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Multidisciplinary approaches in evolutionary linguistics

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ABSTRACT

Studying language evolution has become resurgent in modern scientific research. In this revival field, approaches from a number of disciplines other than linguistics, including (paleo)anthropology and archaeology, animal behaviors, genetics, neuroscience, computer simulation, and psychological experimentation, have been adopted, and a wide scope of topics have been examined in one way or another, covering not only world languages, but also human behaviors, brains and cultural products, as well as nonhuman primates and other species remote to humans. In this paper, together with a survey of recent findings based on these many approaches, we evaluate how this multidisciplinary perspective yields important insights into a comprehensive understanding of language, its evolution, and human cognition.

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1. Introduction

"The story of language evolution underlies every other story that has ever existed and every story that ever will." (Kenneally, 2007, p. 13). Understanding language evolution would doubtless provide the key to answering many related, yet unresolved questions, such as how world languages possess their distinct forms, why language is the way it is, and why only our species possess a complex linguistic system. These questions belong to the realm of *evolutionary linguistics* (Hauser et al., 2007; Fitch, 2010), which aims to identify when, where, and how languages originate, change, and die out (Ke and Holland, 2006). Due to the poverty of empirical data and limitations in methodology, research in evolutionary linguistics has long been suppressed ever since the *Société de Linguistique de Paris* imposed the ban on discussing issues concerning language evolution in scientific discourse in 1886 (Stam, 1976). Owing to the significant breakthroughs and rapid development in computational powers, availability and reusability of abundant language corpora and database, and significant contributions from many other disciplines (Huang and Lenders, 2004), evolutionary linguistics has recently become a new beacon in modern scientific research to understand the nature of language and humans (Oudeyer, 2006), which can be vividly seen in many anthologies and reviews (Harnad et al., 1976; Hurford et al., 1998; Briscoe, 2002; Wray, 2002; Cangelosi and Parisi, 2002; Christiansen and Kirby, 2003b; Minett and Wang, 2005, 2008a,b; Tallerman, 2005; Hurford, 2007, 2012; Bickerton and Szathmáry, 2009; Larson et al., 2009; Tallerman and Gibson, 2012).

Language exists in two complementary aspects, namely language itself (in the form of idiolects and communal languages) and language users (in the form of the biological capacity for language) (Steels, 2005). Accordingly, research in evolutionary linguistics is also conducted in two lines, examining respectively the evolution of languages themselves and that of the biological capacity for language. The first line of research focuses on particular languages or groups/families of languages. Topics include, but are not limited to: (i) how to reconstruct the historical relations among groups/families of languages (e.g. the

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phylogeny of Sino-Tibetan, Indo-European, or Austronesian languages); (ii) how languages come into contact with each other in different socio-cultural settings (e.g. the contact or competition between dominant, invasive, or minority languages); and (iii) how phonological, syntactic or morphological features diversify across languages and change within languages (Evans and Levinson, 2009). By applying computational approaches from evolutionary biology and bioinformatics to the abundant language data (e.g., *World Color Survey* (Cook et al., 2005); *World Atlas of Language Structures* (Dryer and Haspelmath, 2011); and *Ethnologue* (Lewis, 2009)), studies in historical linguistics and typology have been making significant contributions to these topics (e.g., Felsenstein, 2004; Wang and Minett, 2005; Atkinson, 2011; Huson et al., 2011; Levinson and Gray, 2012; Wang et al., 2012).

The second line of research focuses on *the faculty of language* (the set of capacities for mastering and using any natural language, Hauser et al., 2002). Topics include, but are not limited to: (i) whether the generative capacity for language lies solely in syntax (Chomsky, 1986) or whether it can be evident in syntax, semantics, and phonology (Jackendoff, 2002); (ii) whether language processing abilities are determined by language-specific modules in the human brain (Pinker and Bloom, 1990) or whether they are derived from general cognitive abilities not initially specific to language or unique to humans (MacWhinney, 1999); (iii) how language processing abilities develop in children, allowing them to acquire particular linguistic structures; and (iv) how *linguistic universals* (particular features or principles of language structure and use that hold across most but not all world languages, Christiansen and Kirby, 2003a) originate, change and disappear.

Among these topics, *language acquisition* (the process whereby an infant acquires the ambient language, Clark, 2003) has been widely studied in psycholinguists, whereas *language origin* (the process whereby Homo sapiens made the transition from a prelinguistic communication system to a communication system with languages of the sort we use today, Wang, 1982; MacWhinney, 1999) has been largely restricted within a synchronic timescale, due to the fact that linguistic behaviors are hard to retrieve from fossil records (Hauser et al., 2002) and linguistics itself lacks scientific bases to evaluate language evolution in the past based on the data of the present (Ke and Holland, 2006). To overcome these shortcomings, studies in evolutionary linguistics, especially those concerning language origins, have to rely upon disciplines other than linguistics; that is to say, research in evolutionary linguistics is destined to be multidisciplinary. In this respect, evolutionary linguistics, and linguistics in general, needs to acknowledge the scientific approaches from other disciplines, comprehend their contributions to evolutionary linguistics, and conduct collaborative research with interested scholars from other relevant disciplines.

In support of this, we discuss in this paper a number of scientific approaches adopted in the study of language evolution. These approaches come from a variety of disciplines, including (paleo)anthropology and archaeology, animal behaviors, genetics, neuroscience, computer simulation, and psychological experimentation. For each approach, we list its primary assumptions, review some of its major findings that contribute to our understanding of language evolution, and finally, point out its inevitable limitations and uncertainties.

2. Multidisciplinary approaches to evolutionary linguistics

2.1. (Paleo)anthropology and archaeology

Approaches in these disciplines usually adopt two assumptions: (1) unique human behaviors including language could be determined by particular physiological and anatomical structures of humans; and (2) nonlinguistic phenotypes could provide indications of cognitive changes relevant for language evolution. Research of language evolution in these disciplines is often conducted in two ways: (1) comparing anatomically modern humans with fossils of extinct hominins to obtain evidence of the presence/absence of certain bony conformations associated with speech; and (2) examining archaeological records to find clues of every approximate levels of cognitive and social complexity of extinct hominins.

Though rarely touching on real language data, research in these disciplines can inform us of: (1) the evolution and migration of humans; (2) the correlations between linguistic behaviors and individual biological foundations and cultural activities; and (3) the rough time of the first appearance of language in humans. For example, by analyzing the skull endocasts of extinct hominins and modern humans, Schoenemann (2006) observed two changing tendencies of the brain size from early hominins to modern humans: (1) an absolute increase in the overall volume of the brain and (2) a relative growth of certain brain areas, such as frontal regions. Assuming a proportional correlation between the size of certain brain regions and the degree of elaboration of the functions that these regions underlie, Schoenemann ascribed the increase in brain size to the increase in the degree of specialization of certain brain regions, and pointed out that an increasing complexity of hominin conceptual understanding, manifest via the increase in brain size, led to an increasing need for syntax and grammar to perform efficient communications, thus driving language evolution. In addition, by examining tooth fossils of Neanderthals (an extinct hominin species closely related to our ancestor, Homo sapiens), Smith et al. (2007) estimated the life history of this extinct hominin. During tooth formation, biological rhythms are manifest in enamel and dentine, creating permanent records of growth rate and duration. Analyzing tooth fossils can obtain a greater precision than analyzing skeletons, thus better facilitating the assessment of growth rates in hominins. This work revealed a shorter tooth formation period in Neanderthals than in Homo sapiens, indicating that a prolonged childhood and slow life history could be unique to Homo sapiens, just as other biological adaptations and aspects of social organization. Such a prolonged childhood is obviously beneficial for language acquisition.

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