Adequate scenarios for language evolution must take into account these three varieties of selection. Each requires variations among the units upon which it operates; each entails different mechanisms by which environments select surviving variants. Biological contingencies must select requisite physiological attributes (e.g., vocal tract structure, neural organization). Ontogenetic contingencies must maintain the features of languages acquired by individuals. Cultural selection must perpetuate language practices across generations. E&L's discussion of language diversity nicely accommodates these processes, because it allows for substantial ranges of variation while still showing how languages can be maintained within and across generations.

These different varieties of selection often complement one another, but selection at one level may oppose selection at another. For example, behavior selected through ontogenetic processes during an individual's lifetime may reduce the individual's reproductive fitness at the phylogenetic level (consider substance abuse or sexual behavior involving partners at risk for AIDS).

Although they do so sparingly, and typically only implicitly, E&L sometimes discuss language as a container of meanings or of other content expressed in words and sentences. The conduit metaphor of language is pervasive but too often misleading (Reddy 1979). Assuming that language expresses or contains something transmitted from one individual to another raises some of the same difficulties as the assumption that genetic materials transmit information. Dawkins (1982) made that point when distinguishing between blueprints and recipes in characterizing genetic materials, which do not contain body plans or other information about the organism that will be their product. Rather than blueprints, they are recipes for development; the relevant information is not about past selective environments or about the way mature organisms will interact with their environments. A parallel distinction is relevant to language and has implications for language evolution. Words are not carriers of meanings or schemas or other information relevant to the selective environments that engendered them; we should look at words not in terms of what they contain but rather in terms of what they do (Catania 1987). Of all that they can do, one irreducible function of language is providing a mechanism by which one individual can change the behavior of others. This alone may be a sufficient basis for the origins of language. Other functions of language (e.g., communication, calculation, narrative, truth) may then be its derivatives.

I was surprised that E&L did not mention Chomsky's argument from the poverty of the stimulus (Chomsky 1965), because claims that the relevant structures cannot be found in the environmental contingencies justify the reification and internalization of language universals. The argument that children learn grammatical structures even in the absence of examples of negative instances seems to assume that learning any distinction requires exposure to all possible negative exemplars. But, for example, a bird raised in monochromatic light does not discriminate among wavelengths. Yet after learning to discriminate between the original wavelength and just a single new one not seen before, the bird responds in an orderly way to wavelengths across the entire visual spectrum (Terrace 1975). Similarly, any verbal environment including contrasts between several grammatical structures provides the differences on which learning can be based: for example, both active and passive voice are grammatical but provide a contrast that may enable later discrimination of grammatical versus ungrammatical.

Of course, these outcomes tell us about the structure of the underlying continua (the orderliness of the color continuum could be described as its universal grammar). But with regard to grammatical dimensions, those structures are so highly variable across languages, as E&L so aptly argue, that it would be as reasonable to assume that they are driven by language cultures within lifetimes in social environments as that they are driven by brain structures evolved over biological time (Catania 2008; Moerk 1992). This is consistent with evidence that rich verbal environments in which parents spend lots of time interacting verbally with their children make vast and lasting differences in their verbal competence, as measured by vocabulary growth rate, school performance, and IQ scores (Hart & Risley 1995). Verbal environments matter.

The myth of language universals and the myth of universal grammar

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Abstract: Evans & Levinson (E&L) argue that language universals are a myth. Christiansen and Chater (2008) have recently suggested that innate universal grammar is also a myth. This commentary explores the connection between these two theses, and draws wider implications for the cognitive science of language.

It has been widely argued that an innate Universal Grammar (UG) must be postulated to explain two key observations: first, that languages share putatively "universal" patterns, which appear arbitrary from a functional, communicative point of view; and second, that children acquire language so readily from an apparently impoverished linguistic input (the "poverty of the stimulus" argument).

The second point has been the subject of considerable recent interest, with many theorists arguing that linguistic input is richer than has previously been suspected (e.g., Pullum & Scholz 2002; Reali & Christiansen 2005) or that modern learning methods are richer than is often presumed (e.g., Chater & Vitányi 2007; Harman & Kulkarni 2007). The first argument, based on language universals, has gone relatively unchallenged in the cognitive science literature – but no longer. Evans & Levinson (E&L) provide powerful evidence that language universals are myth rather than reality, and hence, that this line of defense of UG is swept aside. It remains to be explained, though, how languages came to display such stunning diversity, and this is where research on language evolution may offer some insight.

We have recently argued (Christiansen & Chater 2008) that an innate UG is not merely poorly evidenced, but indefensible on evolutionary grounds. Specifically, we argue that the cultural variability of language provides a "moving target," which changes too rapidly to support the biological adaptation that would be required to lead to an innate UG (Chater et al. 2009). Thus, language is best viewed as the product of cultural evolution, not biological evolution (Christiansen et al., in press).

The cultural evolution of language does not, of course, take place in a biological or social vacuum, but rather, is shaped by multiple constraints. One type of constraint derives from the nature of the thoughts that language expresses. For example, whatever the nature of our mental representations, they apparently afford an infinite range of different thoughts, promoting the likely emergence of compositionality in language (Kirby 2007). Linguistic structure is also shaped by socio-pragmatic principles relating to the communicative function of language;

for example, as embodied by Gricean implicatures (Grice 1967). A further source of constraints on language evolution derives from the operation of our perceptuo-motor apparatus, which, for example, enforces substantial seriality in both spoken and signed languages. Similarly, cognitive limitations on learning, processing, and memory also provide strong constraints on linguistic structure; for example, our limited working memory promotes a general tendency to resolve ambiguities as quickly as possible in both linguistic (Clark 1975) and perceptual input (Pomerantz & Kubovy 1986).

Individual languages are seen as evolving under the pressures from these constraints, as well as cultural-historical factors (including language contact and sociolinguistic influences), resulting over time in the kind of linguistic diversity described by E&L. Cross-linguistically recurring patterns do emerge due to similarity in constraints and culture/history, but such patterns should be expected to be probabilistic tendencies, not the rigid properties of UG (Christiansen & Chater 2008). Thus, we construe recurring patterns of language along the lines of Wittgenstein's (1953) notion of "family resemblance": although there may be similarities between pairs of individual languages, there is no single set of features common to all languages.

This perspective on language evolution and universals has important implications for language acquisition and processing. The ready learnability of language is explicable not because language fits an innate UG within each child; but rather, because language itself embodies patterns that are most naturally acquired from past generations of learners. We have argued, more generally, that learning cultural forms (C-induction) is very much easier than learning aspects of the natural world (N-induction) – because learning merely requires that each new generations agrees with the previous generation. For example, the number sequence 1, 2, 3... could be continued in any numbers of ways using repetition (1, 2, 3, 1, 2, 3, 1...), oscillation (1, 2, 3, 2, 1, 2...), as a Fibonacci sequence (1, 2, 3, 5, 8...), or some entirely irregular pattern (1, 2, 3, 73, 0, 18...). In the context of N-induction, the learner faces real difficulties: In encountering the sequence in some aspect of the natural world (e.g., the number of planets observed on successive nights), it is very difficult to know how the sequence will continue. However, C-induction is much more reliable and straightforward. The vast majority of people would find it most natural to continue the sequence with "...4, 5, 6... ." Thus, predicting how *other people* will continue the sequence is relatively easy, at least if people have the same inductive biases. Similarly, children must extrapolate a language from the sample of language they encounter; but such extrapolation is likely to be correct, given that it is the result of prior extrapolations by previous generations of learners. Again, the learning problem is dramatically easier if the objective is to mirror a cultural form that has been learned by others. Indeed, through prior generations of cultural selection, the form itself will have been optimized to embody whatever inductive biases the learner may have (Chater & Christiansen, in press).

Our emphasis on C-induction in language *acquisition* dovetails with a usage-based approach to language *processing*. Connectionist cognitive science has for some time explored the computational implications of a usage-based approach to language in which constituency and recursion are not built into the architecture of the language system but rather emerge through learning as probabilistic generalizations (Christiansen & Chater 2003). Importantly, we have developed usage-based models of recursive sentence processing that are capable of constituent-like generalization and have quasi-recursive abilities comparable to human performance on a variety of complex recursive constructions (Christiansen & Chater 1999; Christiansen & MacDonald, in press). Thus, at least some aspects of cognitive science do fit with the picture of language outlined by E&L, in which recursion and constituency are not innately defined universals.

E&L's important paper will substantially shift the debate in the cognitive science of language. Cognitive scientists have often taken rigid language universals as a "given," to be explained by theories of language acquisition and processing (e.g., by the postulation of an innate UG). E&L make clear that this is a mistake – and that a much more nuanced view of the patterns in the world's languages is required. We argue that this perspective is consistent with the view that an innate UG is as much a myth as language universals; and that language should be viewed as primarily a product of cultural, rather than biological, evolution.

Syntax is more diverse, and evolutionary linguistics is already here

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Abstract: Evans & Levinson (E&L) perform a major service for cognitive science. The assumption of Chomskyan generative linguistics – that there are absolute unrestricted universals of grammatical structure – is empirically untenable. However, E&L are too reluctant to abandon word classes and grammatical relations in syntax. Also, a cognitive scientist can already draw on a substantial linguistics literature on variationist, evolutionary models of language.

Evans & Levinson (E&L) make an important point to cognitive scientists about language universals. The nature of language is seriously misrepresented by Chomskyan generative linguistics, which is all too often taken as the standard theory of language that must be accommodated by any interdisciplinary research in cognitive science. In particular, the Chomskyan emphasis on absolute unrestricted universals of grammatical structure flies in the face of overwhelming empirical evidence of the structural diversity of languages. This structural diversity has to be the starting point for any theory that attempts to come up with universals of language. I have only two additions to make to E&L's argument: First, their critique of syntax, the heartland of Chomskyan linguistics, is too timid; and second, the dynamic evolutionary approach to language that E&L advocate already has a lengthy pedigree in linguistics.

E&L's approach to syntax contrasts with their assertions about sound structure. E&L state that phonologists are abandoning the idea of a fixed inventory of possible human speech sounds in favor of a model where languages construct sound systems from fine phonetic details that vary substantially. But in syntax, they assume that word classes of the traditional sort (noun, verb, adjective, etc.) exist, and they respond to diversity by arguing that some languages do not take advantage of some of these classes or add others. This is very much like Jackendoff's notion of a syntactic toolkit, which the authors otherwise reject. In fact, E&L should abandon the assumption that nouns, verbs, and so on, have theoretical, cross-linguistic validity as part of a fixed inventory of word classes, just as they have abandoned the parallel assumption for sound inventories.

Linguists identify word classes by using syntactic criteria or tests. These criteria are the possible occurrence of words of a particular class in a set of grammatical constructions (including morphological inflectional contexts), and their inability to occur in other constructions. This is called the distribution of the words, or word class. But the fact of all languages, including English, is that the distribution of words is highly variable, so that there