Comment on: "Natural language and natural selection",
by Steve Pinker & Paul Bloom

Toward an adaptationist psycholinguistics

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Could and Lewontin (1979) have intimated that the biological and behavioral sciences are infused with Panglossian adaptationism. If only it were true, the state of our knowledge – especially in cognitive psychology – would be decades ahead of where it is now. Better still, of course, would be a community of sophisticated adaptationists, such as Pinker & Bloom (P&B): a community of scientists who are mindful that every aspect of a phenotype is either an adaptation, a concomitant of an adaptation (a spandrel), or noise; who understand that all adaptations were built out of a substrate of earlier designs; and who know how to apply the logic and standards of evidence of evolutionary functionalism. Unfortunately, those who investigate with an adaptationist eye are rarer than pandas' thumbs, so most areas of psychology are lost in a sea of proximate theories, antifunctional quasitheories, and unframed and mute observations. It is a powerful testament to the eloquence of Gould and Lewontin that the single most important and well-documented explanatory principle in biology – adaptation – has become a dirty word outside of evolutionary biology, where it has come to be regarded as intrinsically post hoc and imprecise. Yet the concept of adaptation has a rigorous logical foundation, with stringent standards of evidence resting on probabilistic analyses (Dawkins 1986; Williams 1966). And although most cognitive psychologists are unaware of it, every time they discuss the function of a mechanism, they are automatically invoking the concept of adaptation, which entails these exacting standards. It is time they understood the rules that evolutionary biology places on functional explanation, so as not to invoke functionality – or claims of its absence – sloppily.[1] The injection of stringent adaptationism will not dilute a disciplined field with vacuous post hoc theorizing: Instead, it gives the concept of function specific and rigorous content that is otherwise lacking. And, correctly used, evolutionary functionalism provides crucial theoretical guidance that can help cognitive scientists discover the design features of complex cognitive architectures.

The vigorous proliferation of misinformation about adaptation and natural selection is attributable in part to the intuitions created by the types of data researchers in various fields confront. It is no accident that, for example, paleontologists (such as Gould) and geneticists (such as Lewontin) find the concept of adaptation strained and exotic in most specific psychological applications. Adaptations are complex interdependent systems that interact in intricate ways with the complex particulars of environments to produce functional outcomes. These components are lacking from the data paleontologists recover. Paleontologists deal with the few parts of a complex interdependent system that happen to fossilize, rather than with the complex system itself. Moreover, the environment that the system was designed to interact with has vanished beyond reconstruction. So the data paleontologists encounter are stripped of almost anything that would allow them to think profitably in adaptationist terms; consequently they mistakenly conclude that natural selection is an overrated concept that played little role in the history of life (see Gould 1989b). Geneticists are similarly insulated from data that could be structured with adaptationist concepts. They confront the raw code or else the population level statistical properties of genetic variation (largely noise), rather than the complex functioning system that that code creates. Someone who, not knowing its function, examined a computer program in machine language might equally well conclude that the sequence of 1's and 0's was random. [See Searle: "Minds, Brains, and Programs" *BBS* 3(3) 1980.]

But, like physiologists, cognitive psychologists do look at the functioning of complex architectures, embedded in structured task environments, which either succeed or fail at solving intelligible problems. Because the only scientifically coherent account for the origin of any complexly organized functionality is (ultimately) evolution by natural selection (Dawkins 1982; 1986; Williams 1966), cognitive psychology is a field whose central

phenomena must inevitably be not only explained by selectionist analyses, but illuminated by them as well. All (nonchance) functionality is ultimately attributable to the operation of adaptations – that is, naturally selected innate aspects of the cognitive architecture. Cognitive science and the adaptationist branches of biology are natural intellectual companions and should start exploiting their connections. For this reason, cognitive psychologists can find in a careful and reasoned adaptationism a productive addition to their other analytical tools – if they can be exposed to it in a sophisticated, rather than a bastardized, form. That is why the target article is such a keen pleasure to read: P&B have found their way through a briar patch of rhetorical obfuscation to an impeccable understanding of the core of modern Darwinism. They know which parts of evolutionary biology are relevant to disputed issues in cognition and what their implications are, and have gone on elegantly to dissect the most common prevailing confusions.

P&B's central contention seems inescapable: Given any sensible analysis of the probabilities involved, a system with so many complexly interdependent subcomponents that together interact to produce complex functional output cannot be explained as anything other than an adaptation, constructed by the process of natural selection. Still, language itself is so large and elaborated a system that any precise characterization of the total constellation of selection pressures acting on it over evolutionary time is beyond our present ability to analyze in detail (that is, we seem to be limited to the kinds of global characterizations about adaptive function that P&B make). What then? Recognizing that the language faculty is an adaptation to communication may seem obvious and relatively unilluminating, but it is, in fact, a pivotal step. P&B's demonstration opens the door to a set of promising approaches to psycholinguistic problems: If the language faculty is an adaptation, then its component mechanisms are adaptations also – organized systems that accomplish specific functional ends subserving language production, perception, and comprehension. Psycholinguistics itself can become an adaptationist discipline, by characterizing how the functional design of each mechanism and subsystem solves its particular family of problems. The selection pressures on these component systems are considerably easier to analyze, so the parts will be far more open to lucid dissection than the whole. For example, the task demands on speech perception are considerably easier to find than the total array of uses language has been put to over evolutionary time. Analyzing these selection pressures should allow psycholinguists to discover previously unknown mechanisms and design features.

Not being psycholinguists ourselves, we hope we can communicate, by using traditional examples, the kind of adaptationist reasoning that can help psycholinguists, without requiring them to take the details of our proposals too seriously. Aside from realizing that organisms consist largely of collections of adaptations (problem-solvers), the central tool of adaptationist reasoning involves a recognition of what an adaptation is. Briefly, natural selection coordinates (1) a system of innate (i.e., reliably developing) properties in the organism, with (2) a set of structural properties outside the adaptation (often, but not always, in the "outside world") that recur across generations, in such a way that (3) the interaction of the two produces a functional outcome that ultimately contributes to reproduction (i.e., that solves a problem for the organism). For example, the design features of the digestive tract allow it to interact with the chemical properties of food to produce a functional outcome – the extraction and transport of nutrients to the circulatory system – that contributes to reproduction. To function, adaptations are selected to assume the presence of, to rely on, and to exploit stable and enduring structural and statistical regularities, both in the environment (Shepard 1987) and in other aspects of the phenotype. Just as the design of digestive mechanisms for breaking down starch are more easily discovered if one has identified the chemical properties of starches, the design features of the language faculty will be more easily discovered if one has identified environmental and phenotypic regularities that it can use.

For language – or any other mode of human communication – these regularities include (1) other aspects of the phenotype that the language faculty is embedded in, (2) the recurrent (i.e., innate) architectures of other humans, (3) the patterned behaviors these architectures generate, and (4) the relationships between these behaviors and the situations in which they are generated. The design features of language adaptations should exploit these regularities to solve adaptive problems. For example:

Language acquisition device. Chomskyans have long argued that the innate procedures of a child's language acquisition device (LAD) depend on stable and enduring species-typical regularities of the grammar-producing mechanisms of adults. Many grammars can, in principle, generate whatever subset of adult language the child hears; the child must induce which of these grammars in fact generated that sample. This cannot be done unless the design features of the LAD place constraints on the child's hypothesis space that reflect actual adult grammar. The Chomskyan argument is inherently adaptationist: Nothing, apart from selection, can endow the LAD with just those innate specializations necessary to supply the information regularly missing from adult speech samples, coordinating the two so that the local adult grammar can be uniquely determined.

Semantic bootstrapping. The semantic bootstrapping hypothesis (Grimshaw 1981; Macnamara 1982; Pinker 1982) about how children initially recognize syntactic categories depends on (1) statistical regularities between the aspects of a situation that adults talk about in their speech to or in the presence of children and children's own construal of such situations, and (2) lawful contingencies between the semantic categories that compose such construals (object, action, attribute, spatial relation) and syntactic categories such as noun, verb, adjective, and preposition.

Speech perception. The innate specialized mechanisms involved in speech perception (in the likely event that they exist) should have been selected to reflect and exploit the statistical regularities and universal properties of pronunciation and word formation across human languages, which will in turn derive from such factors as the properties of the articulatory apparatus. For example, microvariation in articulation will lead to a statistical correspondence between meaning and sound that are produced by similar articulatory gestures, rather than between meaning and acoustical similarity. Selection should therefore have designed perceptual systems that categorize by acoustic cues that reflect similarity of articulatory gesture, rather than by overall acoustical similarity; observation suggests that this is the case (e.g., Liberman et al. 1967; one need not invoke the hypothesis that one models the articulatory apparatus, simply that the dimensions of categorization reflect patterns produced by the articulatory apparatus).

Semantic analysis. Children, like cryptographers, can decode messages only because they have a priori statistical knowledge about likely messages. The child's task of discovering the meanings of words involves isolating, out of an infinite set of possible meanings, the actual meanings intended by other speakers. To solve the problem of referential ambiguity, the child's procedures for semantic analysis can depend on the fact that our universal innate psychological architectures impose on the world enough standard and recurrent interpretations between speaker and listener to make the deduction of a core lexicon possible. The system for assigning semantic meaning to arbitrary signs can rely on the presence of an immensely articulated and detailed collection of human information-processing mechanisms: on specialized mechanisms that are activated in the mother early in the child's development; on mechanisms that

reliably identify evolutionarily recurrent situations (such as threat, play, or eating) in such a way that all participants have similar construals of the situation and responses to it, including things likely to be said about it; and so on. For example, emotional expressions obviously function as cues that assign standardized meanings to the contingent elements of situations. Similarly, domain-specific reasoning procedures such as social contract algorithms (Cosmides 1989; Cosmides & Tooby 1989) have both intrinsic definitions for the terms used by their procedures and cues for recognizing which elements in recurrent situations correspond to those terms. These evolved reasoning specializations may function as nuclei around which semantic inference is conducted. They may also assist semantic bootstrapping, relating syntactic and semantic elements through providing interpretations of the situation that the child is witnessing.

"Needs" and pragmatics. Most cognitive psychologists do, and all should, understand that innate architecture is a necessary part of any coherent psychological theory. Every psychological claim should specify (1) what innate equipment is involved, and (2) what environmental variables, in mechanistic interaction with the innate (or innately derived) equipment, produce the phenomenon to be explained. It is magical thinking to believe that the "need" to solve a problem automatically endows one with the equipment to solve it. For this reason, the invocation of social or practical "needs," pragmatic factors, acquired heuristics, or "functionalist" hypotheses to explain language acquisition need to be reformulated in explicitly nativist terms. It may be that the phenomena motivating empiricist arguments are generated by innate microspecializations that depend on subtle statistical regularities (perhaps the first words parents try to teach infants are basic object level names; perhaps the first transitive verbs involve interpersonal action – Mary hit John – and so on). The child cannot use such relationships unless some mechanism in the child is designed either to exploit them specifically, or to exploit a more general class that includes those relationships. To hijack Ramachadran's comments on perception (1990, p. 24), such phenomena as language acquisition, speech perception, and speech comprehension operate through

> "a 'bag of tricks'; . . . through millions of years of trial and error, the [language faculty] has evolved numerous short-cuts, rules-of-thumb and heuristics which were adopted not for their aesthetic appeal or mathematical elegance but simply because they *worked* . . . . This is a familiar idea in biology but for some reason it seems to have escaped the notice of psychologists, who seem to forget that the brain is a biological organ just like the pancreas, the liver, or any other specialized organ."

NOTE

1. Adaptationist analysis can be and often is performed ineptly, but that is true of every analytic tool. Many psychologists have the mistaken impression that adaptationist arguments must meet standards of evidence, but that "spandrelist" arguments need not. But a spandrel is a *byproduct* of an *adaptation.* To demonstrate that a phenotypic property is a spandrel, one must first state what adaptation it is a byproduct of, then demonstrate that that adaptation is, in fact, an adaptation, and, finally, demonstrate that the proposed "spandrel" is, in fact, a byproduct of that adaptation. For example, if one proposes that the ability to acquire a human language is a spandrel of general purpose learning mechanisms, one must state exactly what those general purpose mechanisms are, show that they exist, demonstrate that they are adaptations, and then demonstrate that these general purpose mechanisms can, in fact, allow one to learn language (through, for example, a learnability analysis; see Pinker 1984; Wexler & Culicover 1980). It is currently fashionable in some circles to believe that everything is a spandrel and to eschew the concept of adaptation – yet every time one calls some property of the phenotype a spandrel, one is claiming that some other property of the phenotype is an adaptation. "Naive spandrelism" is every bit as conceptually weak as "naive adaptationism," lacking only the latter's sporadic virtue of prompting insights about functional organization.

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