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Turing and the fragility and insubstantiality of evolutionary explanations: a puzzle about the unity of Alan Turing's work with some larger implications

JUSTIN LEIBER

ABSTRACT *As is well known, Alan Turing drew a line, embodied in the "Turing test," between intellectual and physical abilities, and hence between cognitive and natural sciences. Less familiarly, he proposed that one way to produce a "passer" would be to educate a "child machine," equating the experimenter's improvements in the initial structure of the child machine with genetic mutations, while supposing that the experimenter might achieve improvements more expeditiously than natural selection. On the other hand, in his foundational "On the chemical basis of morphogenesis, " Turing insisted that biological explanation clearly confine itself to purely physical and chemical means, eschewing vitalist and teleological talk entirely and hewing to D'Arcy Thompson's line that "evolutionary `explanations, "' are historical and narrative in character, employing the same intentional and teleological vocabulary we use in doing human history, and hence, while perhaps on occasion of heuristic value, are not part of biology as a natural science. To apply Turing's program to recent issues, the attempt to give foundations to the social and cognitive sciences in the "real science" of evolutionary biology (as opposed to Turing's biology) is neither to give foundations, nor to achieve the unification of the social/cognitive sciences and the natural sciences.*

Among cognitive scientists, Alan Turing is remembered for his foundational 1936 paper on computability and his 1950 paper, "Computing machinery and intelligence," which proposed what we now call the "Turing test," which also devastatingly rebutted objections to that test, and which outlined a number of ways for producing a Turing test passer (Turing, 1936, 1950). Though he is commonly remembered for suggesting programming, Turing in fact also proposed training connectionist nets (Turing, 1948 [1970]) and even, doubtless with Mary Shelly's *Frankenstein* in mind, releasing a computerizing robot into the countryside to learn its way about, laconically adding that "the danger to the ordinary citizen would be serious" (Turing, 1948 [1970], p. 13). More to the point, in a passage often

Professor Justin Leiber, Philosophy Department, University of Houston, Houston, TX 77004, USA, email: phil4Ljetson.uh.edu

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eliminated when the more familiar 1950 paper is anthologized, he also suggested attempting to simulate "the initial state of the mind, say at birth" (Turing, 1950, p. 31), and then giving "the child machine an education." He points out that the experimenter would not be likely to happen on an appropriate child machine simulation immediately but would have to try out various possibilities and he compares this process with biological evolution through the following equations:

- structure of the child machine = hereditary material
- changes of the child machine = mutations
- judgement of the experimenter = natural selection. (p. 32)

He suggests that the experimenter could proceed rather more quickly than natural selection, making planned changes rather than random mutations. In his 1948 paper, Turing similarly suggests that a purely "blank tablet at birth" animal would be wholly improbable, so he supposed that the successful "child machine" would have plenty of native structure.

You cannot escape the thought that a linguist might modularize, and make more specific, these equations as follows:

- structure of the child's language acquisition device = hereditary material
- changes in some proposed child language acquisition device = mutations
- judgements of the linguist = natural selection.

Obviously, as linguistic's goal of *explanatory adequacy* suggests, linguistics aims to specify the initial state of the child's language acquisition device, what the child so to speak must know in order to become a fluent speaker of whatever natural language happens to be spoken locally. I hasten to add that, as Turing's use of the locution "the initial state of the mind, say at birth" clearly suggests, he does not mean genes (i.e. DNA) by "hereditary material" but rather the child's full cognitive apparatus insofar as this is attributable to natural growth and development as opposed to peculiarities of the local environment. "Say at birth" leaves wiggle room, for Turing of course recognized that the child at birth is by no means through with what Turing called the "morphogens" of development (Turing, 1954). "Morphogens" of course included the genes for Turing but it also included all of the cellular and. organic chemical and physical morphological processes that drive growth from zygote through to the mature organism. Indeed, Turing, like some embryologists, was perhaps even a shade too dismissive about DNA, writing, "The function of the genes is purely catalytic. They catalyze the production of other morphogens, which in turn may only be catalysts. Eventually, presumably, the chain leads to some morphogens whose duties are not purely catalytic" (Turing, 1952 [1992], p. 2). But Turing's point is mostly correct and has been profoundly confirmed by biological research of the past two decades. DNA provides a passive set of templates that are deployed by other cellular structures and processes which the DNA does not create nor miotically reproduces (organelles, cell walls, DNA-reading spindles, etc.). And within several days after conception the beginning of the human nervous system is globally directing the development of the whole organism, determining what DNA gets expressed and where, determining what kind of cells get built and what larger structures emerge. The DNA and the rest of the conceptive cell is no blueprint but rather a set of programs for constructing proteins, which do the cell's business and select which genes to read to create more complex intercellular and intracellular structures, eventually creating larger structures that direct cellular differentiation, organ construction, and so on, more and more complicated programs that will eventually spin out the development of the fetus. To think that we can in practice or even in theory "read off" the initial state of the child's mind/brain from its DNA is the height of absurdity.

Among biologists, Turing is famous for his groundbreaking 1952 Royal Society paper, "On the chemical basis of morphogenesis." Indeed, this paper, which introduced what biologists inevitably now call "Turing structures," has received more citations than all the rest of Turing's works altogether (Saunders, 1992, p. xvi). Here Turing tackles a major aspect of what he saw as the central problem of biology, namely, how the zygotic cell of conception manages, through strictly chemical and physical means, to grow into the immensely larger and enormously complicated structures of the fetus, the baby, and the mature organism, creating all along *new* information and structure. The exemplary chaotic reaction-diffusion models that Turing proposed now have an important role in theoretical biology and recently have been observed experimentally (Castets *et al.,* 1990). They show how patterns or structures can burst forth in homogeneous mediums, the most specific example of "Turing structures." (Although I. Prigogine was initially credited for the notion of dissipative and chaotic biological reactions for his work in the late 1950s and 1960s, first credit goes to A. Turing (1952), whose lectures on the topic were attended by Prigogine and who reportedly spent a day in vigorous conversation with Turing (Hodges, 1983, p. 564). Turing's general theoretical stance demands specification of some physical and chemical situation which defines "the state of the system."

> One then describes how that state is to be determined from the state at a moment very shortly before. ... In determining the changes of state one should take into account (i) The changes of position and velocity, as given by Newton's laws of motion. (ii) The stresses as given by the elasticities and motions, also taking into account the osmotic pressures as given from the theoretical data. (iii) The chemical reactions. (iv) The diffusion of the chemical substances. The region in which this diffusion is possible is given from the mechanical data. (Turing, 1952, pp. 37-38)

Notice that Turing's restrictions on biological explanation cast out teleology, evolutionary phylogeny, natural selection, and history (both the final causes of teleology and "origins" or *efficient causality* in Aristotle's original sense that would distinguish two chemically identical molecules if one were produced "naturally" and the other in the laboratory). As Turing wrote, modestly asserting the biological tradition to which he belonged,

> Unless we adopt a vitalistic and teleological conception of living organisms, or make extensive use of the plea that there are important physical laws as

> yet undiscovered relating to the activities of organic molecules, we must envisage a living organism as a special kind of system to which the general laws of physics and chemistry apply. And because of the prevalence of homologies of organization, we may well suppose, as D'Arcy Thompson has done, that certain physical processes are of very general occurrence. ... What is novel in [this diffusion reaction] theory is the demonstration that, under suitable conditions, many diffusion reaction systems will eventually give rise to stationary waves; in fact to a patterned distribution of metabolites. (Turing 1953 MS/1992, p. 45)

As Turing put his project tersely, in a remark to Robin Gandy, his new ideas were intended to "defeat the argument from design" (Hodges, 1983, p. 431). Turing, of course, was only jokingly if at all referring to William Paley's watchmaker argument for the existence of God, one long before displaced by Darwin (who had cut his biological teeth in rapt fascination with Paley's detailed teleology, whose designed-ness he in no way wished to dispel but only sought to derive through Mother Nature's rather than God's selections). Turing, rather, endorsed the D'Arcy Thompson (1917) view that the teleological "evolutionary explanations" endemic to Darwinian "adaptationist" biology are non-fundamental, fragile, misdirected, and at best mildly heuristic. Or as Saunders interprets Turing's remark, "The primary task of the biologist is to discover the set of forms that are likely to appear [for] only then is it worth asking which of them will be selected" (Saunders, 1992, p. xii).

Selection is an historical accident of sorts, and, from the Turing's viewpoint, would *not* biologically distinguish two chemically identical animal proteins because one was produced through "natural" as opposed to "laboratory gene splicing induced" methods; nor would a biological description of a particular organism be incomplete or indeterminate if several descent pathways might have led to it, with *which one* simply a historical accident. Turing and Thompson articulate the morphological and anti-teleological tradition that goes back to Etienne Geoffroy Saint-Hilaire, who, in a month-long debate before the Academie des Sciences in 1830, maintained the *unity of type* thesis that all animals have the same ground plan *(bauplane)* against the selectionist *demands of existence* of Georges Cuvier, whom Charles Darwin called his "idol." Poet naturalist Johan Wolfgang Goethe also felt party to the debate since he maintained that plant appendages-carpels, stamens, petals, sepals, and leaves-were all metamorphoses of a kind of urleaf. While the more famous and masterful Cuvier was held to have won the debate at the time, work by geneticists in the last decade have extravagantly confirmed the claims of Geoffroy and Goethe. With one trifling exception-Bryozoa-all 20-odd animal phyla appeared within a few score million years in the great Cambrian "explosion," as if nature were quick to run through all the basic possibilities of the animal type in less than 5% of the time there have been animals on earth. More substantially, it appears more and more likely that all animal phyla use virtually the same *homeobox* "master genes" and proteins to determine segmentation and segmental identity.

> [W] e have accumulated more and more evidence that the same homeobox genes are used in both vertebrates and invertebrates to specify the body

> plan and that the mechanisms of the genetic control of development are much more universal than anticipated. (Gehring, 1998, p. 53)

Parallel results have appeared in the study of plants. Goethe's fondest hopes have been realized: carpels, stamens, petals, sepals, and leaves are variations on the urleaf tripped off by homeobox structural genes (Coen, 1999). *Unity of type* has made an extraordinary comeback.

The fragility and insubstantial nature of evolutionary explanations received another ample demonstration recently. For several decades the eye has been evolutionary biologists' stock example of analogical development, a device so nifty that nature supposedly has "re-invented" it several times, for example, in mollusks, insects, and vertebrates if not, as some enthusiasts would have it, scores of times. Recently, molecular biologists showed that the same *Pax-6* DNA makes eyes in squids, fruit flies, and mice, so economical and homological nature apparently "invented" eyes only once (Tomarev *et al.,* 1997).

> Based on these substantial differences in morphology and mode development the biologist Ernst Mayr has argued that different types of eyes evolved as many as forty times independently in the animal kingdom. Because the evolution of the prototype eye, at a stage before selection can exert its effect, must be a rare event, the independent evolution of so many prototypes represents a serious problem that is difficult to reconcile with Darwin's theory. ... [Our] findings lead to the further conclusions that the prototypic eye may have originated only once, rather than some forty times, and that the large variety of eye types found in the animal kingdom is derived from this prototype by divergent, parallel, and convergent evolution. (Gehring, 1998, pp. 204-209ff)

Similarly, a single fruit fly gene, dubbed *tinman,* determines whether the fly, or any other animal, will develop a heart, activating a cascade of single gene assembly modules, "an apparently ancient metazoan property with molecular pathways conserved from insects to mammals," which may first have developed out of some humble flatworm's throat (Bodmer, 1993; Fishman & Olson, 1997, p. 719).

Just this year Ernst Mayr acclaimed Darwin for founding evolutionary biology on four original theses:

> The first is the non-constancy of species, or the modem conception of evolution itself. The second is the notion of branching evolution, implying the common descent of all species of living things on earth from a single unique origin. Up until 1859, all evolutionary proposals, such as that of naturalist Jean-Baptiste Lamarck, instead endorsed linear evolution, a teleological march toward greater perfection that had been in vogue since Aristotle's concept of *Scala Naturae,* the chain of being. Darwin further noted that evolution must be gradual, with no major breaks or discontinuities. Finally, he reasoned that the mechanism of evolution was natural selection. (Mayr, 2000, p. 80)

Historically, Lamarck and others anticipated Darwin on "evolution itself'; Lamarck, while linear in *Philosophie Zoologique* (1809), clearly and forcefully converted to branching in his masterwork, the seven volume *Histoire Naturelle des Animaux sans vertebres* (1815-1822). Moreover, in much of his writings, Darwin clearly expresses a progressivist "march toward perfection," or "higher forms," viewpoint. Although he is often presented as refuting Lamarckian "inheritance of acquired characteristics," in every edition *of Origins of Species,* Darwin endorses Lamarck's claim that direct influence *of* the environment and an organ's "use-disuse" of its parts play an important role in evolution, although Darwin held it to be secondary to natural selection. Indeed, "inheritance of acquired characteristics" became so prominent in Darwin's later thinking that he invented the spurious theory of epigenesis to supply the mechanisms that would make such inheritance possible.

Setting history aside, how does Darwin's branching tree and his gradualism look today? It now appears that for well over two-thirds of the evolution of life on earth, life evolved as much through lateral transfer of genes and gene sets across species or even "domain" barriers as through vertical, branching descent (this form of evolution of course continues today among single celled organisms). We have a lattice of life, not a tree. As the author of "Uprooting the Tree of Life" sums up the results of the accelerating research of the last three decades:

> The most reasonable explanation for these various contrarian results is that the pattern of evolution is not as linear and treelike as Darwin imagined it. Although genes are passed vertically from generation to generation, this vertical inheritance is not the only important process that has affected the evolution of cells. Rampant operation of a different process-lateral, or horizontal, gene transfer-has also affected the course of that evolution profoundly. Such transfer involves the delivery of single genes, or whole suites of them, not from a parent cell to its offspring but across species barriers. (Doolittle, 2000, p. 94)

While biologists now speak of the three life domains of bacteria, archaea, and eukaryota, with the last domain eventually giving rise to the modern structured multicellular organisms of the Cambrian explosion, biologists suspect there must have been even less distinct precursors of the domains. Carl Woese, who developed the technique for determining phylogeny through genetic difference that grounded the domain and lateral transfer view, recently commented, dismissing Mayr's Darwinian demand for a unique ancestral organism from which all life branched.

> The ancestor cannot have been a particular organism, a single organismal lineage. It was a communal, a loosely knit, diverse conglomeration of primitive cells that evolved as a unit, and it eventually developed to a stage where it broke into several distinct communities, which in their turn become the primary lines of descent [bacteria, archaea, and eukaryotes]. (Woese, 1998)

In 1966, microbiologist Lynn Margulis proposed that the eukaryote cell arose not through the gradual whittling away of natural selection but through instantaneous lateral transfer-ingestion-of whole gene sets that settle into a symbiotic relationship as organelles inside their host. In particular, she claimed that the power plant or respirator necessary to the eukaryote cell, mitochondria, stemmed from such a symbiotic ingestion (mitochondria still retain some DNA of their own and are now thought to stem from an alpha-proteobacterial cell). Similarly, the chloroplast organelles vital to plant life stemmed from ingested cyanobacteria that settled in symbiotically. Given the Darwinian emphasis on gradualism and natural selection, it is perhaps no wonder that her first paper propounding endosymbiosis received 15 rejection slips before it was finally published in 1966 (Margulis, 1998, p. 29). Perhaps because she was reviving views that Darwinian evolutionary biologists had previously hooted down as "Lamarckian," Margulis argues that these are absolutely clear cases of the inheritance of acquired characters. Not of course "use-disuse" but the acquiring a heritable characteristic through the direct action of the environment, of the invading bacterium (Margulis, 1998). Literally, Margulis is surely right, but most biologists cannot stomach the phrase, although her claims about the origins of mitochondria and chloroplasts are now wholly accepted and their extension to explain the origin of other organelles proceeds apace. What no one disputes is that we have here dramatic growth in heritable organic complexity, not through gradualist whittling but through single events of lateral transfer. As a recent textbook on symbiosis puts it,

> The foundation of this text is that symbiosis has expanded the metabolic repertoire of eukaryotes. The greater part of the book has concerned associations that evolved in the Phanerozoic: the past 600 million years and the age of multi-cellular eukaryotes-the animals, plants, and fungi. In an evolutionary sense, however, the most significant symbiosis in eukaryotes is Precambrian in origin: the acquisition of aerobic respiration through mitochrondria. It is not entirely fanciful to suggest that, without this symbiosis, the eukaryotes would today be relegated to a few anaerobic environments, and the world would have been dominated by bacteria. (Douglas, 1994, pp. 131-132).

By current taxonomy one could call the domain distinction between eukaryotes and bacteria the most basic, with structured multicellular organisms eventually stemming from the eukaryote line, and further dividing into plants and animals by another bacterial lateral ingestion. So the most basic distinctions among biological organism have been wrought by single symbiotic events rather than gradual natural selection. (Of course, once the symbiosis occurs, natural selection presumably helps to adjust and improve the symbiosis. The DNA of the bacterium are eventually mostly transferred to the more protective eukaryote nucleus, although in the case of mitochondria some are not transferred, apparently because they would endanger the nucleus.)

Cautions about evolutionary explanations are particularly in order when evolutionary biologists speculate about *behavioral* traits, for which fossils can give only indirect and scanty evidence, and become additionally acute when homologies between humans and other primates, and animals more generally, are sought and still more so when the behavior touches our *amour propre* (namely, thinking, morality, sexuality, or language as opposed to singing, smelling, grooming, or chest pounding).

To give but one example, sociobiologists and evolutionary psychologists, employing a folk psychological idiom, have almost taken it as axiomatic that, in mammal species, males are dominant and, when social, form status hierarchies and jealously and polygynously compete for females. Our closest relative, the chimpanzee, with whom we share 99% or so of our structural genes, is a standard example. Chimpanzee males are dominant over females. The males use guile, violence, and alliances to establish, defend, or alter the hierarchy; jealous competition for females is the *raison d'etre* of the hierarchy, though the alpha male cannot entirely monopolize the females because the females all go into (a brief) estrus at the same time. Like many male mammals, the male chimpanzee is likely to kill infants, so a female with a newborn often stays away from the pack, and its resources, until her infant is older (behavioral research with a chimpanzee usually terminates at age five or so, a couple of years before puberty, because by that time the animal is sufficiently strong and aggressive to be a real danger to humans). Chimpanzee packs war with and may exterminate other chimpanzee packs; cannibalism is not unknown.

However, we are genetically just as closely related to bonobos (formerly called "pigmy chimpanzees," although the size difference is slight and overlapping). About six million years ago, our common ancestral line split into the australopithecine branch that led to us and the chimpanzee/bonobo branch, which itself fissioned some time later. Compared with chimpanzees, bonobos have slighter (gracile) builds, thin necks, narrow shoulders, flatter, more open faces, with higher foreheads. In terms of weight distribution between arms and legs, bonobos are more like us than other apes. They have a more upright human posture than chimpanzees, and among current apes they come closest to the proportions of australopithecines and may serve as a prototype for the common ancestor of humans, chimpanzees, and gorillas (Zihlman, 1984; Zihlman *et al.,* 1978).

Because of their geographical isolation, bonobo behavior has only been investigated over the last two decades. As Frans de Waal, who did as much as anyone to establish details about the sketch of chimpanzee behavior I have summarized above, recently put it:

> Had bonobos been known earlier, reconstructions of human evolution might have emphasized sexual relations, equality between males and females, and the origin of family, instead of war, hunting, tool technology, and other masculine fortes. Bonobo society seems ruled by the "Make Love, Not War" slogan of the 1960s rather than the myth of a bloodthirsty killer ape that has dominated textbooks for at least three decades. ... The bonobo is best characterized as a female-centered, egalitarian primate species that substitutes sex for aggression. ... Whereas in most other species, sexual behavior is a fairly distinct category, in the bonobo it has become an integral part of social relationships, and not just between males and females. Bonobos engage in sex in virtually every partner combination:

> male-male, male-female, female-female, male-juvenile, female-juvenile, and so on [de Waal estimates that over 75% of bonobo sex is purely social and cannot serve any reproductive end]. (de Waal, 1997, pp. 2-4)

The bonobo pack is dominated by the older, well-bonded females, who among other things, cooperate to preempt choice food finds from males until they have had their fill, a standard measure of dominance. While there is something of a status hierarchy among the males, this is hardly so evident in the solidarity of older females. Because sex is so frequent in so many different combinations, paternity seems totally obscure. In any case, there is no infanticide or jealous, aggressive competition to control access to females, who are sexually receptive most of the time. Bonobo females also differ from chimpanzee females in three ways once claimed by sociobiologists to be exclusive to human females: they often have intercourse in the ventro-ventral "missionary" position, seem to be anatomically adapted to it, and they have orgasms (de Waal, 1997, pp. 103-105). A bonobo male forms a strong, dependent, life-long bond with his mother. Somewhere :around puberty, a bonobo female seeks another pack and will be accepted into it if an older female becomes attached to her. Bonobos are an unmentionable nightmare for most evolutionary psychologists.

One of the few mammal species in which males are not dominant is much less distressing. Unusually, among mammals, the female hyena is as heavy, strong, and aggressive as the male. But the physical proportions between bonobo males and females are about the same as between chimpanzee and human males and females. Bonobo males are heavier and more muscular than the females and they sport long canines, which the females lack. None the less, the females are consistently dominant both in zoos and the forest, and while the level of violence is much less than among chimpanzees, injuries sustained by males in both habitats attest that the females assert themselves physically when necessary.

> From a female point of view chimpanzee society seems a rather stressful arrangement. Male chimpanzees do share food with females and are most of the time on good terms with them, but they are supremely dominant, and instead of helping out with offspring, they sometimes pose a threat. Bonobo society offers females a more relaxed existence. Females control the resources, dominate the males, and have little to compete over aside from their sons' careers. (de Waal 1997, p. 135)

Given that Turing, in his cognitive work, should have equated "judgement of the experimenter" with "natural selection," is he not inconsistent to insist on throwing teleology and natural selection out of fundamental biological explanation? Similarly, given the equation of "the judgement of the linguist" would the linguist be inconsistent in throwing teleology and evolutionary speculation out of fundamental biological explanation of the language faculty? Not at all! And the reason is the same in both cases. The historical origins (the vagaries of nature's or the experimenter's selection) of the researcher's "initial state of the child machine" or "initial state of the language acquisition device" proposal have nothing to do with its cognitive or biological explanatory value. Cognitively speaking, you don't have to grow or follow any particular procedure in producing a Turing test passer or the specifications of a Language Acquisition Device! Whatever does the job, *does the job.* This is the line, as Turing puts it, in distinguishing the cognitive from the specifically physical and chemical. Similarly, but speaking biologically, when we are concerned with the *actual* physics and chemistry of the human biological development of cognitive traits, the teleology, the actual phylogenetic and evolutionary history, are centrally irrelevant and distracting.

Let me locate the point in terms of recent debates about the supposed "foundational character" of sociobiology or evolutionary psychology for the cognitive sciences. Reviving and renaming a familiar gambit, E.O. Wilson's *Sociobiology* (1975) proposed to ground the social and cognitive sciences in evolutionary biology, thus to "unify" the sciences. Wilson has continued the proposal through several subsequent books, culminating in *Consilience* (1998). Many others have embraced his line, though "evolutionary psychology" is now the favored label for it.

Ironically, Wilson himself had much earlier suffered from the same subordinating disciplinary imperialism that Wilson *et al.* propose for the social and cognitive sciences. James Watson, co-discoverer of the chemical structure of DNA, joined Harvard's Biology Department the same year as Wilson in 1956. Wilson writes of him in his engaging autobiography, *Naturalist,*

> I found him the most unpleasant human being I had ever met.... He arrived with the conviction that biology must be transformed into a science directed at molecules and cells and rewritten in the language of physics and chemistry. What had gone before, "traditional" biology-my biology-was infested by stamp collectors who lacked the wit to transform their subject into a modem science. (Wilson, 1994, p. 219)

Watson ridiculed Wilson's suggestions that Harvard hire more evolutionary biologists and behavioral ethologists, insisting that evolutionary biology really was more natural history than real science. Watson demanded molecular, genetic, cellular, and embryological biologists whose work would rest on strictly chemical and physical explanations, with no loose talk of *purpose, function,* or *adaptation* allowed except for heuristic purposes. That, to the degree it can be achieved, would mean real unification between biology and natural science. Watsonians now clearly predominate at research universities, while evolutionary biologists, whether of the Wilsonian "adaptationist" persuasion or the "pluralist" one of Stephen Jay Gould, often hold museum posts (although Gould has also published hundreds of research papers in the "strictly physical and chemical" Watsonian vein as well).

E.O. Wilson began *Sociobiology* with duplicitous "vaunting ambition," perhaps still smarting from Watson's scorn.

> Let us now consider man in the free spirit of natural history, as though we were zoologists from another planet completing a catalog of social species on Earth. In this macroscopic view the humanities and social sciences shrink to specialized branches of biology; history, biography, and fiction are the research protocols of human ethology and anthropology and sociology

together constitute the sociobiology of a single primate species. (Wilson, 1975, p. 547)

What if we earth-bound but would-be extraterrestrial zoologists "consider man" *not* "in the free spirit of natural history" but in the scientific spirit of Watson-Turing biology, dismissing evolutionary biology as "history and stamp collecting" as opposed to real natural science? Wouldn't that be the real unification? Might the reviewer of Wilson's most recent book, *Consilience* (1998), be right to wonder whether "sociobiology isn't just a kind of folk psychology, only with field work and more decimal places" (Siano, 1998)? Actually, it is much worse than that. Anthropomorphism works by far the best with humans. The illusion-prone pictures this teleological and intentional idiom give us of nonhuman animals are much less determinate, detailed, or verifiable.

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