bution to this effort by showing generative linguists how to break out of the straitjacket of syntactocentrism by integrating their work into a rich multi-modal architecture.

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Language evolution without evolution

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Abstract: Jackendoff's major syntactic exemplar is deeply unrepresentative of most syntactic relations and operations. His treatment of language evolution is vulnerable to Occam's Razor, hypothesizing stages of dubious independence and unexplained adaptiveness, and effectively divorcing the evolution of language from other aspects of human evolution. In particular, it ignores connections between language and the massive discontinuities in human cognitive evolution.

I approach Jackendoff's ambitious and many-faceted *Foundations of Language: Brain, Meaning, Grammar, Evolution* (Jackendoff 2002) as an unashamed syntactocentrist. Jackendoff, however, is far from being that, and the main example he picks to illustrate syntactic relations could hardly have been better chosen had he deliberately intended to marginalize and trivialize syntax:

(1) *The little star's beside the big star.*

This sentence, first analyzed on pages 5 through 6, is returned to repeatedly throughout the text.

But, copular sentences like (1), sentences with the verb "to be," form a small and highly idiosyncratic subset of sentences; their properties differ sharply from those of the vast majority of sentences. The latter describe actions, events, or a variety of states, and deploy a rich variety of argument structures; copular sentences express only identity, location, or the attribution of qualities (The rose is red/in the vase/a Molly Perkins) and take only a *theme* argument. In a non-copular clause, no two noun-phrases will have the same referent (unless a specifically reflexive form such as himself is used), and transposition of noun-phrases inevitably changes meaning:

(2) a. *John hit the captain.*
b. *The captain hit John.*

In copular clauses, no two noun-phrases will have different referents; consequently, transposition of noun-phrases inevitably leaves meaning unchanged:

(3) a. *John is the captain.*
b. *The captain is John.*

There are many more syntactic relations that can't be illustrated via copular sentences, too many to list here. Perhaps in his response to commentary Jackendoff will tell us why he chose such an atypical sentence as his prime syntactic exemplar.

Much more could be said about Jackendoff's treatment of syntax, but I must reserve the bulk of this commentary for his chapter on language evolution. Right off, Jackendoff confuses the issues with a straw-man version of "the common view of Universal Grammar" (p. 233). According to him, that view treats phonology and syntax as "passive handmaidens of syntax" that could not, therefore, have evolved prior to syntax. But syntax without phonology and semantics would be useless, so this view is absurd.

In fact the current status of semantics and phonology (whatever that may be) carries no entailment for their order of evolution. No one disputes that apes and hominids had some sort of conceptual structure, therefore semantics (in some form) had to precede syntax (indeed, this is made quite explicit in my own writings, from Bickerton 1990 on). As for phonology, this (at least in some primitive form) was presumably present in protolanguage, which had no syntax. But the emergence of syntax selected for a sophisticated phonology, while the capacity to assemble semantic units into complex propositions radically expanded conceptual structure.

Jackendoff then turns to the proposal of Bickerton (1990) that language developed in two steps, an asyntactic protolanguage and syntacticized modern language, and instead opts for "a more graceful, incremental evolution" (p. 236). But are the incremental stages he proposes really stages at all?

Take the three stages: (1) "use of symbols in a non-situation-specific fashion," (2) "use of an open, unlimited class of symbols," and (3) "development of a phonological combinatorial system" that supposedly intervene between an alingual state and protolanguage. No real difference exists between the first two. A symbol freed from the here and now has to be cultural rather than biological; if you can invent one, you can invent an unlimited number. A protolanguage adequate for the needs of hominids two million years ago wouldn't have needed many. Nothing suggests that an insatiable demand for new symbols would have driven the emergence of a phonological combinatorial system.

As Jackendoff is well aware, at least one current framework (Optimality Theory) proposes "a united grammatical framework for syntax and phonology" (Smolensky 1999). Whether or not one buys the theory itself, it seems highly likely that language's two combinatorial systems came in together, perhaps exploiting some single underlying capacity, but more likely with phonology employing mechanisms derived directly or indirectly from syntax. This pushes the third of Jackendoff's stages to a post-protolanguage position.

"Concatenation of symbols" is supposed to constitute another intermediate between call systems and protolanguage. But since "language-trained" apes appear to have concatenated symbols with no explicit training and minimal modeling, why is this stage not implicit in the development of symbols? And why invoke, as a distinct stage, "use of symbol position to convey basic semantic relations"? In every variety of protolanguage I know of, such use is not principle-based but merely a statistical tendency. The real evolution in language was not from unordered symbols to regularly ordered symbols to modern syntax. It was from concatenation in linear strings to concatenation in hierarchical structures (Bickerton 2002). Between these two types there is no intermediate, therefore, not even the possibility of a gradual evolution from one to the other.

Regarding post-protolanguage changes, I have already conceded (Bickerton 2000, sect. 4) that the original two-stage model has to be supplemented by a third stage, the grammaticization of a morphologically bare syntax to enhance parsability. I see no point in arbitrarily dividing this third stage into several sub-stages, as Jackendoff does in his Figure 8.1, especially as Creole languages quickly create both grammatical (albeit unbound) morphology and symbols encoding semantic relations through demotion of regular lexical items. Moreover, each hypothetical stage requires its own selectional history; it will not do merely to suppose that any improvement in a system is automatically selected for.

Whatever its defects, the three-stage model sought to ground itself in known human-evolutionary developments and anchor itself at least provisionally in time. Jackendoff rejects these constraints (explicitly, in the case of time) in the belief that they "make little difference" (p. 236). I'm sorry, they make a lot of difference.

The most striking fact about human evolution is the massive cognitive and behavioral difference between our species and all antecedent species. Moreover, most writers agree that language was strongly contributory to, if not wholly constitutive of, that difference. But if language was evolving gradually over a long period, as Jackendoff's account implies, then why did improvements in language yield no apparent changes in cognition or behavior until the last hundred thousand years?

The gross mismatch between the archaeological record and any gradualist account of language evolution is something that linguists and nonlinguists alike have been studiously avoiding or

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evading ever since I pointed it out more than a decade ago (Bickerton 1990). The cognitive discontinuity between humans and prehumans precisely mirrors the linguistic discontinuity between linear and hierarchical concatenation. Can this be mere coincidence?

Whether it is or not, any gradualist account of language evolution that does not even try to explain why, if language evolved gradually, human cognition and behavior did not evolve equally gradually has little explanatory value. I do not wish to single out Jackendoff in this respect. He himself says, "I see no need at the moment to hold myself to a higher standard than the rest of the field" (p. 237). But if somebody doesn't do just that, we might as well give up on language evolution.

Why behavior should matter to linguists

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Abstract: Jackendoff's *Foundations of Language: Brain, Meaning, Grammar, Evolution* has many points of similarity with Skinner's analysis of verbal behavior, though the former emphasizes structure whereas the latter emphasizes function. The parallels are explored in the context of a selectionist account of behavior in general and of verbal behavior in particular. Part of the argument is that behavior drives evolution and therefore also drives brain organization. Another concerns itself with the nature of explanation. Recent experimental developments in behavior analysis are reviewed as potential contributions to an understanding of language that incorporates its functional as well as structural dimensions.

It is easy to see where the constructive collaboration Jackendoff invites in his Preface (Jackendoff 2002) can be offered; but to present the relevant material within brief compass is hard. Despite many affinities outlined below, I argue that more is to be gained by focusing on how linguistic structures can be illuminated by behavioral functions than by using linguistic structures to illuminate hypothetical brain mechanisms.

It helps that Jackendoff places his account firmly within an evolutionary context, because evolution is driven by behavior. Whether an organism survives and reproduces depends on what it can do and the conditions under which it does it. Its environment consists not only of the physical world but also members of its own and other species. Its brains and muscles and other organ systems all evolved in the service of its behavior. Therefore, it is a reasonable proposition that behavior drives brain structure, not only through evolutionary contingencies that select behaving organisms with certain kinds of brains, but also through environmental contingencies that shape different patterns of behavior and alter brains within the lifetimes of individuals. Jackendoff acknowledges this when he states that "perceptual systems have evolved in order that organisms may act reliably in the real world" (p. 308).[1] But if behavior drives brain organization, behavior is the place to start (Catania 1972; 1995b; 1997; Catania & Harnad 1988; Skinner 1988).

Let us first dispose of some common misconceptions. Behavior is not defined by muscle movements or by glandular secretions. It is defined by function rather than form. Shifts of attention are behaviors, for example, even without overt movement; what matters is that they are modified by their consequences. So, also, are seeing and looking. You can look without seeing and see without having looked; both are subject to contingencies and either can occur in the absence of visual stimulation (Jackendoff calls these actions *percepts,* as in his bug example on pp. 311–12, but thinking of them as actions rather than states has advantages).

In biology, studies of structure and function are respectively called anatomy and physiology. Their priorities were once an issue (Russell 1916). Behavior also has both structure and function. For example, when a horse runs, muscle flexions combine to produce coordinated leg movements that change with shifts from one gait to another. All gaits, either natural (trotting) or trained (the rack), are constrained by neurophysiological and mechanical factors and constitute a grammar of the horse's running. But that grammar is orthogonal to function: for example, when and where the horse runs; with which gait; what consequences follow. As organs differ in anatomy and physiology, so also varieties of behavior differ in what they look like and what they do. A horse may overtake another at lope or gallop, and gallop in overtaking others or in escaping from predators. In the former, actions of different form have similar functions; in the latter, actions of similar form have different functions. Language too has both structure and function.

Beyond the structure-function distinction is the issue of selection. Within individual lifetimes behavior is selected by its consequences, much as organisms are selected over generations by evolutionary contingencies. Operants, classes of behavior selected by their consequences, are fundamental units of behavior defined by function. All operants participate in three-term contingencies in which discriminative stimuli set occasions on which responses have consequences (e.g., at traffic intersections, the consequences that follow from stepping on the gas or the brakes vary with the colors of the traffic lights). Parallels between natural selection in phylogeny and in ontogeny have been explored in detail (Catania 1973a; 1973b; 1987; 1996b; Skinner 1935; 1938; 1981; Smith 1986). Behavioral accounts are often identified with S-R associations, but behavior analysis is a selectionist rather than associationist account (for a more detailed discussion, see Catania 1998; 2000).

The poverty of the stimulus (Chomsky 1959; Crain 1991) takes on a different aspect in the context of selection. The selection of operant classes by their consequences does not depend on extensive sampling of negative instances. Consider the evolutionary analogy: Populations are not selected from pools exposed to all possible environments, and not all variations are included in the pools upon which selection operates. It remains reasonable to consider structural constraints on what is selected, but those constraints do not negate genealogy. As Darwin made abundantly clear, both structure and function must be viewed through the lens of selection.

Other biological analogies are also relevant. For example, organisms have been characterized as theories of their environments. Jackendoff exemplifies this view when he pushes the world into the mind. But it is a risky move (Andresen 1990), and parallel moves in biology have not fared well. For example, genetic material is no longer said to carry blueprints of organisms, nor does it reveal properties of the environments within which it was selected; it is instead best regarded as a recipe for development (Dawkins 1982). It is, similarly, a useful move to think of what is remembered as a recipe rather than a blueprint for recall.

With these preliminaries, let us compare Jackendoff and Skinner. In this undertaking, it is on the one hand not reassuring that Jackendoff disposes of behaviorism with a 1913 reference to John B. Watson (p. 280) and comments on Skinner only in passing without citation (p. 372). On the other hand, it is intriguing that so many of Jackendoff's distinctions and categories have clear parallels in Skinner's (1957) account. Both present modular systems and their modules are necessarily heterogeneous (cf. Jackendoff 2002, p. 160). Both consider how the modules can arise and how they are coordinated with each other. When Jackendoff says "reading, for example, acts like a module in an accomplished reader, but it requires extensive training for most people in a way that the phonology-syntax module does not" (p. 227), he parallels Skinner's textual, tact and echoic classes of verbal responses. Consistent with the status of operant classes, Skinner's modules are based on considerations of function rather than form: "we cannot tell from form alone into which class a response falls" (Skinner 1957, p. 186).

Both Skinner and Jackendoff wrestle with the problem of defining verbal classes in terms of reference or meaning or environ-

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