Strong versus Weak Adaptationism in Cognition and Language

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Abstract

Strong adaptationists would explain distinctively complex organic design as task-specific adaptations to particular ancestral environments. Weak adaptationists do not assume that complex organic (including cognitive and linguistic) functioning represents evolutionary design in the sense of niche-specific adaptation. Progress in understanding cognitive structures may not warrant strict adherence to strong or weak adaptationism. For certain domain-specific competencies (e.g., folkbiology) strong adaptationism has been useful but not necessary in advancing research. In other cases (e.g., language, especially universal grammar) weak adaptationism has proven most productive. A mix of strong and weak adaptationist strategies may be the best strategy overall.
In a sense, everyone who isn’t a creationist and who thinks that Darwin’s theory of natural selection isn’t moonshine is an adaptationist when it comes to explaining the origins of human cognition. Nevertheless, there are serious differences in research strategies between “strong adaptationism” and “weak adaptationism.” Strong adaptationists hold that researchers should first attempt to explain any distinctive (noncultural) complex organic design in terms of task-specific adaptations to particular ancestral environments (Barkow et al., 1992, Cosmides & Tooby, 1995, Dennett, 1995, Pinker, 1997, Thornhill, 1997, Buss et al., 1998, Sober & Wilson, 1998, Andrews et al., in press). Strong adaptationism assumes that each functional trait contains telltale signs of the evolutionary cause – the selective force - that created it, that is, the specific historical environmental problem that was causal in creating the adapted trait.

Weak adaptationists hold that strong adaptationist arguments from design often involve Panglossian “just-so” stories that are consistent with natural selection, but which lack evidentiary standards that could rule out indefinitely many alternative and even contrary explanations. As a matter of methodological principle, weak adaptationism is equally open to the possibility of explanations that do not directly rely on natural selection. Resort to task-and-environment-specific adaptationist accounts of the origins of human cognitive systems, including language, should be used only when comparative (fossil or ethological) evidence strongly warrants it – which is rarely the case (Gould & Lewontin, 1979, Gould & Vrba, 1982, Chomsky, 2000, Finlay et al., 2001, Fodor, 2001, Leiber, in press, Hauser et al., in press). Each camp routinely claims that the other camp doesn’t really understand Darwin or evolution; both routinely pay homage to George Williams’ (1966) modest use of adaptationism.

Here I argue that in cases of certain domain-specific cognitive competencies (e.g., folkbiology) strong adaptationism has proven useful but not necessary to recent progress in the field. In other cases (e.g., language) a weak adaptationist strategy has been arguably most productive in advancing scientific understanding, without precluding that the structures uncovered by other means are actually adaptations.
(physics), the more specific properties of plants and animals (biology), and the particular properties of their fellow human beings (psychology). Recent developmental, cognitive and cross-cultural experiments strongly indicate that all (non-brain-damaged) humans have distinct core faculties of mind with privileged access to these distinct but overlapping domains of nature: folkmechanics (object boundaries and movements), folkbiology (biological species configurations and relationships), folkpsychology (interactive agents and goal-directed behavior) (for reviews, Hirschfeld & Gelman, 1994, Sperber et al., 1995, Pinker, 1997, Geary & Huffman, 2002). These plausibly innate (but maturing), domain-specific faculties are candidates for naturally-selected adaptations to relevant and recurrent aspects of ancestral environments. Under analytic idealization they are “universal” and “autonomous” from other cognitive faculties the way the visual system is universal and autonomous from other cognitive and biological systems (with significant individual genetic variation, and viability only in functional interaction with others faculties).

Take the case of folkbiology. Humans and their ancestors undoubtedly depended for their survival on intimate interaction with plants and animals, which likely required anticipatory knowledge of at least some plant and animal species (it doesn’t really matter which individual apple you can eat, or whether its Leo or Larry the tiger who can eat you). This makes it likely (but not necessary) that adaptations for special dealings with plants and animals evolved. In addition, there is growing and converging evidence for innateness and domain-specificity in human folkbiological understanding. Although domain-specificity is a weaker claim than adaptation (and innateness is a weaker claim than domain-specificity), evidence for domain-specificity helps to focus claims and research on adaptations.

Evidence for domain-specificity in folkbiology comes from a variety of converging sources (Atran, 2001a). These include: ethology (comparative studies of species recognition), cross-cultural studies (universality of special taxonomic design), developmental psychology (precocity and regularity in acquisition of essentialized species concepts and ranked taxonomic groupings), cognitive psychology (independence from perceptual experience of biological essentialism and taxonomic organization), pathology (selective cerebral impairment of folkbiological taxonomies and distinct taxonomic levels),
social and educational studies (hyperactive use of biological essentialism and taxonomization, and their resistance to inhibition through formal or informal instruction or changing social conditions), and cognitive anthropology (rapid cultural transmission, easy mnemonic retention, and enduring historical survival of any given folkbiological taxonomy under varied and changing conditions of experience). No single condition may be necessary for domain-specificity; however, joint satisfaction of these conditions constitutes strong evidence for it (although they provide no causal explanation of it).

In every human society, people seem to think about plants and animals in the same special ways. These special ways of thinking, which can be described as "folkbiology," are basically different from the ways humans ordinarily think about other things in the world, such as stones, tools or even people:

From the most remote period in the history of the world organic beings have been found to resemble each other in descending degrees, so that they can be classed into groups under groups.

This classification is not arbitrary like the grouping of stars in constellations. (Darwin 1859:431). The structure of these hierarchically-organized groups, such as white oak/oak/tree or mountain robin/robin/bird, is referred to as "folkbiological taxonomy." These nonoverlapping taxonomic structures can often be interpreted in terms of speciation (related species descended from a common ancestor by splitting off from a lineage).

The human taxonomic system for organizing species appears to be found in all cultures (Berlin et al., 1973, Atran, 1990). It entails the conceptual realization that, say, apple trees and robins belong to the same fundamental level of (folk)biological reality, and that this level of reality differs from the subordinate level that includes winesap apple trees and mountain robin as well as from the superordinate level that includes trees and birds. Biological ranks are second-order classes of groups (e.g., species, family, kingdom) whose elements are first-order groups (e.g., lion, feline, animal).

Folkbiological ranks vary little across cultures as a function of theories or belief systems. Ranks are intended to represent fundamentally different levels of phenomenal (readily perceived) reality, not convenience (Berlin, 1992). In principle, this ranking system allows incorporation of indefinitely many folk species into an inductive compendium that “automatically” connects properties of the new species to
the properties of all other species. This taxonomic framework supports indefinitely many systematic and graded inferences about the distribution of known or unknown properties among species (Atran, 1998).

People in all cultures studied on the issue partition local biodiversity into taxonomies that are structurally anchored to the level of the “generic species” (Berlin et al., 1973, Atran, 1990), the common man’s (folk) species (Wallace 1889:1). Generic species often correspond to scientific species (e.g., dog, apple tree); however, for a majority of perceptually salient organisms, such as vertebrates and flowering plants, a scientific genus frequently has only one locally occurring species (e.g., bear, oak). There is growing experimental and cross-cultural evidence of a commonsense assumption that each generic species is presumed to have underlying causal nature, or essence, which is uniquely responsible for the typical appearance, behavior and ecological preferences of the kind (Gelman & Wellman, 1991, Hickling & Gelman, 1995, Atran et al., 2001, Sousa et al., in press).

People in diverse cultures consider this essence responsible for the organism’s identity as a complex entity governed by dynamic internal processes that are lawful even when hidden. This essence maintains the organism’s integrity even as it causes the organism to grow, change form and reproduce. For example, a tadpole and frog are conceptualized as the same animal although they look and behave very differently, and live in different places. Western philosophers, such as Aristotle and Locke, attempted to translate this commonsense notion of essence into some sort of metaphysical reality, but evolutionary thinkers reject the notion of essence as such (Hull, 1965, Mayr, 1982). Nevertheless, biologists have traditionally interpreted this conservation of identity under change as due to the fact that organisms have genotypes separate from phenotypes.

Although biological science does not abide metaphysical essentialism, there is a wide variety of evidence supporting the notion of psychological essentialism (Ahn et al., 2001); that is, even when people do not have specific ideas about essences they may nonetheless have a commitment to the idea that there is an underlying nature (i.e., they may have an “essence placeholder,” Medin and Ortony, 1989). This hidden, causal essence is presumably responsible for the manifest properties of the kind. The special causal presumptions inherent in essentialism cannot apparently be derived from more domain-general
notions of causality (e.g., a three-legged tiger is still presumed to be a quadruped by nature but a three-legged or bean-bag chair is not although most chairs are quadrupedal, Atran, 1987a). The fact that biological science can overturn psychological essentialism in theory construction doesn’t imply that psychological essentialism is dismissible from everyday thought, any more than rejection of constant intervals of space and time in physics implies abandoning ordinary use of space and time (Atran, 1990).

Briefly, then, there is a folkbiological system (FBS) of the human mind. It discriminates and categorizes parts of the flux of human experience as “biological,” and develops complex abilities to infer and interpret this highly structured domain. In a general sense, there is nothing intrinsically different about FBS – in terms of innateness, evolution or universality – than the visual system (VS) or any other evolved cognitive system. FBS is no more (or less) “autonomous” from the surrounding social environment, or from other mental systems, than VS is detachable from surrounding light and object patterning or from other physical systems (including linguistic and other cognitive systems, Marr, 1982).

FBS and VS do not exist, and cannot develop, in isolation, but only as subsystems of even more intricate structures. Moreover, to function properly, such systems require adequate access and exposure to the appropriate environmental input that triggers or enables them; otherwise they tend to degenerate (Hubel, 1988). Thus, claims about the biological “autonomy” or “modularity” of FBS or VS refer only to a specifiable level of systemic functioning, within a system hierarchy, under appropriate environmental conditions. Claims for “innateness” refer only to special biological preparedness that canalizes maturing and developing manifestations of FBS under environmental constraints. This does not imply genetic uniformity among individuals. A difficult empirical issue concerns the extent to which other cognitive systems, such as folkpsychology and folkmechanics, are themselves geared to interface with folkbiology.

FBS constrains and guides the way biological inferences are generalized from particular instances (experiences, observations, exemplars). The particular persons observed, actual exemplars targeted, and specific inferences made can vary a lot from person to person. Nevertheless, much as rain falling anywhere in a mountain valley converges into the same natural mountain-valley river basin (Waddington,
1959), so each person's knowledge will converge (in the appropriate cultural idiom) toward the same basin of thought and action (Sperber, 1996).

Thus, many different people, observing many different exemplars of dog under varying conditions of exposure to those exemplars, all still generate more or less the same general concept of dog. The concept dog – or any other basic sort of living-kind concept - represents more than just “correlational features in the world.” It is hard to imagine how a categorization system exclusively attuned to perceptually-based “correlational structure” (cf. Rosch et al., 1976, Berlin, 1992) could possibly predict the classification of Pekinese with Saint Bernards and not Persian cats, and huskies with chihuahuas and not wolves – much less the convergence across cultures of people’s understanding that tadpoles belong with frogs, caterpillars with butterflies, and so forth. Rather, correlated surface features together with deep inferential principles that go beyond given appearances (e.g., essentialism) spontaneously create natural living-kind categories that capture and predict organic relationships at roughly the level of human ecological proclivity (including larger vertebrates and flowering plants) (Atran, 1987b).

Within the emerging paradigm of cognitive domain-specificity, there is much speculation and controversy, as might be expected in any young and dynamic science. For example, there are competing accounts of how human beings acquire basic knowledge of the everyday biological world, including the categorical limits of the biological domain and the causal nature of its fundamental constituents. One influential view of conceptual development in folkbiology has been articulated by Susan Carey and her collaborators (Carey, 1985, Carey & Spelke, 1994, Solomon et al., 1997). On this view, young children's understanding of living things is embedded in a folkpsychological, rather than folkbiological, explanatory framework. Only by age 7 do children begin to elaborate a specifically biological framework of the living world, and only by age 10 does an autonomous theory of biological causality emerge that is not based on children’s understanding of how humans think and behave. A competing view is that folkbiology and folkpsychology emerge early in childhood as largely independent domains of cognition that are clearly evident by ages 4 or 5, and which may be innately differentiated (Atran, 1987a, Gelman & Wellman, 1991, Keil, 1994, Hatano & Inagaki, 1999).
To address this issue, a series of cross-cultural experiments were carried out (Atran et al., 2001, Sousa et al., in press, Ross et al., in press). One set of experiments shows that by the age of 4-5 years (the earliest age tested in this regard) urban American, rural Yukatek Maya, and urban and rural Brazilian children employ a concept of innate species potential, or underlying essence, as an inferential framework for understanding the affiliation of an organism to a biological species, and for projecting known and unknown biological properties to organisms in the face of uncertainty (Atran et al., 2001, Sousa et al., in press). For example, young children overwhelmingly believe like adults that the identity of animals and plants follows that of their progenitors, regardless of the environment in which the progeny matures (e.g., progeny of cows raised with pigs, acorns planted with apple seeds, cf. Gelman & Wellman, 1991).

Another set of experiments shows that whereas young urban American children exhibit strong anthropocentric construals of nonhuman biological kinds, the youngest Maya children, as well as Native American (Menominee) and rural majority-culture American children, do not (Atran et al., 2001, Ross et al., in press). These children do not initially need to reason about nonhuman living kinds by analogy to human kinds. The fact that urban American children show anthropocentric bias appears to owe more to a difference in cultural exposure to nonhuman biological kinds than to a basic causal understanding of folkbiology per se (cf. Inagaki, 1990). Together, the first two sets of experiments suggest that folkpsychology can’t be the initial source of folkbiology. They also indicate that to master biological science, people must learn to inhibit activation of universal dispositions to view species essentialistically and to see humans as inherently different from other animals.

A third set of experiments reveals significant cross-cultural agreement in folktaxonomic structures, and in correspondence of folktaxonomies with evolutionary taxonomy (Lopez et al., 1997, Atran, 1999, Bailenson et al., 2002; cf. Boster, 1991, Malt, 1994). A final set of results shows the same taxonomic rank being cognitively preferred for biological induction in two diverse populations: people raised in the Midwestern USA and Itza’ Maya of the Lowland Mesoamerican rainforest (Atran et al., 1997, Coley et al., 1997). This is the generic species - the level of oak and robin. These findings cannot be explained by domain-general models of similarity because such models cannot account for why both
cultures prefer species-like groups in making inferences about the biological world, although Americans have relatively little actual knowledge or experience at this level. In fact, general relations of perceptual similarity and expectations derived from experience produce a "basic level" of recognition and recall for many Americans that corresponds to the superordinate life-form level of folkbiological taxonomy – the level of tree and bird (Rosch et al., 1976). Still, Americans prefer generic species for making inductions about the distribution of biological properties among organisms, and for predicting the nature of the biological world in the face of uncertainty.

Together, these findings suggest the generic-species level to be a partitioning of the universal (folk)ontological domains of plant and animal into mutually exclusive essences that are assumed (but not initially known) to have unique underlying causal natures. The findings intimate that folkbiology represents evolutionary design; that is, universal taxonomic structures, centered on essence-based generic species, are routine "habits of mind," which may be in part naturally selected to grasp relevant and recurrent "habits of the world." Pigeonholing generic species into a hierarchy of mutually exclusive taxa allows incorporation of new species and biological properties into an inductively coherent system that can be extended to any habitat, arguably facilitating adaptation to many habitats (a hallmark of Homo sapiens).

In the case of folkbiology, adaptationism may justifiably serve as a heuristic that guides research; however, it has no descriptive or explanatory role. Domain specificity is as far as the scientific account goes (for now). A strong adaptationist stance also helps to counter claims that folkbiology develops ontogenetically as an "exapted learning mechanism" (Andrews et al., in press). For example, in the controversy over whether folkbiology develops out of folkpsychology, or constitutes a functionally autonomous and pre-existing mode of construing the world, initial arguments focused on the fact that the structural representation of (essentialized taxonomy) in the adult state is more or less uniform across individuals and cultures. If so, it is unlikely that widely varying learning conditions are responsible for such a relatively stable and uniform state; however, evidence for developmental specificity was lacking. The recent studies cited suggest that the apparent effects of folkpsychology on developing folkbiology (e.g., anthropocentric interpretations of animals and plants) weaken or disappear for "nonstandard"
populations, that is, for any human group other than children or students linked to major research universities. One interpretation is that nonstandard societies more closely approximate ancestral conditions of intimate interaction with nature. By contrast, standard populations (the near-exclusive focus of most developmental and cognitive psychology) need compensatory learning strategies for lack of sufficient exposure to triggering conditions that enable folkbiological knowledge, including strategies derived from folkpsychology and even folkmechanics (Au & Romo, 1999).

From this vantage, the study of “standard” populations reveals more about the effects of devolutionary cultural processes on innate knowledge than about the character of innate knowledge as such – much like the study of language acquisition in feral children tells us more about how the language faculty degenerates than about how it evolved to develop (Medin & Atran, in press). Notice, though, that the evidence cited against exaptation stems from cross-cultural research. This research may be compatible with heuristic use of prior or post hoc adaptationist interpretation, but by no means requires it for description or explanation. Other aspects of folkbiology might benefit from a weak adaptationist strategy that looks at general physical and processing constraints (e.g., economy of information through taxonomic organization), as may important aspects of folkmechanics and even folkpsychology (e.g., embedding of mental states, see below).

Weak Adaptationism: The Case of Language. Strong adaptationists and weak adaptationists alike accept the premise that natural selection is the only known (noncultural) explanation for functionally complex design - a functionally complex design being one that is “workable” (Gould, 1997) or “goal-directed” (Pinker, 1997). But this doesn’t really say much. Natural complexity in itself doesn’t warrant considerations of natural selection (e.g., snowflakes, crystals, the structure of organic molecules, the fractal structure of a sea coast, etc.). A workable complex design means little more than a complex design that exists (if it weren’t workable it wouldn’t survive). A “goal-directed” complex design is more of a vaguely metaphorical anthropomorphic idea than a formalizable or testable concept of biology. Pinker (1997) uses goal-directed as a fuzzy sort of “as if” notion – as if evolution were purposely designed by an “intelligent designer” (Wallace 1889:138), blind watchmaker (Dawkins, 1986), “stupid” designer
(Williams, 1992:73), tinkerer (Jacob, 1977) or whoever. All one can really say that nonrandom biological
design is produced by cumulative natural selection of more or less random mutations.

One possibility consistent with this is that much complex design has no presently known
exploration (most human cognitive architecture, Fodor, 2001), and there may be some functional
complexity that results largely from more general physical, chemical or biological processes governing
complex systems. Such textbook adaptations as the strikingly analogous aerodynamic designs of bird and
bat wings, insect wings, and windborne seeds of certain trees (e.g., mahogany) may result chiefly from
general physical laws and mechanical processes. Similarly, hydrodynamic laws place general constraints
on the structural design of aquatic organisms, so that they tend to be bullet-shaped. Such traits as wings or
bullet-shaped bodies are adapted principally to general conditions on earth (gravity, wind, water)
distinctive of no particular environment. Talk of adaptation to “ancestral conditions” has little, if any,
meaning in such cases.

To be sure, these general constraints on the “design space” of airborne and aquatic structure and
movement are components of selective forces operating in particular environments. At each stage in the
evolution of these traits, natural selection likely produced encoding in the genes. Nevertheless, further
research into the gradual and cumulative action of natural selection on the production of wings and bullet-
shaped bodies in particular historical environments and phyletic lineages seems warranted only within the
framework of a general design space that is already clearly in view.

Take the case of language. Strong adaptationist scenarios for the emergence of language include
stories about bee dances, bird songs, fish courtship, dog barking, simian aggression displays, ape signing,
hominid tool-making, object recognition, gesturing, sensorimotor intelligence, self-awareness, food
sharing, hunting, spatial mapping, cheater detection, gossiping, social planning and so forth. Most can be
dismissed from serious consideration because they ignore panhuman structural (“design”) features of
language, such as syntactic structures. Pinker and Bloom (1990) provide the most compelling story for
language learning as a strong adaptation for communicating propositional structures over a serial channel.
Pinker and Bloom’s proposal has two parts: demonstrating biological preparedness (using “poverty of stimulus” reasoning) and inferring adaptation. The first part is widely accepted by strong and weak adaptationists. Indeed, it is a virtual tautology. As Hume stressed, the ability to “automatically” extend a few (or finitely many) instances of experience to an indefinitely large (virtually infinite) set of complexly related cases logically requires the prior existence of projecting structures that do the work of generalization. For those who accept human minds to be biological systems that evolved under natural selection (as both strong and weak adaptationists do) the issue is decided and decidedly uninformative.

But biological preparedness doesn’t imply “hence, adaptation for language learning” (as Andrews et al. in press suggest). The claims for syntax as an adaptation at best involve retrodictions of syntactic structures discovered through weak adaptationist reasoning and research (mostly through generative grammar). No novel predictions ensue. Reasonable people can argue over whether strong adaptationism provides novel predictions or discoveries for any higher-order cognitive process. Many adaptationist arguments for higher-order cognition are mere consistency arguments. They lack even the power of retrodiction because they so easily accommodate conflicting and contrary adaptationist accounts.

Finally, this one seriously strong adaptationist argument for language may be nearly circular, at least in its strongest claim that language was selected to communicate subject-predicate relations. There is no example I’m aware of indicating subject-predicate structures in any creature save language-competent humans. Even that stellar bonobo, Kanzi, consistently fails to apprehend such structures; his novel “sentences” are maximally just two concatenated arguments with no subjects, such as “chase bite,” that humans shun (Atran & Lois, 2001). So, this strongest of adaptationists proposal may reduce to: language was naturally selected to communicate what only language can formulate (propositions).

The proposal that language emerged as a vehicle for “thoughts struggling to get out” isn’t logically circular as it’s logically possible for a mind to internally represent subject-predicate relations (or any other format for structured thought) without having means to encode and externalize them (e.g., a program running on a computer with no keyboard, speaker or screen). If the claim were merely for communicating predicate-argument relations, without any argument being distinguished as the subject,
there would be some independent support by analogy (although no direct empirical test or confirmation).

First, theories of a variety of forms of information representation (relational databases, formal logic, computer programming languages) and information processing (human vision, conceptual memory, real-time reasoning) hypothesize manipulation of predicate-argument relations. Second, whatever the format, communication of information (which has evolved repeatedly in the animal and plant kingdoms) has fitness benefits when uncertainty is reduced: for example, if transaction costs for information exchange are lower than costs of individually rediscovering the information (Pinker, 1997:573).

Nevertheless, for the stronger claim that syntax is selected to communicate subject-predicate relations there may be little prospect for independent support by analogy, let alone empirical support that directly tests the argument. A syntactic subject combines a logical function (a particular thematic role, typically agent) with the pragmatic function of topic in a topic-comment structure (allowing sentences to be pragmatically linked together in discourse). According to Pinker and Bloom (1990), the grammatical subject has this character because the medium of human communication is serial and attention is finite. Because attention is finite in all animals and other forms of serial communication exist in other animals, the subject in mind must have evolved to accommodate the medium of communication, and not the other way around. But the only known case of an agent-focused thought (the logical-pragmatic subject) being structurally fit to a serial communication medium is human language. How and where the fitting process got “kick-started” is left to the dark recesses of pure speculation. “Bootstrapping” only fudges the issue.

One alternative, weak adaptationist approach assumes no direct natural selection (no task-specific adaptation to distinctive features of ancestral environments) for language’s “creative core,” that is, the faculty of syntactic recursion that allows potentially infinite production of words and well-formed word-combinations with relatively few and finite means (Chomsky, 2000). Putting aside the argument from design as too open-ended or nearly circular, this “minimalist program” operates on the (huge but bold) assumption that language’s creative core is a recently evolved accommodation to more general physical or biological processes - in ways analogous to the apparent optimization of information flow in a material medium through minimization of “wire length,” as in microchip design, nematodes and human brains
The idea is that recursion in language may be a physically optimal sort of interface (internal accommodation) between two physically suboptimal (but perhaps genetically optimal and adapted) systems of more ancient evolutionary origins: the sensorimotor system (including phonation) and the conceptual-intentional system (including categorization, reference and reasoning).

The idea of physical optimality has a distinguished tradition in natural philosophy (Galileo, Newton) and natural history (Blumenbach, A.L. Jussieu) as well as in modern cosmology (Einstein, Hawking) and in studies of biological form and development (D’Arcy Thompson, 1961[1917], Maynard Smith et al., 1985). For evolutionary biology in particular, the primary objective is to discover and predict, through strictly physical and chemical means, the set of organic forms (molecular, morphological, neuronal) that are likely to emerge from a given starting point. Only then is it worthwhile to inquire into which of those forms might be selected and how. For example, extensive sharing of genomic structure among all vertebrates, and even vertebrates and invertebrates, suggests that many of the same “master genes” program body plan and the control mechanisms of development (Gehring, 1998). Even eyes, which were thought to have evolved analogously and independently in different phyla, may be in each case a homologous derivation from the same DNA (Pax-6). Physical law and mechanical processes appear to be responsible for much of what follows: development of each component of the eye is narrowly constrained by the laws of optics and mechanical contingencies involved in sharply projecting images of three-dimensional objects onto a planar surface of receptors.

In line with Turing’s (1952) vision of biological explanation, much the same organic architecture and behavior may evolve in very different historical environments just as basically similar cognitive architectures and behaviors may be developed in very different physical media (cf. Hodges, 1983, Leiber, 2001, in press). If so, it is plausible to try to explain significant aspects of the structure and emergence of these architectures and behaviors without considering how they have been accommodated to (selected for) particular historical environments and physical media. Indeed, further understanding of particular historical and physical accommodations (e.g., the “Cambrian explosion” of multicellular organisms, the “real-time” processing of information) may depend crucially on such nonteleological insights.13
Worthiness of this approach depends on success in providing significant and surprising predictions and discoveries. In the minimalist program, these arguably (if controversially) far exceed what its originators previously thought possible (for a formalization, see Chomsky, 2001). At most, strong adaptationist arguments retrodict old discoveries. This isn’t to deny that adaptationist arguments may ultimately prove insightful into language structure; only, novel biological and evolutionary understanding of language (and other cognitive structures) may occur beforehand.

Weak adaptationist (not necessarily minimalist) investigation of language crucially uses aspects of the strong adaptationist program, especially the comparative approach (Hauser et al., in press). Thus, arguments for natural selection of phonation have involved claims about the uniqueness of categorical auditory discrimination and descent of the larynx in humans. Comparative studies prove otherwise: chinchillas and other mammalian species categorically discriminate human phones; deer and several bird species drop the larynx (possibly to exaggerate size, Fitch & Reby, 2001). Perhaps human phonation is itself a by-product of a jerry-rigged combination of other by-products and adaptations: the (originally pre-vertebrate) alimentary system and the respiratory system of terrestrial vertebrates interface at the larynx (which drops in humans), hence by chance enabling production of phones later “exapted” to language.

Other comparative studies show contrary evidence for prehominid antiquity in parts of the conceptual-intentional system. Intriguing experiments purporting to show that subordinate chimps can take the perspective of dominant chimps (Hare et al., 2001) have yet to be replicated in different laboratories (Povinelli, 2001). In any event, chimps don’t seem able to repeatedly embed states of mind: [Danny thinks that [Marc believes that [Brian knows that… Etc. Short-term memory typically limits iterated embedding of mental states to five levels (L. Barrett et al., 2002); however, as with “center-embedding” of linguistic clauses (also usually limited to under seven levels), computational machinery allows for indefinitely many embeddings. For any apparent limit, simply embed the maximal thought or phrase into the further belief or clause: “(Do) you really think that…?” or something of the sort. By giving a person more time and external memory, more embedding is interpretable in a unique and uniform way (not predicted by associationist models, connectionist or other). Other parts of the conceptual-intentional
system may be more ancient in primates, including perceptually-based reference (Gallistel 1990),
categorization (Brown & Boysen, 2000) and reasoning (Povinelli, 2000).

**Conclusion.** Combining strong and weak adaptationist strategies might be most likely to generate
evolutionary insights into human cognition. Evidentiary standards for deciding between competing lines
of research must go beyond mere consistency (which does not disallow contrary explanations), or even
retrodiction, to include surprising deductions and significant empirical confirmations. Viewing progress
in understanding the emergence of human cognition exclusively through a lens of strong adaptationism
(search first and always for the adaptation that a complex trait might represent) or weak adaptationism (if
in doubt about some adaptation as a trait’s explanation – which is usually the case - give nonadaptationist
accounts the benefit) could lead science into blind alleys. A modest use and mix of strong and weak
adaptationist insights may prove most effective in producing novel discoveries about human language and
cognition.
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Notes.

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2 For the arguments in this paper, no distinction is made between “society” and “culture, or between “mind” and “brain.”

3 For Aristotle and the ancients, the term “largest genus,” or megiston genos, applied to living kinds denoting life forms (e.g., bird, fish, quadruped) and not genera in any recognizable modern sense (Atran, 1987b). No principled distinction between biological genus and species existed until Europe’s Age of Exploration. To manage the order of magnitude increase in information, J.P. Tournefort (1694) attached some 6000 newly discovered species to 600 European types (i.e., the type species of the new genera) (cf. Raven et al., 1971). A geometrical rate of exploration and discovery soon undermined the taxonomic priority of the genus, and attention turned to the family level, intermediate between genus and life form. The family was itself rooted in local groupings that native folk implicitly recognize but seldom name, such as felines, equids, legumes, umbellifers. The ancients called these eide anonyma or genera innominata. A local series of such groupings does not fully partition a local environment, but is instead riddled with gaps. A strategy emerged for closing the gaps: Looking to other environments to complete local gaps, naturalists sought to discern a worldwide series that would cover the lacunae in any and all environments. Linnaeus (1751) dubbed this strategy “the natural method” for completing “family fragments.” A.-L. Jussieu (1789) reduced the thousands of genera proposed since Tournefort to exactly 100 families, but acknowledged this number to be based more on convenience than necessity. Jussieu’s families became the standards of modern plant taxonomy. Extending the « méthode naturelle » to animals, including humans, Buffon (1774-1789) identified family plans as lineages of temporally related species. This was crucial to evolutionary thinking by Lamarck and Darwin. Although Enlightenment taxonomy kept biology tied to a readily visible world of species, genera and families, it provided a
cognitively expedient morphological framework for initial exploration of the causal relations and history of species. Darwin (1859) used all levels of folk taxonomy: from folk specifics (e.g., poodle) and varietals (toy poodle) whose variation humans had learned to manipulate, to intermediate-level families and life-form classes, such as bird. For example, he described the family affinity of Galapagos bird species to those of continental America, as “manifest in every character…. So it is with other animals, and with a large proportion of plants…. Facts such as these admit of no sort of explanation on the ordinary view of creation.” The heuristic value of folk-based taxonomic strategies for scientific inquiry remains compelling (cf. Labandeira & Sepkoski, 1993), despite awareness that no "true" distinctions exist between various taxonomic levels.

4 The Ross et al. (in press) experiment with Boston-area children replicated Carey’s (1985) earlier findings with Boston-area children in relevant respects but gave different results for Native and rural majority-culture Americans.

5 By “(folk)ontological” is meant the apparent structure of the world that panhuman cognitive structures – especially domain-specific ones – intuitively (and to some extent, innately) present us with.

6 « Exaptation » (Gould & Vrba, 1982) is a modern rendition of Darwin’s concept of « pre-adaptation ». It is a pre-existing trait that has already evolved (e.g., feathers for insulation) but which acquires a new functional effect (feathers for flight) without being naturally-selected for this effect. Still, an exaptation may be subsequently modified by selection in response to environmental challenges associated with the coopted effect (into bird wings). By extension, an « exapted learning mechanism » (Andrews et al. in press) evolved in association with a specific cognitive trait to allow the organism to modulate its response to the changing environment in that trait’s domain; however, the mechanism also develops traits that perform tasks not originally intended. These developed traits may “perform new tasks with specificity and proficiency and the traits may even exhibit complex design for those tasks,” that is, domain-specificity.

7 It’s curious that some scientists who reject poverty-of-stimulus arguments for more specialized cognitive systems also routinely accept Humean arguments for general concepts, such as causality or
similarity, and for noncognitive biological systems, such as the growth of an embryo to a fish or chicken. This is so despite the fact that the evidence in favor of poverty-of-stimulus arguments is, if anything, even more readily apparent for specialized cognitive systems (e.g., a young child’s spontaneous ability to produce and understand infinitely many well-formed sentences or thoughts). This peculiar form of dualism is alive and well among many anthropologists, psychologists and even biologists.

This excludes – perhaps artificially - “lower-order” cognitions related to sex, kinship and violence.

Perhaps the most celebrated example of a higher-order cognitive adaptation in evolutionary psychology is the alleged “social exchange algorithm” (Cosmides, 1989), or “cheater-detection module” (Gigerenzer & Hug, 1992), adapted as a “domain-specific” system of representation and inference (Fiddick et al., 2000).

These claims are based entirely on results obtained from the Wason Selection Task, which may be hopelessly incapable of yielding results that could distinguish speculations about cheater detection from any number of alternative and contrary speculations (Sperber et al., 1995, Atran, 2001b). Adaptationist reworking of Kahneman and Tversky’s “biases and heuristics” may have a bit more to offer. According to Cosmides and Tooby (1996), Kahneman and Tversky wrongly portray people as poor intuitive statisticians (Bayesian probabilists), although good Bayesian judgements are readily elicited in standard subjects when information is given in a frequency format. Yet, Kahneman and Tversky show support for Bayesian reasoning in at least some contexts (e.g., for the conjunction fallacy). Moreover, it remains unclear how and when people attend to frequencies (relative or absolute) involving large numbers, or even whether people in some cultures count past four (Susan Carey, personal communication, on South American tribals that distinguish few from many claps but not, say, 15 from 16 or 28 from 32).

A fundamental principle of (pre-minimalist) generative grammar to which Pinker and Bloom adhere is the “theta criterion,” which applies to the arguments of a sentence. Each argument must be assigned a theta role, and each theta role must be uniquely associated with one and only one argument. Theta roles are assigned to noun phrase positions in a sentence, such as the subject and object in a transitive sentence. In a typical transitive sentence the predicate has two arguments. One of the arguments is assigned an
agent role and the other argument is assigned a patient role by virtue of the noun-phrase positions these arguments occupy. The theta criterion excludes the following structures as paradigms for possible human sentences: an agent without a patient, such as “*I hit.” (meaning “I hit something”); or a patient without an agent, such as “*Hit a dog.” (meaning somebody hit a dog); or a patient role associated with two arguments, such as “*The man hit a dog a cat.” (meaning “The man hit a dog and a cat”), and so forth.

No currently available information on extinct hominid brains or behaviors seems pertinent to these issues. There has been much speculation that the growth of specialized structural-functional systems under niche-specific selective pressures was responsible for human big brains. Alleged support comes from partial hominid endocasts that overlap with language-focused regions in the human brain, from evidence of tool-making behavior, from enlargement of camp size, and so forth (on language as a key factor, see Holloway, 1983, Barber & Peters, 1992). But comparison of allometric data for 131 mammalian species indicates only a generalized covariation in the scaling up of brain and body structures (Finlay et al. 2001). Absolute brain size predicts sizes of specific brain components by a nonlinear function. If hominid cortical structures expanded in tandem, there may be no way of discriminating between those brain structures that expanded in response to task-specific cognitive challenges and those that expanded regardless of selection pressures.

Peter Carruthers, personal communication, 5 November 2002, on why Pinker’s strong adaptationist view of language isn’t circular (as Atran, in press, suggests).

Steven Pinker, personal communication, 8 November 2002, on why his proposal isn’t circular.

Elimination of teleology (with its intentional and anthropocentric overtones) from explanation in biology – except as a possible heuristic – goes back to Kant, and perhaps Aristotle (at least for efficient causal explanation). Perhaps because natural selection involves a good deal of apparently lawless “accident,” recourse to teleology is a way of getting a handle on things in evolutionary (as opposed to molecular) biology.
Recent studies identifying multiple genetic loci for language disorders and delays seem to belie any single mutation account for language. Moreover, at least one of these genes seems to have been a target for selection, although the gene at issue (FOXP2) concerns speech and processing of morphology rather than syntactic recursion (Enard et al., 2002).

Noam Chomsky, personal communication, 27 October 2002, referring to center-embedding experiments he performed with George Miller in the early 1960s.