easier to conceptualize than memes. Whereas genes are virtually always obliged to take the form of a sequence of nucleotides within a DNA molecule, memes face no such chemical constraints. According to Dennett, memes are not even composed of physical parts. Memes are composed of *information*.

To hard-nosed materialists, this claim is doubly bad: it invites confusion by importing the dubious notion of information into the study of evolution, and, at the same time, it spoils the analogy between culture and genetics. Dennett dedicates a chapter to showing that the notion of information is not as dubious as it may seem, and that, moreover, the analogy between genetics and culture is in fact *strengthened* by the appeal to information, since, on his view, genes turn out to be informational entities too.

What kind of information are we talking about? One might think that only a quantitative conception of information will help to preserve the meme-gene analogy. After all, genetics is a heavily quantitative discipline. On this point, however, Dennett sides with philosophical tradition and insists that there is a semantic conception of information that is distinct from the quantitative ideas discussed in information theory.[2] But Dennett's analysis of semantic information is not the usual one.

[1] This is a doctored version of one of the classical formulations of Morgan's Cannon. The original uses the phrase "animal activity" rather than "human activity."(Morgan, 1903).

[2] See, for example, Piccinini and Scarantino (2011), Floridi (2017), and Godfrey-Smith (2000).

Social scientists often use the term "information" as a general term for propositional knowledge. In economics, for example, an agent has perfect information about a good if she knows some relatively abstract facts about its price, quality, and production method. According to Dennett's analysis, semantic information is more about know-how than it is about abstract facts. Information is whatever helps an organism learn how to behave adaptively. To put it in Dennett's own exceedingly compact phrasing, information is *design worth getting* (p. 115).

Although the term "design" is quite vague, it highlights an idea that Dennett thinks is crucial to understanding how culture spreads: codeless transmission. Humans exchange information opportunistically. Unlike computers, we can exchange know-how without worrying first about whether the information is encoded in a format that its intended recipients will be able to interpret. To borrow one of Dennett's own examples, when Marco Polo (allegedly) brought the design for noodles back from China, he did not need to express the recipe in terms of a coding scheme that was already familiar to the Italians. He may have simply brought back a jar of noodles, and put them in hot water. Clever Italian chefs might have then reverse engineered the recipe, and their efforts would have been copied and then recopied by other chefs, all without the use of any conventionally defined symbols.

Students of information theory will notice a problem here. If cultural evolution relies on copies of copies, and if the copying process is not regimented by a coding system, won't information be lost over time?[3] The puzzle is solved by acknowledging that human language does have some code-like structure, but that this code-like structure is relevant to only one of two roles that language plays in cultural evolution. Dennett illustrates the code-like role of language with a discussion of phonemes, which, on his view, serve to digitize the auditory representations of speech. Dennett captures the point nicely in the following passage:

> Without a digitization scheme, audible sounds are hard to remember, hard to reproduce, likely to drift imperceptibly away from their ancestors, leading to the "error catastrophe" phenomenon, in

[3]The need to preserve transmission fidelity is precisely why information theory played such a crucial role in the rise of communications technology. Part of the reason for the enormous influence of Shannon and Weaver's original book is the fact that it contained a proof of the noisy channel coding theorem, which must have been an encouraging insight for the struggling communications engineer. Why? Because it shows that, for any degree of noise you may encounter, a code exists that will transmit your information without loss (Shannon and Weaver, 1949).

> which natural selection cannot work because mutations accumulate faster than they can be selected for or against, destroying the semantic information they might otherwise carry (p. 200).

This passage describes the rationale behind the *preservation of transmission fidelity*, which is the first role that language plays in cultural evolution. The second role is exemplified by the phenomenon of pragmatic implication. If you are meeting a friend for dinner, and send her a text saying that the subway is delayed, she will know that you are going to be late, despite the fact that this information is not literally encoded in the words you sent. So language helps us transmit information in ways that transcend its encoding role. In addition to functioning as an encoder of messages, it is also an enabler of inference; a provider of clues.

When applied to the realm of cultural transmission, Dennett's dual role analysis of semantic information is compelling. When applied to the realm of biological information transmission, it feels somewhat forced. On Dennett's view, biological information is *just like* cultural information: most of it is transmitted by means of a copying process that is not regimented by a coding scheme. Consequently, it too is threatened by the spectre of "error catastrophe." Catastrophe in the biological case is avoided in much the same way it was avoided in the cultural case: Dennett acknowledges the existence of a code-like structure, and then articulates two roles played by that structure, only one of which is directly related to its code-like character. The first role, which is to preserve transmission fidelity as information flows across biological generations, is achieved by the replicable, code-like character of DNA. In this role, DNA really does encode information, but its content is highly constrained, and concerns only proximate matters such as protein construction.

DNA's second role is to help transmit messages that are not literally encoded. Dennett's central example is the information implicit in bird DNA about how to build a nest. Because there is no clean mapping between genes and nest building behaviors, it is a mistake to say that nest building know-how is literally encoded in the genome. Nevertheless, the transmission of that know-how relies on the structural integrity and digitized character of DNA, much as the information about your late arrival to dinner relies on the structural integrity and digitized character of the English language.

One of the attractive features of this view of semantic information is that it forges a deep connection between the dynamics of cultural change and the

dynamics of biological change: both are fundamentally informational, and both are subject to natural selection. However, forging this connection requires us to stretch our conception of semantic information close to its breaking point, and perhaps a bit beyond it. To preserve the parallel between the dual role of language and the dual role of DNA, we have to say that, although DNA does not literally encode information about nest-building, it *provides clues* about how to accomplish the job. The problem becomes apparent once we ask: who reads the clues?

In order to "infer" nest-building know-how from the bird's nucleotides, those nucleotides must be embedded quite precisely, not only within the transcription and translation machinery of the cell, but also within a massive conglomeration of both developmental and environmental scaffolding. Can that scaffolding perform inference operations? I'm skeptical. There is nothing agent-like about it; no physically unified *thing* in development or in the environment that responds with much sensitivity and specificity to the relevant genes. The purported message about nest building is therefore destined to remain unread.

Like beauty, semantic information is in the eye of the beholder. It isn't there if there are no eyes around to see it. Or, more generally, it isn't there if there is no receiver mechanism around to use it (Stegmann, 2009; Millikan, 1984).[4] So, the idea that DNA enables inference about how to build a nest - although an improvement over the idea that DNA literally encodes that information - might, nevertheless, be an over-application of semantic ideas.

3.1 Why believe in memes?

The central thesis in Part II is that the dynamical processes that generate human culture have changed over time. Early in our history, all cultural change was Darwinian. Memes proliferated much like viruses do. Humans played the role of host rather than steward. Once in a while, a mutant appeared that could outperform other variants for space within human brains and amidst human artifacts. As culture accumulated and diversified, it became part of the fitness landscape in which genetic evolution occurs. Human brains got better at imitation, which increased meme diversity, and also got better at combining memes into larger structures. These structures came to serve as conceptual tools that enriched human minds, allowing humans to represent their own mental states

[4] There is, of course, room for debate about what it takes to play receiver to an informational signal. See, for example, Cao (2012) and Rathkopf (2017). Also, see Shea (2012) for an argument that developmental scaffolding *can* read genetic information.

and become aware of their culture. Eventually, humans gained the power to criticize memes, and finally, they gained the power to engineer new ones.

The first question to ask about this theory of culture is: why believe in memes at all? Dennett emphasizes two answers. The first is that memes can explain cultural adaptations without invoking teleology. Some cultural innovations are clearly adaptive for those who adopt them, despite the fact that no one understands why. Henrich (2015) discusses the example of ash cooking among the Yanduwhandra tribe in eastern Australia during the middle of the 19th century. A large portion of their diet came from a tough sporocarp[5] that was ground into flour and then cooked according to an elaborate recipe. Only a few steps in the recipe are necessary for making the food digestible, and no individual in the tribe knows exactly which they are. It turns out that mixing the flour with ash is a crucial step because it lowers the pH of the flour to a tolerable level. This is an example of competence without comprehension, and it calls out for explanation in the same way that a particularly well-adapted anatomical form calls out for explanation in the biological domain. Moreover, since cooking is not a human instinct, genetic explanations of adaptation are ruled out. Meme theory is particularly well suited to explaining cases like this because it satisfies the conditions required to produce natural selection. Memes constitute a population of "individuals" with some variation, differential rates of reproduction, and heredity (Godfrey-Smith, 2016). When these three conditions are met, selection kicks in and adaptations appear, despite the absence of rational guidance.

The second reason to embrace memes is the insight gained by asking questions about the fitness of memes, rather than than that of human genes or lineages. When we see a universal cultural capacity that promotes human fitness, it is tempting to infer that natural selection on genes must have shaped it. In most cases, however, natural selection is too slow to explain cultural change. Moreover, the focus on meme fitness provides a novel strategy for explaining the spread of pathological cultural variants. Consider, for example, the phenomenon of copycat suicide, sometimes known as the Werther effect (Sisask and Värnik, 2012). After controlling for the influence of common causes, news about one teenage suicide appears to increase the probability of subsequent teenage suicides within a given country for a period of weeks to months. Teenage suicide clearly doesn't spread because it promotes reproductive suc-

[5] A sporocarp is a seed-like structure that is part of the life cycle of fungi and some plants. In this case, it came from a species of fern.

cess; nor does it spread because people suddenly acquire a rational appreciation of its value. Meme theory provides an alternative proto-explanation: the idea spreads because it has been designed to reproduce in its ecological niche, which just happens to be constituted by a collection of human brains. This suggestion is admittedly thin, but it may at least provide a framework within which more detailed work in social psychology can be carried out.

Much of the account of memes so far is familiar, and accordingly, stands open to familiar criticisms. But Dennett does offer a novel strategy for responding to them. Of particular importance are two new ideas: Darwinian spaces (introduced in Chapter 7), and the idea that *words* are the paradigm case of memes (introduced in Chapters 8).

3.2 Darwinian spaces

On Dennett's view, there are lots of intermediate selection-like processes that are neither wholly Darwinian nor wholly intelligent. The middle ground is rich, and Dennett represents it by way of Peter Godfrey-Smith's innovative Darwinian space diagrams (Godfrey-Smith, 2009). These three-dimensional diagrams cleverly represent the many ways that population-level changes can be shaped by the strategies that its members pursue.

Dennett discusses a handful of these diagrams, but one of them stands out because it serves as a visualization of his central thesis about cultural evolution. In that figure (13.2), the first axis represents the degree to which individuals in a population comprehend the changes in their culture. The second axis represents the role of randomness or chance in the discovery of new cultural variants. The third axis represents the degree to which cultural change is directed from the top down. Thus far, the debate about meme theory has focused almost exclusively on small regions close to the maxima and minima of this space. In one corner, near point $< 1, 1, 1 >$, we have paradigmatically rational phenomena, such as a proof in number theory. Typically, the discovery and articulation of a proof requires high comprehension, an efficient search of mathematical space, and meticulous top-down control. At the opposite corner, near point $< 0, 0, 0 >$, we have paradigmatically evolutionary phenomena, such as shifts in word pronunciation. These shifts are often imperceptible to individual speakers; arrived at by chance rather than search; and governed by a distributed, bottom-up process of unreflective imitation.

The novelty of Dennett's introduction of Darwinian spaces into the discussion of memes is that it allows us to make some principled claims about the vast grey area between these extremes, and also, that it suggests a natural way of characterizing some puzzling examples of cultural change that would otherwise tug our intuitions in opposing directions.

Think, for example, of Hubel and Wiesel's discovery of line detectors in V1, which depended on the fact that a crack happened to appear in one of the glass slides they used to project visual stimuli. Or think of a tech start-up that uses machine learning techniques to identify new applications for cancer drugs. A drug designed for pancreatic cancer, it turns out, has the unintended benefit of helping to prevent dementia. Are these cases of rational insight, or blind cultural evolution? In the light of Dennett's Darwinian space diagrams, we can see that there is no need to accept the forced choice implied by this question. Neither case is fully rational, but the two cases deviate from rationality in interestingly different ways. The first involves a high degree of comprehension and top-down design mixed with a large dose of chance. The second involves an exhaustive search of the data, which minimizes the role of chance. Moreover, the search for the new drug application is directed from the top down. Nevertheless, because nothing is yet known about the mechanism by which the drug prevents dementia, there is little comprehension involved.[6]

The second and more important benefit Dennett derives from his use of Darwinian spaces is that it allows him a novel response to one of the most common criticisms of meme theory: the idea that too much of human culture bears the imprint of rational decision-making to plausibly be explained by natural selection on memes. This criticism, which has been advocated by Steven Pinker among others (Pinker, 1997), presumes that rational and evolutionary mechanisms of change are strictly mutually exclusive, so that each new example of a rationally designed cultural variant weakens the case for meme theory. In light of the Darwinian space diagram, Dennett can respond that rational insight is an extension of meme theory rather than a refutation.

To the extent that rationally directed cultural innovation becomes an important force in cultural change, natural selection drops out, but the memes to which that process gave rise stick around, and constitute the raw materials from

[6]Evolutionary processes can explain the origin of a given variant as well as its distribution within the larger population(Godfrey-Smith, 2009). In this pair of examples, I am focusing on the question of origin, but a similar kind of novelty could be applied to distribution explanations.

which rational designs are made. A metaphor may help to illustrate the view. Although the ingredients in a cake recipe cannot be distinguished once the cake has been baked, it can be useful to know what they were. Similarly, although rational reflection may blend and bake memes past the point of recognition, it can be useful to know that the culture's raw ingredients are thoroughly memetic.

Is this an effective reply to Pinker? Are memes a useful theoretical construct even when describing cultural change that involves explicit rational control? The cake metaphor suggests that perhaps there are contexts in which it is useful to be told that a rational phenomenon has memetic origins. Which contexts? Dennett suggests that often, cultural history is "written by the victors, triumphantly explaining the discoveries and passing over the mistakes and misguided searches (p. 309)." Here, then, is at least one context in which the meme concept may be applicable, even when the role of natural selection is minimal. It offers a corrective to "great man" cultural histories in which good ideas manifest themselves inexplicably in the minds of the gifted.

3.3 Words and digitization

Another criticism, which Dennett attributes to Richerson and Boyd (2008), is that cultural transmission does not admit of decomposition into the discrete, faithfully transmitted entities that meme theory requires. Consider the common phenomenon in which a teacher misspells a word, and a student corrects the spelling in her notes (Claidière et al., 2014). Is this faithful transmission of a discrete meme? Richerson and Boyd say that it is not. It is instead what they call *guided transmission*, which must be distinguished from cultural selection because it depends on the application of a rationally applied corrective force (Richerson and Boyd, 2008, p. 69). Dennett, however, can describe this case as one of faithful transmission because, on his view, mere *subjective similarity* is sufficient to render two meme tokens members of a single type (p. 226). The student recognizes that the teacher's written representation of the word is similar to one of the meme-types that have been established in her memory, and that recognition *makes it the case* that the written representation is a token of that type.

This aspect of Dennett's view is unique, and it has some interesting consequences. The first consequence is that memes are more digitized than they may appear, because the correction-inducing norms of language sort meme tokens into reasonably stable types. This coheres nicely with Dennett's analysis

of information. Without such correction-inducing norms to preserve faithful transmission of types, culture would succumb to error catastrophe.

The second, and perhaps less favorable consequence of the subjective similarity view is that there will be a substantial amount of fuzziness around meme-types, because individual people will make different similarity judgments. There is a link here with the other aspect of Dennett's theory of information - codeless transmission.

In some cases - such as with judgments about word spelling - there will be a lot of overlap between judgments about whether two meme tokens belong to the same type. In other cases - such as with trends in fashion - there will be substantial variability between similarity judgments. Where variability is high, the intrinsic features of the meme are no longer predictive of its success. Success will be driven instead by whatever contingent factors happen to be involved in the disparate set of similarity judgments. Insofar as the population of people who make these similarity judgments constitute the environment in which a meme reproduces, this high variability scenario is one in which drift, rather than selection, has become the driver of evolutionary change.

Unlike selection, drift cannot explain adaptation. However, the capacity to explain undirected adaptation was Dennett's primary reason for taking memes seriously. This is an interesting result. In order to decide whether to accept Dennett's view of memes, we should want to know more about the uniformity of people's similarity judgments. In those domains where similarity judgments are diverse and disorganized, meme theory has less application.

3.4 On the evolution of language

The evolutionary transition that led most directly to the rise of cumulative culture is the emergence of human language. Dennett applies his theory of memes to construct a well-informed but speculative account of language evolution, designed to expose some of the smaller evolutionary transitions that must have occurred along the way.

There is a general chicken-and-egg problem that all theories of language evolution must confront. Cognition and linguistic behavior depend on one another. If you take one away, the result seems to be either inexpressible thoughts or meaningless expressions, neither of which seem to offer much adaptive advantage, and neither of which, therefore, seem capable of getting the evolutionary

ball rolling. On Dennett's view, adopting the meme-first perspective makes this puzzle tractable.

Dennett argues that our most recent alinguistic ancestors must have had some basic imitative abilities. Once that assumption has been made, the next question is usually about what additional competencies humans must have arisen in order for language to get a foothold. For Dennett, the more pressing line of inquiry concerns possible *vulnerabilities* human brains displayed that made them, collectively, an appropriate niche in which memes could thrive. The shift is subtle but important: once made, the temptation to speak of the discovery (or worse, the invention) of words disappears. Words are like the symbiotic bacteria in our guts. They colonized us long ago, without our awareness. Occasionally, our uncomprehending vocalizations turned out to be helpful, perhaps in hunting and scavenging; perhaps in sexual selection. Words became a synanthropic species whose evolutionary interests were aligned with our own often enough to become a permanent part of the human way of life.

Once a stable colony of words has established itself, two kinds of selection drive the trend towards complex morphology. The first of these is a trend toward meme diversification, itself driven by the meme's interest to "distinguish itself from the competition," without diverging so radically from established vocal forms as to become unpronounceable (p. 268). At the same time, given resource constraints in human brains, there will be selection for meme-variants that are amenable to efficient neural storage. Under these conditions, natural selection will "discover" the virtues of combinatorics, much as communications engineers have done when trying to find efficient ways of storing data. In my view, this is an area where the memetic perspective is particularly insightful. At the very least, Dennett's meme-centric view provides a valuable how-possibly sketch of the evolution of morphology that deserves to be developed and tested.

4 Intelligence and its Future

The last third of the book, comprised of just two chapters, is relatively short. The first chapter is about the relation between culture and consciousness. To many philosophers, consciousness is the most private of all possible phenomena. But on Dennett's view, which echoes Dan Sperber and Hugo Mercier's recent work (Mercier and Sperber, 2011), it has deeply social roots. Our ability to represent our own thoughts developed in response to selection pressures associated

with communication, and in particular, in response to the payoffs of persuasion. To persuade others, we must offer them a coherent narrative in which inconsistency is either removed or made obscure. That narrative becomes a perspective on the world; a reflective variety of self-awareness that no other animal has.

The final chapter uses the memetic perspective to shed light on future trends associated with artificial intelligence. In one sense, the chapter departs dramatically from the rest of the book, which is about how culture arose from its biological roots in the past. In another sense, however, the discussion of AI is a natural extension of the trajectory Dennett has described thus far. The main idea is that very recently, there has been a reversal in the trend that has long dominated the evolution of culture. Culture began as a product of a thoroughly Darwinian processes, but increasingly came to be steered by rational control and human comprehension. The process of cultural change became, in Dennett's phrase, de-Darwinized.

With the advent of deep learning and genetic algorithms, however, some aspects of cultural change are becoming re-Darwinized. New car designs, for example, are selected by machine learning algorithms for reasons that human engineers can't precisely articulate (Volodymyr et al., 2013). Perhaps more importantly, the computer simulations we rely upon to predict climate change and other complex systems give us results for reasons that can be "epistemically opaque" to the very teams of scientists who built them (Humphreys, 2009). Although Dennett is not worried about runaway artificial intelligence or doomsday scenarios, he is worried that a world in which technology development has become too Darwinian might be one in which it is impossible to comprehend our own creations.

5 Back to Memes

From Bacteria to Bach and Back defends an evolutionary theory of culture that is packaged and sold under the label of meme theory. However, part of Dennett's defensive strategy is to broaden the meaning of the term "meme" so that the substantive differences between his views and those of other theories of cultural evolution that reject the meme label, such as that of Richerson and Boyd (2008), become difficult to discern. At one point, Dennett says, in a formulation that could have been from Heidegger, that *a meme is a way* (p. 206).

Many authors, including Sperber (2000) and Lewens (2015) have argued that meme theory only makes sense if cultural individuals replicate in a strict sense. On their view, mere *reproduction* is insufficient. To see the difference, consider what happens when you use a music recognition app, such as Shazam. The app identifies a song, and you then purchase the song from iTunes, say. This replication process is unlike biological information replication, because the form of the parent is not a direct cause of the form of the offspring. Rather, each copy inherits its form from the original studio track. Sperber calls cases like these "triggering reproduction," and argues that they have the wrong causal structure to count as cases of meme transmission. For Dennett, however, they are perfectly good examples of meme transmission. He says: "...triggering reproduction is itself, if not parenting at least a bit of midwifery, making a contribution - perhaps a biased contribution - to the further reproduction of the type" (p. 245-46). For Dennett, the deep metaphysical truth about parent-offspring relations is either futile or unimportant.

By defending this pragmatic view of parentage, Dennett seems to reject what other authors consider an important necessary condition on memes. So why insist on the label? As far as I can tell, Dennett has two reasons. First, he thinks that asking questions about selection on cultural individuals, rather than biological individuals, is often eye-opening. Since framing cultural change in terms of memes steers us toward those questions, the meme idea is theoretically valuable. On this point, Dennett has me convinced.

Nevertheless, this perspective shift is afforded by the other established terms. For example, according to Tim Lewens' (2015) helpful taxonomy of cultural evolutionary theories, Dennett's theory would be categorized as "selectionist" rather than memetic (if it weren't for his explicit embrace of the term.) So there must be another reason. I suspect it is the fact that the term "meme" reinforces the impression of theoretical continuity between biology and culture. Like genes and organisms, and to a lesser extent, like groups and germ-line cells, memes are just another one of the many kinds of object upon which natural selection blindly works its magic. That is a seductively simply way of framing the big picture. However, as Dennett himself clearly argues, it isn't quite correct. Much of cultural change has been de-Darwinized. Often, its dynamics is driven, not by natural selection, but by alternative, quasi-selective processes. This brings us back to a comment I made near the outset about a trade-off between emphasizing the explanatory novelty of natural selection, and emphasizing the continuity between natural selection and quasi-selective processes. In this book, Dennett's

approach assigns greater weight to continuity. After reading it, I'm tentatively more open to using the meme label in contexts in which natural selection does not play a role, but suspect that the primary application of meme theory will always be cases in which comprehension is low and replication is strict.

Regardless of the range of phenomena to which the meme label is applicable, Dennett has used the label effectively, and shown that the evolutionary approach to culture has far more to offer than its detractors have supposed.

Acknowledgments

Many thanks to Daniel Dennett and Tim Lewens for their insightful commentary on an earlier draft of this review.

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