Innateness, Evolution, and Genetics of Language

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Abstract Our goal in this article is to review a debate over the evolution of language and to suggest some keys to its resolution. We begin with a review of some of the theoretical and empirical evidence for the innateness of language that has caused renewed interest in the evolution of language. In a second section we review some prominent theories of the evolution of language, focusing on the controversy over whether language could have been adapted for some purpose. We argue that for evolutionary studies of language to advance, theorists must make more persuasive arguments for the purpose of language, and, furthermore, linguists must continue to develop a detailed theory of syntax. Finally, we suggest ways that behavioral and population genetics could help to inform studies of the evolution of language.

Innateness of Language

Language is frequently cited as the skill that sets humans apart from other primates. As such, it is not surprising that the origins of language have been the subject of much debate. Speculations about the evolution of language go back at least to Darwin (1872), who advocated continuity between human and nonhuman communication. For most of the twentieth century, though, the evolution of language has not been a popular topic in psychology, probably because psychologists emphasized the role played by learning and conditioning rather than genetic factors. However, as momentum in the social and cognitive sciences has shifted away from behaviorism and toward a more balanced view of the origins of behavior (i.e., a view that takes into account both genetic and environmental factors), it has become more popular to theorize about the evolution of cognition, including language.

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Early investigations of language evolution grew out of a fascination with the communicative abilities of nonhuman primates and the desire to find continuity between their communication systems and human language [see Hauser (1996) for a recent review of animal communication]. In the past few decades, however, interest in the evolution of language has largely been triggered by advances in the study of language and its acquisition by children. These advances have led many scientists to the conclusion that language is a cognitive module grounded in a biological program that unfolds during infancy and early childhood. To give the reader a sense of the discoveries that have inspired recent interest in the evolution of language, we begin with a review of the evidence that language is innate.

Some of the evidence is theoretical in nature and stems from the review by Chomsky (1959). It can be proven that a system of rules as complex as that for the syntax of natural language cannot be learned by a general-purpose learner who receives no correction. Such a learner will inevitably posit rules that are too permissive and thus will be unable to correct them with only positive examples (Gold 1967; Wexler and Culicover 1980). Children appear to be in exactly this situation: They hear only positive examples and receive no correction if they overgeneralize grammatical rules [e.g., Brown and Hanlon (1970) and Marcus (1993)]. Furthermore, we know that correction is not necessary for acquisition because some children who are unable to speak (and therefore cannot be corrected) have normal receptive language (Stromswold 1994). Given that the rules of syntax are too complex for a general-purpose learner to deduce without training and that children do not require training, children cannot be general-purpose learners when it comes to language. They must come equipped with special-purpose learning algorithms that allow them to learn language in a rapid and error-free manner.

Observational and experimental studies provide additional evidence for the innateness of language. Space limitations preclude a thorough review of relevant research, but we touch on three lines of evidence for this claim: universals of language acquisition, creolization, and the development of language in deaf children. Language acquisition is qualitatively uniform in all normal children. Most children say their first words at about 9 to 12 months of age (Morley 1965), and for the next 6 to 8 months children continue to acquire single words in a fairly slow fashion until they have acquired approximately 50 words, at which point their vocabularies usually increase rapidly in size [e.g., Nelson (1973)]. The development of syntax is also rather uniform. At about 18 to 24 months of age English-speaking children begin to combine words to form two-word utterances (Brown 1973). They gradually begin to use sentences longer than two words, but for several months their speech lacks phonetically unstressed functional morphemes such as determiners, auxiliary verbs, and inflectional markings (Brown 1973). Gradually, these omissions become rarer until children are about 4 years old, when the vast majority of their utterances are completely grammatical (Stromswold

1990). The order in which children acquire grammatical morphemes of English is also relatively uniform across children (Brown 1973; de Villiers and de Villiers 1973), as is the order in which children acquire complex constructions such as questions, negatives, datives, and passives (Stromswold 1988, 1989, 1990, 1995; Snyder and Stromswold 1997). As we will see in the final section of this paper, although some children are faster than other children at acquiring language, the fact that most children acquire the components of language in essentially the same order suggests that language development is largely the result of innate processes.

In principle, though, the uniformity of language development under normal conditions could be due to a genetic or an environmental process. More informative are studies of children whose early language environments differ from the norm. One such situation is *creolization*. Creolization typically occurs when migrant workers who speak a variety of languages are brought together to work and their only common language is a simplified version of the dominant language, known as a *pidgin*. Pidgins typically consist of fixed phrases and pantomimes and can be used to express only basic needs and ideas. Unlike normal languages, pidgins are heavily context dependent and lack many basic properties, such as a consistent means of expressing tense and aspect, fixed word order, consistent word-meaning mappings, and sentences longer than a single clause.

Derek Bickerton studied the language of second-generation pidgin speakers (i.e., children whose parents spoke pidgin) and found that they use a creolized language that is much richer than their parents' pidgin. For example, the creolized language of second-generation pidgin speakers includes embedded and relative clauses, aspectual distinctions, and consistent word order, despite the absence of such features in the input language (Bickerton 1981). Thus children who are given a pidgin as their language input go beyond their input and "invent" a language that is more complex and includes the grammatical necessities of natural language. Studies of creolization thus provide compelling evidence that human children are programmed to develop a specific kind of language even with minimal input.

How minimal can the input be? Although children in the creolization situation have impoverished input, there are even more extreme situations of language deprivation. Consider cases of deaf children born to hearing parents who do not use or expose their infants to sign language. These children essentially grow up with no language input at all, but, unlike the mythical feral child, they do receive normal care and comfort from their parents. These deaf isolates provide a fascinating picture of the limits of the innate endowment to create language and hence a glimpse at the early unfolding of language in all infants. It has been shown that if these children are not exposed to a signed or written language before puberty, they do not develop normal language. However, as infants and toddlers they seem to go through the same procession of early language acquisition as hearing children. Right on schedule at about

6–8 months, deaf isolates begin to make hand motions analogous to the spoken babbling of hearing babies. They invent their first signs or gestures at the same age as (or earlier than) hearing children produce their first words. They even begin to form short phrases with these signs, also on a comparable schedule to hearing children (Goldin-Meadow and Mylander 1984). Thus these early milestones are apparently able to unfold according to their genetically programmed schedule with minimal linguistic nurturing from the environment.

In summary, results of empirical and theoretical studies have persuaded many linguists and psychologists that language is not a social construct or cultural convention. Rather, human language is the result of our innate biological endowment: Children will develop language under most circumstances, even if a perfect model of language is not provided. Once we realize that language is largely innate, it is tempting to ask about the origins of language, to ask how and why it developed in our species. Many scientists, including linguists, psychologists, and biologists, have proposed answers to these questions, spurring debate in these fields. We now turn to a review of some of the more prominent theories.

Evolution of Language

In evaluating evolutionary theories of language, it is useful to think of them as divided along two dimensions. The first major dividing line is the means of evolution. At one extreme is adaptation, according to which language evolved by Darwinian natural selection for some purpose, such as communication. Opposing adaptation is nonadaptation, which can be realized as exaptation (the appropriation of previously developed structures for new functions), serendipity (the opportune birth of a structure or function as a byproduct of other structures), or various other possibilities. This division is an ongoing debate in psycholinguistics and paleontology and has inspired much of the work discussed in what follows. The second dividing line is the kind of precursor, such as a specified level of conceptual representation or motor control, that language may have required in order for it to evolve. Theories also differ crucially on this dimension.

We begin with a nonadaptationist account that has been expressed by Noam Chomsky and is representative of the views of many linguists. Because Chomsky is perhaps the most prominent champion of the innateness of language, one might expect that he would be receptive to adaptationist theories of the evolution of language. To the contrary, Chomsky espouses the view that paradigms such as exaptation or even serendipity may be at work in the evolution of language. He has argued that, although language appears to be used for communication in modern humans, we cannot know whether the computations underlying language were actually selected for because of their utility for communication or whether they were exapted for communication from some other purpose. Chomsky also suggested that linguistic computational ability may reflect "the operation of physical laws applying to a brain of a certain degree of complexity" (Chomsky 1988, p. 170). In other words, language could be a spandrel. His arguments are similar to those put forth by Gould for exaptation in paleobiology [e.g., Gould and Vrba (1981)] and Lewontin for exaptation in cognition (Gould and Lewontin 1978; Lewontin 1990).

Because no theory of how language could be an emergent property of a complex brain has yet been specified, Chomsky's position is baffling at first glance. It looks like a refusal to believe the obvious: that a complex and clearly advantageous behavior could have been engineered by natural selection. Dennett (1995, p. 387) characterized Chomsky as thinking: "Better the mind should turn out to be an impenetrable mystery, an inner sanctum for chaos, than . . . it should [be amenable to] an engineering analysis." But from a linguist's point of view, Chomsky's position makes some sense. Piattelli-Palmarini (1989), a frequent clarifier and distiller of Chomsky's position on the evolution of language, noted that detailed study of the rules and patterns of syntax reveals a system that is neither obviously optimized for communication nor analogous to any other known cognitive rule system. Piattelli-Palmarini goes one step further and takes the position that not only are linguistic rules arbitrary or imperfect but they also can actually hinder communication. If Chomsky and Piattelli-Palmarini are right about the arbitrariness of linguistic rules, then it is reasonable to argue that syntax was not adapted for communication and therefore did not evolve by natural selection for communicative ability.

Like Chomsky, most linguists have avoided speculating about the adaptive value of language and its evolution. However, a few researchers have argued that Chomsky's view is too pessimistic and have explored natural selection in the evolution of language. Following Dawkins (1986 and elsewhere), Pinker and Bloom (1990) put forth an adaptationist explanation, arguing that natural selection is the only scientific explanation known for adaptive complexity. However, the importance of natural selection for adaptive complexity is uncontroversial; what *is* controversial is whether language has adaptive complexity at all. Chomsky and Piattelli-Palmarini claim that syntax is not well adapted for its purpose (communication). Pinker and Bloom argue that we have objective measures such as adaptiveness to environment, engineering design, and measures of reproductive fitness to use in deciding whether to invoke natural selection and that on each of these measures language qualifies.

Pinker and Bloom argue that language is extremely adaptive because those who possess language can use it to obtain knowledge secondhand and to find out about others' internal states. According to Pinker and Bloom, language has been engineered to incorporate many characteristics that are essential for communication from an objective point of view (e.g., ontological categories, intentional states, truth values, focus, absolute and relative time indicators). This does not mean that any particular language is optimal; languages may appear to be imperfectly designed because specific grammars instantiate the abstract traits in different ways and with inevitable trade-offs. Finally, on the reproductive fitness measure, Pinker and Bloom claim that genetic variation exists and could serve as the substrate for differential reproductive fitness (see the section "Genetics and Language" for more on this point).

Pinker and Bloom chose to participate in the debate with Chomsky, Gould, and others over the feasibility of adaptation in the evolution of language, essentially representing opposite ends of the adaptation dimension. Other linguists have ignored this debate altogether, however, and have operated under the assumption that language has adaptive value. They have formulated more specific theories of how and why language evolved, spreading themselves out along the precursor dimension. Because these theories are more specific, they are necessarily more speculative. Nonetheless, these theories are intriguing and each raises points worth considering.

Several researchers have argued that syntax serves as a link between mental representation and speech or motor control and that syntactic properties are due to trade-offs between these functions. The linguist Frederick Newmeyer provides a representative example of this type of theory. According to Newmeyer (1991), our ancestors already had a system of conceptual representation and a system of vocalization in place when selection occurred for syntax (a system linking the two). Thus syntax was not selected for *directly* because of its communicative and representational functions but because it served as a link between preexisting systems. As evidence for a prelinguistic conceptual system, Newmeyer refers to comparative studies [e.g., Premack (1976)] that show that some nonhuman primates have a sophisticated level of mental representation, thus implying that our common ancestors also had such abilities. By the same kind of reasoning, Newmeyer argues that a prelinguistic system of vocalization must have been in place before the first hominids. His evidence for syntax as an interface system comes from the structure of grammar itself: Newmeyer uses specific examples to argue that grammar is in some ways perfected for conceptual representation and in other ways better suited for speaking and communicating efficiently. Thus both systems may have been in place before syntax appeared. His arguments therefore depend on comparative biological evidence as well as his theory of grammar.

Although Newmeyer's theory is appealing, it has some shortcomings, the most important of which is that the existence of modern systems of representation and speech before the development of syntax is controversial. Although it is true that nonhuman primates can vocalize, it is not fair to say that nonhuman primates (or our common ancestors) have advanced speech

abilities. Lieberman (1984) pointed out that the physiological and anatomical adaptations in jaw shape and the tongue and larynx placement required for speech are disadvantageous for breathing and swallowing. He argued persuasively that such a detrimental situation could not have evolved unless it caused improvements in syntax or some other aspect of language. Therefore speech and syntax must have evolved in concert, not in succession.

The role of language for communication has figured prominently in the evolutionary theories discussed thus far, but another potentially important use of language is mental representation. Bickerton, whose creolization studies provided support for the innateness of language, argued that language evolved because it provided a way to represent objects without requiring their physical presence. According to Bickerton (1990), many other species (including our presyntactic ancestors) share with modern humans certain basic representational abilities. These representational abilities constitute a proto-language, which Bickerton argued was a precursor to human language. According to Bickerton, early humans were unique in having made the leap to syntax, a system with secondary representational properties. Unlike single words or inconsistent combinations of words, syntax allowed whole ideas to be represented, including actions and their participants.

Bickerton (1990) made specific claims about when and how this representational ability evolved. He argued that the jump from proto-language to syntax was made all at once in one species. According to Bickerton, the diversity of tools and artifacts one might expect from a linguistic society was not present in pre-*sapiens* species, so ours must have been the first to use language. Furthermore, he argued that full-fledged syntax could have arisen as a single mutation from proto-language in our species' progenitor. The magnitude of this leap may seem large, but Bickerton argued that the same gap is bridged in two modern day situations: (1) normal children as they go from the telegraphic speech of 1–2-year-olds to the more embellished language of 3–4-year-olds and (2) the creolization of pidgin languages.

Although Bickerton's hypothesis is intriguing, it has some flaws. First, there is no clear relationship between artifacts and language. The discovery of certain tools and paintings in a given culture has sometimes been interpreted as evidence for language in that culture, but such conclusions are speculative because there is no logical link between manual or cognitive skills and language. A leap in complexity of artifacts does not imply a leap in brain complexity; consider the technological progress made in the Western world in the last century as an example. Furthermore, to the extent that such skills could be correlated with language, Tobias (1994) used evidence from the tool use of pre-*sapiens* (*Homo erectus* and *H. habilis*) to argue that these species had language and culture. Without considering the archeological evidence in much greater detail or deciding on criteria for the connection between artifacts and language, it is difficult to judge these contradicting claims.

A second problem with Bickerton's theory is that, just because children make a leap in their second year of life from a proto-language to full-fledged syntax, this does not imply the same leap could have been made in a single mutation. As we saw earlier, syntax is not much use without highly developed systems of communication and representation. Despite what is certainly a narrowly constrained *Bauplane* of the human brain, syntax probably did not develop all at once without some form of these other abilities in place, nor is it likely that these other abilities developed without syntax. Given that these abilities must have coevolved, Bickerton's jump is more likely to be an extended period of coadaptation, as Lieberman proposed.

We have now seen theories in which the precursors of language are proto-communication and mental representation. Another popular idea is that language piggybacked on another cognitive skill that shares a similar structure or function. One such theory is that language evolved from tool use, a skill we share to some extent with other primates. A recent and well-explicated example of the tool-use theory comes from Greenfield (1991). Greenfield argued that, like language, tool use is hierarchically structured in that simple tools can be combined with one another to make more complex tools. Because language and tool use are similar in this way, she proposed that tool use preceded or evolved together with language. Greenfield presented three kinds of evidence to support the intimate relationship between language and tool use. The first is the organization of the modern human brain in which tool use and language find their neural substrates in adjacent regions of the frontal cortex. The second is developmental data from children that show that object manipulation becomes more complicated in analogous ways to language and on a similar timeline (Greenfield 1978). The third source of evidence comes from comparative studies of Bonobo chimpanzees. Although Bonobos' ability to use tools and manipulate linguistic symbols is inferior to that of humans, their tool use is on a par with their linguistic abilities, implying that the two abilities are closely and perhaps causally linked (Greenfield and Savage-Rumbaugh 1990).

The physiological and functional proximity of language to tool use may account for how language evolved, but not why. To answer this second question, Greenfield proposed that language evolved as a way to pass on knowledge of tools to others. If an individual can benefit from the inventions of previous generations, he does not have to reinvent the wheel, so to speak, with each problem. More complex and useful tools can be developed with each generation. Greenfield envisioned tool-making abilities and language as coevolving and mutually beneficial. Tool use gained from the increase in communication, and language benefited from the neural substrate that developed for tool use, according to her theory.

Greenfield's theory is appealing because it provides a link between our linguistic abilities and the impressive tool-making abilities of closely related species. However, the argument for physiological and functional correspondence of tool use and language relies on a tenuous analogy of hierarchical structure. Greenfield (1991) described in detail how methods for manually combining many objects into an organized assembly are necessarily hierarchical, giving as an example three nested pots. To become nested, the pots must be combined in a certain sequence. Nesting succeeds only if the smallest and middle pots or the middle and largest pots are combined first. Thus the task is hierarchically organized: Some steps must precede others.

Syntax shares this characteristic in a superficial way. Nouns and clauses that modify them must be combined first (e.g., "the boy" → "the boy who had a red cap"), and then the whole noun phrase must be combined with the verb (e.g., "ran") to make a grammatical sentence ("The boy who had a red cap ran"). If the noun and verb are combined first (e.g., "the boy ran") and then modifiers are added, the result may be an ungrammatical sentence such as "The boy ran who had a red cap." However, the analogy ends at this point. When linguists say syntax is hierarchically structured, the fact that small elements may be combined to form larger ones is only part of what is meant. Another aspect of the hierarchical structure of syntax is that one part of a sentence can depend on another by virtue only of their hierarchical relationship and not the linear distance between the two elements.

Pronoun reference is one example of this type of hierarchical dependence. Consider the contrast between sentences 1 and 2:

When he thinks John listens to music. (1)

He thinks John listens to music. (2)

In sentence 1 *John* and *he* may refer to the same individual, but in sentence 2 they may not. The sentences are identical in surface form except for one extra word (*when*). The explanation for the difference in interpretation between the two sentences lies in their hierarchical structure. In sentence 1 the first clause (*when he thinks*) is subordinate to the second clause (*John listens to music*). In sentence 2 there is no such hierarchy. Thus the hierarchical structure is important not only in putting the sentence together but also in forming dependencies that critically affect meaning. Humans do not seem to have a system of everyday tool making that has the same sort of properties.

To sum up, it is difficult to advance the study of evolution of language if we do not know the purpose for which language was adapted. Language may have been adapted for a specific communicative purpose, such as tool use or hunting, or for communication in general. It may have been adapted for better representation of the world, which in turn allowed for more abstract thought and reasoning—or perhaps just for better hunting. But, as Chomsky warns, language may merely be a spandrel of the brain's complexity and hence may not have been adapted at all. Researchers must realize that when they propose that language was adapted for a particular function, no matter how innocent and intuitively obvious that purpose seems (e.g., communication), is not uncontentious. Researchers need to put more effort into justifying the function of language that they advocate. Such argumentation must be an integral part of a good theory.

Another problem with the theories we considered is that the same aspects of syntax have been used as evidence for both the adaptiveness and maladaptiveness of language depending on what suits the researcher's purpose. For example, Newmeyer argued that a hierarchically parameterized system of anaphor binding is adaptive, and Piattelli-Palmarini (1989) argued that it is maladaptive. Pinker and Bloom argued that the *theta criterion* and *subjacency* are adaptive, whereas Piattelli-Palmarini argued that these syntactic principles are arbitrary. It is true that language itself is the place to look for clues about its evolution. However, the fact that respected linguists can persuasively argue opposing sides on the adaptiveness of specific rules suggests that the rules of syntax may not yet be well enough understood to support argumentation about their evolution. Although the last four decades have brought many advances in our understanding of syntax, linguists are still far from a complete characterization of Universal Grammar, the hypothesized underlying grammar of all languages [e.g., Chomsky (1986)]. Until more details are learned about the structure of language, it may not be possible to make firm arguments for the adaptive complexity of specific rules. More detailed study of the structure of language will allow researchers to make better arguments for (or against) its adaptive complexity.

Genetics of Language

Another area that can inform the study of evolution is behavioral genetics. Although the striking within-species uniformity of language has inspired the study of language evolution, ironically it is the small quantitative variations in linguistic abilities within our species that may provide empirical evidence for natural selection of language. Natural selection requires genetically based variation in a population. If we can discover genetic variation in language in modern humans, we may gain insight into the genetic variation that was relevant in the evolution of language. Of course, it is also necessary to show that the genetic variation in today's population affects or once affected reproductive success. Such studies are difficult in humans, because even a 1% difference in reproductive rate would require the complete reproductive history of 100,000 individuals (Lewontin 1990). Although scientists are not yet in a position to measure differential reproductive success in humans, we can at least determine whether there is genetically based variation on which natural selection could be acting. The search for genetic variation begins with the study of behavioral variation, or individual differences, in the linguistic abilities of adults.

Most linguists believe that the best way to study people's internal language or grammar is to have them judge the grammaticality of sentences.

These judgments can be used to make inferences about the nature of the underlying grammar. The critical assumption underlying such research is that when a person judges the grammaticality of a sentence, she must consult her internal grammar and determine whether that sentence can be generated by her grammar. Interestingly, it has been reported that even among native speakers who are competent in their language, there are individual differences in grammaticality judgments (Ross 1979; Nagatu 1992; Cowart 1994; and references therein). Such differences do not seem to correspond solely to dialect differences. Instead, there just seems to be random individual variation in grammars.

Individual differences have also been reported in sentence processing (Corley and Corley 1995; Bever et al. 1989), in the interpretation of novel noun compounds (Gleitman and Gleitman 1970), in verbal fluency (Day 1979), and in second language learning (Fillmore 1979). Unfortunately, to date, there has been no systematic behavioral genetic investigation into any of this linguistic variation in adults, so we cannot know whether any of it is due to genetic sources. It is encouraging that such differences exist, though, and it is clear that genetic studies are needed to investigate them.

Although all adults eventually arrive at essentially the same basic level of linguistic competence in their native language, the rate at which they acquire language varies. As discussed earlier, one of the most striking qualities of language acquisition is its robustness and uniformity. However, children may differ dramatically in their *rates* of acquisition. For example, Brown (1973) and Cazden (1968) investigated when 3 children mastered the use of 14 grammatical morphemes. Although all three children eventually obtained competence in the use of the third singular verbal inflection *-s* (as in *he sings*) and although all three children reached this point after they achieved adult-like performance on plurals and possessives, one of the children reached competence at age 2 years and 3 months, one at 3 years and 6 months, and one at 3 years and 8 months. Similar findings concerning individual differences have been found in rate of acquisition of questions (Stromswold 1988, 1995), auxiliaries (Stromswold 1990), and datives, verb particles, and related constructions (Snyder and Stromswold 1997; Stromswold 1989). A number of studies have also reported that children's vocabulary development can vary greatly in both rate and style [e.g., Nelson (1973), Goldfield and Reznick (1990), and Fenson et al. (1994)].

Individual variation in language appears to exist. But is the variation the result of genetic factors? The results of behavioral genetic studies of language are somewhat mixed but generally suggest that there is a genetic component to language and language disorders [see Stromswold (1996, 1997b) and Stromswold (1998) (this issue) for a more thorough review]. Stromswold (1996, 1998) reviewed studies of spoken language disorders and, based on this review, concluded that in most cases familial language disorders are the result of both genetic and environmental factors. For example, researchers who have compared the linguistic ability of adopted children with that of their biological and adopted relatives have found that for normal and impaired children genetic factors play a greater role than environmental factors in language abilities (Cardon et al. 1992; Cypher et al. 1989; Felsenfeld and Plomin 1996). Several twin studies have also shown significant heritability in language development. Plomin et al. (1993) found considerable differences between monozygotic (MZ) and dizygotic (DZ) twin correlations at both 14 and 20 months of age for word comprehension; Reznick et al. (1997, p. 132) reported significant heritability for expressive verbal skill at 24 months; and Ganger et al. (1997) found significant MZ-DZ differences in the rate at which children acquired their first 100 words. Furthermore, some genetically transmitted developmental disorders specifically impair language [for a review of specific language impairments, see Stromswold (1997b)] or spare language [for a review of Williams syndrome, see Bellugi et al. (1992)]. In summary, although research on the genetics of language and language acquisition is still in its infancy, the results of existing behavioral genetic studies suggest that there is some variation in the genes that underlie language in humans. The existence of such variation suggests that these genes could have been acted on by natural selection.

Our somewhat critical review of current evolutionary theories of language should not be taken to mean that we think it is impossible to make progress in investigating the evolution of language. It is clear that each evolutionary theory brings to light new problems and possible solutions on which future theories can build. Taken together, further study of the function of language, the formal properties of syntax, and the genetic variation in language in today's population will advance understanding of the evolution of language.

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