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Evolutionary Perspectives

It may seem counterintuitive that evolutionary perspectives on language should have any consequences for theories of language development. After all, apart from relatively minor shifts in vocabularies and pronunciations, the linguistic environment remains relatively stable over the period of primary language development. Researchers have therefore tended to assume that language is essentially fixed when it comes to the study of language acquisition. However, this does not mean that language evolution theories are irrelevant for language acquisition researchers. Indeed, recent evolutionary considerations promise to cast the problem of language acquisition in a new light, potentially ruling out certain approaches while, at the same time, suggesting that the task facing children may be simpler than previously assumed.

Early Approaches to Language Evolution

The study of language evolution has a long, checkered history. The mid-1800s were so plagued by unfounded speculations regarding the origin of language that the Société Linguistique de Paris in 1866 imposed a ban on discussions of this topic at its meetings. The study of language evolution subsequently underwent a long hiatus that lasted until 1990, when a landmark paper by S. Pinker and P. Bloom led to a resurgence of research in this area. Since then, language evolution research has blossomed, fueled by theoretical and empirical constraints deriving from advances across the various cognitive sciences with a stake in language. Whereas early work focused on the biological evolution of specific neural mechanisms for language, the new millennium has seen a shift toward an emphasis on the emergence of linguistic structure through the cultural evolution of language.

Language evolution research aims to explain why language is the way it is and how it came to be that way. Language appears to be species specific; no other animal appears to have a communication system of equal expressivity, complexity, and diversity. This is often taken to imply that language evolution has involved biological adaptation specific to language. Another possibility is that the complexity of language has primarily emerged as a consequence of cultural evolution across generations of language learners and users. Recent work on the evolution of language has sought to disentangle these two perspectives by bringing together evidence from a variety of sources, including theoretical considerations, computational simulations, and behavioral experimentation.

A longstanding influential approach to language acquisition argues that the input to children is too impoverished for them to acquire an adult linguistic competence. The suggestion is therefore that children come to the task of language acquisition with a genetic endowment of linguistic knowledge—a so-called Universal Grammar (UG)—consisting of a set of abstract constraints that hold across all languages. As such, UG provides a possible explanation for the close fit there seems to be between language and learners. Pinker and Bloom proposed that UG has evolved gradually by way of natural selection by analogy with the evolution of the visual system. Although initially controversial, this perspective quickly emerged as the null hypothesis in language evolution research in the 1990s.

The Logical Problem of Language Evolution

The UG perspective on language acquisition has been criticized on a variety of grounds, from underestimating the information available in children's input to lack of linguistic coverage. Independent of the merits of these criticisms, the UG approach faces a logical problem of language evolution. A central assumption of UG is that the linguistic constraints are arbitrary in the sense that they do not facilitate language learning and use, improve communicative effectiveness, or play any other functional role. This creates an evolutionary problem because natural selection works on functional properties that increase an organism's chances for survival and reproduction. Because UG constraints are arbitrary, any combination of constraints would be equally adaptive, leaving natural selection little with which to work. A possible solution is to construe the UG constraints as constituting a communicative protocol by analogy with inter-computer communication: It does not matter what specific settings (constraints) are adopted as long as everyone uses the same set of settings. However, this solution comes up against three fundamental obstacles relating to the question of what is genetically encoded, language change, and the dispersion of human populations.

First, natural selection produces adaptations designed to fit the particular environment in which selection occurs. Consider the exquisite adaptation of the beaks of Darwin's finches, from the short, wide bills of the seedeaters to the long, narrow bills of the grub catchers. In all cases, the finches' beaks are superbly adapted for foraging in their local environments. It is thus puzzling that an adaptation for UG would have resulted in the genetic underpinnings of a system capturing the abstract features of all possible human linguistic environments rather than fixing the superficial properties of the immediate linguistic environment in which the first language originated.

Second, assuming that the first difficulty could be resolved, the UG account faces another problem because, as products of cultural evolution, linguistic conventions change orders of magnitude faster than biological evolution. For example, it took less than 7,000 years for such mutually unintelligible languages as Danish and Hindi to evolve from a common proto-Indo-European ancestor, whereas hominid evolution is measured in terms of hundreds of thousands of years. Thus, the adaptationist account of UG faces the problem that linguistic conventions change much more rapidly than genes, creating a moving target for natural selection. Computational simulations have shown that, under conditions of relatively slow linguistic change, arbitrary principles do not become genetically fixed—even when the genetic makeup of the learners is allowed to affect the direction of linguistic change.

Third, even if the first two obstacles could somehow be overcome and a biological adaptation for UG emerged in a group of early humans, this account would still be confronted with the issue of diverging human populations. If we assume that UG emerged by gradual genetic assimilation of the arbitrary linguistic conventions found within a particular group of early modern humans, different languages (and linguistic conventions) would emerge as they later migrated out of Africa to Asia, Europe, and beyond. The problem is that the same gradual adaptation needed to evolve a UG in the original population would also gradually change the UG as the languages diverged. Computational modeling of a range of different scenarios concerning language evolution and human migration suggests that the only way for UG to evolve is to assume a process of gradual adaptation prior to the dispersion of human populations and an abrupt cessation of adaptation afterward as humans migrated across the world. This is, of course, a highly unlikely evolutionary scenario.

Nonetheless, it remains possible that language had a substantial impact on human genetic evolution. Whereas there appears to be no viable evolutionary account of how arbitrary linguistic constraints could emerge, it seems plausible that functional features of language that remain stable across linguistic environments might have led to biological adaptations. Such adaptations may have included changes to the vocal tract for optimal speech production, enhanced memory for form-meaning mappings, or complex pragmatic inferences. Crucially, though, these are features of language that are functional in nature—that facilitate language learning and use—and thus would not typically be considered part of UG.

Language as Shaped by the Brain

But without UG, how can we explain the close fit there seems to be between language and the mechanisms involved it its acquisition and use? M. Christiansen and N. Chater suggested that, instead of asking how the brain may have been adapted for language, more insight into language evolution can be gained by turning the question upside down: How has language been adapted to the brain? As they noted, this question emphasizes the fact that language cannot exist independently of human brains. Without humans, there would be no language. Thus, there is a stronger selective pressure on language to adapt to the human brain than the other way around. Processes of cultural evolution involving repeated cycles of learning and use are hypothesized to have shaped language into what we can observe today. The solution to the logical problem of language evolution is, then, that cultural evolution has shaped language to fit the human brain.

The 21st century has seen a growing body of research supporting the hypothesis that language primarily has evolved by way of cultural evolution rather than biological adaptation. This evidence has come from many different lines of research, including computational modeling of the processes of cultural evolution, linguistic analyses of patterns of grammaticalization in linguistic change, and human simulations of cultural transmission. A key hypothesis emerging from this work is that the cultural evolution of language has been primarily shaped by domain-general constraints deriving from neural mechanisms existing prior to the emergence of language. Language is thus viewed as an evolving, complex system in its own right; features that make language easier to learn and use, or are more communicatively efficient, will tend to proliferate, whereas features that hinder communication will tend to disappear (or not come into existence in the first place). This perspective on language evolution has a long pedigree going back to Charles

Darwin, who in *The Descent of Man*, noted that a struggle for survival goes on among words and linguistic structures and that this process of cultural evolution in language closely resembles the process of natural selection in biological organisms.

S. Kirby and colleagues have simulated this kind of cultural evolution in the lab by exposing learners to an "alien" language in which syllable strings were mapped onto pictures showing colored objects undergoing a specific kind of motion. The learner only saw a subset of the possible string-picture mappings in this miniature language but was tested on the ability to name all the pictures in the language. This meant that the learner had to generalize from a finite input sample to a larger language (similar to the task facing a child learning natural language). The responses that the learner provided for these test items were then used as the language for a subsequent learner; that is, the output of one learner became the input for the next learner, thus simulating a process of cultural transmission of language across generations of learners. Crucially, the first learner was exposed to a completely random language, in which there were no regularities between the strings and the pictures. As this process unfolded across 10 generations of learners, the language became more structured and consequently easier to learn. In many cases, morphology-like structure emerged, with specific prefixes or suffixes indicating color, shape, or type of motion. Such structure allowed the learners to generalize to unseen strings, thus suggesting that the artificial language had adapted to a narrow transmission bottleneck whereby learners were exposed only to subsamples of the full language.

More generally, M. Christiansen and N Chater describe four different types of constraints that act together to shape the cultural evolution of language. The nature of our cognitive architecture provides restrictions on the cultural evolution of language through limitations on learning, memory and processing. For example, limitations on working memory will further accentuate the effects of the transmission bottleneck observed in the human simulations of cultural evolution. A second source of constraints derives from the perceptual and motor machinery that supports language. For example, the serial nature of vocal (and sign) production forces a sequential construction of messages with a strong bias toward local information due to the limited capacity of perceptual memory. Socio-pragmatic considerations provide yet another set of constraints on how language can evolve. As an example, consider how a shared pragmatic context may lighten the informational load on a particular sentence (i.e., it does not have to carry the full meaning by itself). Finally, the structure of our mental representations and reasoning abilities constitutes a fourth kind of constraint on language evolution. For instance, human basic categorization abilities appear to be reflected in the structure of lexical representations. Importantly, these four types of constraints do not act independently of one another; rather, specific linguistic patterns arise from a combination of several of these constraints acting in unison during language acquisition and use.

Viewing language evolution as cultural evolution has several important implications for our understanding of language acquisition. It suggests that the neural hardware put to use in acquiring language is not likely to be dedicated for this purpose. Instead, brain mechanisms are recruited during development to allow the child to comprehend and produce language. This can be seen to be analogous to the cultural recycling of neural circuits during development to accommodate children's emerging reading and writing skills. Just as the left ventral occipito-temporal cortex can be construed as part of a neural niche that has shaped writing systems, so has our language ability been shaped by preexisting constraints deriving from largely domain-general brain mechanisms.

The cultural evolution perspective also promises to recast the problem of language acquisition in a new and more tractable form. N. Chater and M. Christiansen suggest that, during development, children face two radically different kinds of induction problems. In some cases, the child needs to learn about the structure of the natural world from a sample of data. The child is like a scientist trying to discover the structure of a particular domain. This kind of natural induction (N-induction) is hard because the biases that the child brings to bear on the learning task may not be the rights ones. Acquiring language is often construed as an N-induction problem resulting in a logical problem of language acquisition: The child is seen as a linguist who seeks to discover the arbitrary constraints of some target grammar, given impoverished data. However, from the viewpoint of cultural evolution, the child's acquisition task is radically different. The goal is not to uncover regularities generated by an arbitrary structure in the natural world but rather to converge on regularities created by past generations of learners. This kind of cultural induction, where the objective is to coordinate with others (C-induction), is considerably easier. When children acquire their native language(s), their biases will be the right biases because language has been optimized by past generations of learners to fit those very biases. This does not, however, trivialize the problem of language acquisition but instead suggest that children tend to make the right guesses about how their language works—not because of an innate UG but because language has been shaped by cultural evolution to fit the domain-general constraints that they bring to bear on language acquisition.

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See Also: Chunk-Based Language Acquisition; Grammatical Categories, Acquisition of; Item-Based/Exemplar-Based Learning; Mechanisms of Cultural Transmission and Language Learning; Multiple Cues in Language Acquisition; Syntactic Development: Construction Grammar Perspective.

Further Readings

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