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

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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 implication 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 obvious 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 1983) 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 developments in 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 (1978; 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 universal 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; 1981; Squire 1987). They also show difficulties ordering words into sentences and detecting grammatical errors (Novoa & Ardila 1993). 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 (1989) 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.

Commentary/Müller: Innateness, autonomy, universality
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 chimp's brains 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 Copek 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 co-opted preexisting processing abilities to accomplish specific kinds of communication.

Autonomy and its discontents

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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 sociocentrism, 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. 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 sociocentrism, acknowledging the importance of sociocultural processes in language and cognitive development.

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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 1970), 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 grammatical development (e.g., Boas 1944; Siibiak 1988). 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 grammatical module," is premature. It would also suggest that Müller's own hypothesis that "content" (lexical) cell assemblies are more distributed than "function" (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