infant were prewired with universal grammar and only needed input from a particular language to trigger that prewiring, then in the case of children with no input, the genetic program should not be triggered. How else does their conception of "genetically coded" function? Thus, if some form of language appears in the absence of any input, that language must be triggered by more general cognitive processes that do not require linguistic input and therefore cannot be used as an example of a genetically coded language organ.

NOTE

1. Variation on a theme by Cervantes: "Del dicho al hecho hay gran trecho" (*Don Quixote*).

Evolutionary principles and the emergence of syntax

P. Thomas Schoenemann[a] and William S.-Y. Wang[b]

[a]*Department of Anthropology, University of California, Berkeley, Berkeley, CA 94720-3710 and Center for Functional Imaging, Lawrence Berkeley National Laboratory, Berkeley, CA 94720;* [b]*Project on Linguistic Analysis, Department of Linguistics, University of California, Berkeley, Berkeley, CA 94720-2170 and Department of Electronic Engineering, City University of Hong Kong, Kowloon, Hong Kong.* schoenem@qal.berkeley.edu; wsyw@violet.berkeley.edu

Abstract: The belief that syntax is an innate, autonomous, species-specific module is highly questionable. Syntax demonstrates the mosaic nature of evolutionary change, in that it made use of (and led to the enhancement of) numerous preexisting neurocognitive features. It is best understood as an emergent characteristic of the explosion of semantic complexity that occurred during hominid evolution.

Müller has done a commendable job reviewing the neuroanatomical evidence relevant to language processing. We basically agree with his conclusion that arguments for the autonomy and innateness of language become increasingly problematic the closer one looks at the way language is actually processed and represented in the brain. It is important to note that knowing how language processing is organized neuroanatomically cannot settle the question of language innateness, as Müller would no doubt agree. Any behavior must necessarily be processed somewhere in the brain, whether or not that behavior is "innate." The ability to read is not innate, for example, but it is still processed in the brain, apparently using many of the same circuits that are used to process speech (which may or may not be innate). Müller is right that the existence of putative language areas in the brain is not evidence of the innateness or autonomy of language. We would go further and argue that an evolutionary perspective casts serious doubt on the hypothesis of innateness and autonomy of syntax.

In our view, the more than three-fold increase in brain size in hominids is directly related to the unparalleled increase in the degree of complexity of our ancestor's mental worlds (following Jerison 1985). This would in turn have increased the need to invent conventionalized means of communicating this complexity, that is, syntax.

At each step along the path of increasing complexity, the syntactic forms would have been nongenetic, but they would have made use of preexisting neurocognitive abilities out of simple necessity. The increased use of these invented syntactical forms would have spurred the further evolution of the neural components upon which these abilities depended, leading to an enhancement of existing neurocognitive structures, but *not* the evolution of unique, syntax-specific modules (c.f. Bates & MacWhinney 1990; Bates et al. 1991). Our contention is that syntactical forms are either obviously nongenetic inventions or share such similarities with other forms of cognition (e.g., semantic and memory systems) that they cannot reasonably be considered autonomous.

Syntax, just like the other linguistic features Müller discusses, is based on preadaptations. An evolutionary perspective demands that we look for homologies. The widespread existence of homologies was in fact one of the most powerful pieces of evidence used by Darwin to argue for the existence of evolution. It makes no evolutionary sense to expect hominids to wait until genetic features evolved to allow them to do what they could already do (perhaps less elegantly from an engineering standpoint) with preexisting abilities. Making use of preexisting pieces for language evolution in this fashion has led one of us to describe the product as a "mosaic" (Wang 1991). Given widespread homologies in other aspects of language, it would be extremely odd to find no homologies whatsoever for syntax (as Pinker, 1994, and others would have us believe).

We must keep in mind that a significant portion of syntax is obviously *not* genetic. There is a wide range of variation across languages in syntactic forms, and we know that grammatical changes can occur over relatively short periods of time (see, e.g., Ogura 1993). The widespread existence of grammaticalization (Hopper & Traugott 1993) further attests to the degree to which syntax is not innate. The question is, exactly how much of syntax can be considered essentially cultural inventions (or "emergent," as in Hopper 1987) and how much must be innate?

What is interesting about recent descriptions of universal grammar (UG) is that they are not lists of rules at all, but instead closely resemble general descriptions of how we structure and organize our reality (see, e.g., Bickerton 1990; Pinker 1994; Pinker & Bloom 1990). One of the most crucial features of UG is that it has hierarchical structure. However, as Sampson (1979; 1980) points out, this follows directly from a basic understanding of evolutionary principles (Simon 1962) and does not require either innateness or autonomy. Furthermore, since the point of language is communication, and since hierarchy is ubiquitous in the outside world, it stands to reason that language would reflect this in its structure.

Another closely related feature of UG is "structure dependency." This is simply the recognition that specific syntactic transformations depend on the structure of the sentence. To create a question from a statement in English, as contrasted with German, for example, only a few selected verbs can be moved to the front of the sentence (Ogura 1993). We do not see structure dependency as an argument for the autonomy of language either, because it follows understandably from the fact that these "structures" are not arbitrary groups of words but self-contained semantic units. The innate component to structure dependency therefore derives from its dependence on semantic structures that no doubt do have innate components, but it does not itself provide a convincing case for the autonomy of syntax.

The use of serial order in syntax provides a particularly clear illustration of our argument. While it is true that serial order is not considered part of UG because some languages, Latin for example, make less use of serial order in their syntax, *all* languages nevertheless display some form of word order constraint.

Clinical evidence suggests that the prefrontal cortex plays a crucial role in memory for serial order. Patients with prefrontal damage find it difficult to remember the order of past events, even though they remember the events themselves (Fuster 1985; Milner et al. 1985; 1991; Squire 1987). They also show difficulties ordering words into sentences and detecting grammatical errors (Novoa & Ardila 1987). Prefrontal damage also affects serial order memory in monkeys (Petrides 1991; Squire 1987) and even rats (Kesner 1990; Kesner & Holbrook 1987). The fact that the prefrontal cortex appears to be specifically involved in memory for serial order in species as far removed from humans as rodents suggests that this specialization is very old (primate–rodent common ancestry dates to about 65 million years ago; Sarich 1985). Furthermore, Deacon (1988) calculates that the prefrontal cortex in humans is at least twice as large as would be expected for a primate brain of our size. Because our brain is between three to four times as large overall as the earliest hominids (Falk 1987), our prefrontal cortex is six to eight times as large as the homologous region in other apes.

Given that this area was emphasized during hominid neuroanatomical evolution, that it plays a key role in serial order memory, and that serial order is used in all languages, it is a likely example of how syntax made use of, and emphasized, preexisting cognitive abilities. We should note here that chimps can learn to use serial order to distinguish argument relationships (Premack & Premack 1972).

What about specific evidence for a genetic basis of syntax? Müller does not go far enough when he states that "The evidence for language genes is as yet far from straightforward" (sect. 3.2.2, para. 2). With respect to Specific Language Impairment (SLI), for example, he points out that it consistently cooccurs with other cognitive deficits, thereby calling into question the specificity of the supposed language genes. This is an important point, but an even more damaging finding is that 41% of the errors on tests of irregular verb forms given to a set of SLI individuals were in fact overregularizations (Vargha-Khadem et al. 1995), indicating that they must actually know the morphosyntactic rules that Gopnik and Crago (1991) claimed they were blind to.

Most important, the specific form of morphosyntax thought to be deficient in these SLI individuals (the inability to generate proper verb inflection) isn't even a part of UG to begin with. Verb inflection is not used in many languages, including, for example, all dialects of Chinese (Wang 1991). Thus, even if this feature of morphosyntax can be shown to be genetically coded, this would only provide evidence for the idea that syntactic processing coopted preexisting processing abilities to accomplish specific kinds of communication.

Autonomy and its discontents

Chris Sinha

Institute of Psychology, University of Aarhus, 8240 Risskov, Denmark.
psykcgs@aau.dk

Abstract: Müller's review of the neuroscientific evidence undermines nativist claims for autonomous syntax and the argument from the poverty of the stimulus. Generativists will appeal to data from language acquisition, but here too there is growing evidence against the nativist position. Epigenetic naturalism, the developmental alternative to nativism, can be extended to epigenetic socionaturalism, acknowledging the importance of sociocultural processes in language and cognitive development.

Innateness, autonomy, and universality are the Holy Trinity of the generativist program, but autonomy of syntax is the Prime Mover. Autonomy is crucial to nativist arguments from the poverty of the stimulus, including learnability theory, since if grammar is seen – as it is by both cognitive and functional linguists – to be motivated by meaning, the mystery of language acquisition becomes less perplexing and the innateness postulate less compelling. Although the argument from the poverty of the stimulus has sometimes been presented as an empirical one ("degenerate input"), it is principally a logical one based upon specific theoretical assumptions: If (a) syntactic rules cannot be derived from generalization over the form of the input, and if (b) the form of the input is independent of (autonomous form) its structure and content under, say, semantic and pragmatic description, then (c) the acquisition of syntax requires the postulation of innate knowledge of universal grammar (UG). Universality follows logically from innateness, although the establishment of exactly *what* is universal is recognized to be a matter for empirical research in both linguistics and language acquisition.

The converse implications do not hold. Empirical evidence for language universals is consistent with but does not imply the innateness of such universals (they might, for example, be experiential or functional in origin); and the innateness of any component of human language capacity is consistent with, but does not imply, the autonomy of that component. Premises (a) and (b) of the argument from the poverty of the stimulus are contested in learning theory and in linguistic theory (Elman 1993; Lakoff 1987; Langacker 1987). It is therefore reasonable to require of the generativist program that it give empirical content to the concept of autonomy independently of its own theoretical assumptions regarding the proper treatment of syntax.

In the first half of his target article, Müller focuses on various readings (phylogenetic, ontogenetic, microgenetic, clinical) of the concept of autonomy from a neuroscientific perspective. As he points out, his aim is not to present a strong, equipotentialist and environmentalist counterclaim to the generativist account, but to demonstrate that the neurobiological evidence in some cases (e.g., microprocessing) runs counter to the autonomy hypothesis, and in other cases (e.g., language evolution) it is equivocal. There are, from neurobiology, no compelling reasons to reject a null hypothesis in favor of a nativist autonomy hypothesis.

Müller's other main aim is to point out that the notions of "innateness" and "universality" as standardly used in the generativist literature are, from a developmental biological point of view, hugely oversimplified; he also wishes to argue, as did Piaget (e.g., Piaget 1979), for an epigenetic developmental account of language acquisition and processing. Müller's proposed epigenetic account is much more specific neurologically than Piaget's, but it shares with the Piagetian account an emphasis on the codevelopment of language and perceptuomotor processes. Like cognitive semantics, it sees language acquisition and the language capacity as semantically driven and embodied. According to the epigenetic hypothesis, the neurological representation of grammar is continuous with the representation of other language "components" and the neural substrate for language is distributed over cell assemblies that also represent nonlinguistic capacities and processes. The limited extent to which syntax is modular in the mature organism is due to self-specifying and self-organizing processes in which linguistic input/output is processed in concert with other information. Is this sufficient to account for the acquisition of syntax? And what other kinds of evidence bear on the rival claims of this and the nativist hypothesis?

Müller does not treat productive language acquisition in any detail; this neglect of one of their principal evidential sources will no doubt be severely criticized by generativists. Accounting for children's acquisition of grammar is a challenge to nativist and nonnativist theories alike, one which has not yet been and may never be conclusively met if one maintains a strict criterion of comprehensive and exhaustive explanation. Acquisition data are, nevertheless, the main empirical testing ground. Müller's critique of autonomous nativism receives support from recent comparative work relating language acquisition to language typology and grammaticalization theory (e.g., Bowerman 1994; Slobin 1995). This suggests that the language learning task may best be seen in terms of the construction of language-specific, meaning–form mappings, in which semantic content carried and configured by "grammatical" items in one language may be carried and configured by lexical items in another (or, for that matter, may be distributed across both lexical and grammatical items in a single language). This account would rule out neither "innate" capacities nor universals, but it would suggest that the identification of what is innate and what is universal with a "grammar module" is wrong. It would also suggest that Müller's own hypothesis that "content" (lexical) cell assemblies are more distributed than "functor" (grammatical) assemblies should be modified to take account of both the language specificity and the continuous (clined) rather than discontinuous nature of this distinction.

Müller's discussion does not resolve the issues of autonomy, innateness, and universality, but it is a milestone of a kind. The importance of the paper lies in its use of neuroscientific evidence to challenge an orthodoxy that is viewed by many generative linguists as akin to Holy Writ, and (hopefully) to dispose of the overworked rhetorical ploy that "There Is No Alternative." Müller's epigenetic account can be taken one step further away from the generativist paradigm, by emphasizing that the epigenetic plasticity of human higher cognitive processes is an evolutionary