Introduction

> *SOME Hindus had brought an elephant for exhibition and placed it in a dark house. Crowds of people were going into that dark place to see the beast. Finding that ocular inspection was impossible, each visitor felt it with his palm in the darkness. The palm of one fell on the trunk. 'This creature is like a water-spout,' he said. The hand of another lighted on the elephant's ear. To him the beast was evidently like a fan. Another rubbed against its leg. 'I found the elephant's shape is like a pillar,' he said. Another laid his hand on its back. 'Certainly this elephant was like a throne,' he said.*
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> *The sensual eye is just like the palm of the hand. The palm has not the means of covering the whole of the beast.*
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> – From Rumi's Tales from the Masnavi (translated from Persian by A. J. Arberry)

Language, more than anything else, is what makes us human: the unique power of language to represent and share unbounded thoughts is critical to all human societies, and has played a central role in the rise of our species in the last million years from a minor and peripheral member of the sub-Saharan African ecological community to the dominant species on the planet today. Despite intensive searching, it appears that no communication system of equivalent power exists elsewhere in the animal kingdom. The evolution of human language is thus one of the most significant and interesting evolutionary events that has occurred in the last 5–10 million years, and indeed during the entire history of life on Earth. Given its central role in human behavior, and in human culture, it is unsurprising that the origin of language has been a topic of myth and speculation since before the beginning of history. More recently, since the dawn of modern Darwinian evolutionary theory, questions about the evolution of language have generated a rapidly growing scientific literature. Since the 1960s, an increasing number of scholars with backgrounds in linguistics, anthropology, speech science, genetics, neuroscience, and evolutionary biology have devoted themselves to understanding various aspects of language evolution. The result is a vast scientific literature, stretched across a number of disciplines, much of it directed at specialist audiences. The purpose of this book

is to survey the major issues debated in this literature, from a non-specialist and balanced viewpoint.

The single most significant problem plaguing this field, in my opinion, is aptly symbolized by the parable of the elephant (told above, in one of many forms, by the Sufi poet Rumi). Language is hugely complex, and is so central to humanity that it infiltrates all aspects of human cognition, behavior, and culture. Practitioners of many different disciplines can fairly claim insight into its workings. After twenty years of studying and discussing language evolution, I conclude that many different scholars have reached valid insights about human language, some of them quite far-reaching, but that no one scholar or discipline has yet achieved an adequately comprehensive overview of this complex system. All of us are still exploring the elephant of language in the darkness, all of us with only partial understanding, and each discipline will have its place in the richer description and understanding that all are seeking.

The diversity of perspectives can be bewildering. Where linguist Noam Chomsky sees a highly abstract core of syntax as central to the biology of language, psychologist Michael Tomasello finds it in the human capacity for shared intentions, and speech scientist Philip Lieberman sees it in the motor control of speech. In semantics, psychologist Ellen Markman argues that a suite of detailed constraints on "possible meanings" are critical for language acquisition, while computer scientist Luc Steels envisions meaning as emerging from a broad social, perceptual and motor basis. While neuro-scientist Terrence Deacon seeks the neural basis for symbolic thought in the over-developed prefrontal cortex of humans, his colleague Michael Arbib finds it elsewhere, in the mirror neurons that we share with monkeys. While most scholars agree that human language evolution involved some sort of intermediate stage, a "protolanguage," linguist Derek Bickerton argues that this system involved individual words, much like those of a two-year-old child, while anthropologist Gordon Hewes argued that it was gesturally con-veyed by the face and hands, and Charles Darwin argued that protolanguage was expressed in the form of song-like phrases. Linguist Allison Wray argues that the link between sounds and meanings was initially holistic, while her colleague Maggie Tallerman sees it as inevitably discrete and compositional. Turning to the selective pressures that made language adaptive, linguists Ray Jackendoff and Steven Pinker cite ordinary natural selection, evolutionary psychologist Geoffrey Miller argues for sexual selection, and I argue that kin selection played a crucial role. Scholars appear evenly split concerning whether language evolved initially for its role in communication with oth-ers, or whether its role in structuring thought provided the initial selective

advantage. Where some scholars see evolutionary leaps as playing a crucial role, stressing the discontinuities between language and communication in other animals, others stress gradual change and evolutionary continuity between humans and other species. All of these, and many other, issues have been vociferously debated for decades, often with little sign of resolution.

A core argument in this book is that each of the scholars has grasped some truth about language, but that none of these truths are complete in themselves. Language, I will argue, requires the convergence and integration of multiple mechanisms, each of them necessary but no one alone sufficient. From such a multi-component perspective, arguments about which single component is *the* core, central feature of "Language" are divisive and unproductive. Just as the parable urges us to reconcile apparently contradictory perspectives, I believe that an adequate understanding of language evolution requires us to reconcile many of the contrary opinions alluded to above.

In one common variant of the elephant parable, a king calls a group of blind scholars to explore the elephant, and they fall to fighting over their various interpretations. I prefer Rumi's version, for, in the case of language, there is no clear-sighted king who can survey the entire elephant: all of us have only partial insights. Unfortunately, the bellicose conclusion of this second version of the parable often applies to work in language evolution, since rhetorical battles and disciplinary turf-wars have been depressingly pervasive. I have all too frequently seen intelligent, respected scholars accuse each other of "knowing nothing about" language, evolution, the brain, or other relevant topics. Researchers whose perspective champions one or another approach often accuse their colleagues of missing the point, or of failing to understand what "Language" really is.

Because I do not think that anyone, including myself, has an adequate, comprehensive overview of language evolution, this book will not present "the answers" or resolve all debates. Rather, it will provide an overview of many different perspectives on language, and the many types of data relevant to the debates, accepting each as a necessary component of some future synthesis. The data that can help resolve the perennial issues of debate in language evolution come from so many different disciplines (spanning from physics and molecular biology to linguistics, anthropology, and sociology) that no single human could hope to master them all. Thus researchers must cooperate with others to achieve a broader and more satisfactory picture. Answers to the difficult questions about language evolution, which include some of the deepest and most significant questions concerning humanity, require interdisciplinary teamwork of a sort that remains regrettably rare in this field. My central goal in writing this book has been to increase the

potential for such collaboration by providing access to the insights from many relevant fields to any interested reader.

The nature of this book

This book provides an introduction to the interdisciplinary study of language evolution, stressing the importance of both modern biology (including neo-Darwinian evolutionary theory, developmental and molecular genetics, and neuroscience) and the modern language sciences (including theoretical linguistics, psycholinguistics, and comparative linguistics). Although biology and linguistics have traditionally traveled quite separate paths, there is growing evidence that a rapprochement and synthesis is in the making (sometimes subsumed under the term "biolinguistics"). This potential for synthesis makes the topic of language evolution both exciting, and ripe for productive interdisciplinary collaboration.

The book fills a currently empty niche. Despite an ever-increasing number of accessible books on language evolution, none attempts a comprehensive overview of the sort given here. Instead, most provide long and detailed arguments favoring one particular hypothesis or point of view. I think the field needs, and is ready for, a dispassionate survey of the available hypotheses, and an even-handed evaluation of their strengths and weaknesses in the light of currently available data. This book is problem-oriented, advocating the hypothesis-testing stance of the mature sciences. I will focus on hypotheses and data that have appeared in peer-reviewed publications in the last two decades, but I have also sought the roots of contemporary ideas and do not ignore older contributions. Although I obviously have my own perspective on these problems and my own judgments about the plausibility of various hypotheses, my goal is to enable interested readers to draw their own conclusions by providing an unbiased overview of the relevant questions, approaches, and data. In order to aid this balance, I have shared draft versions of each chapter with many relevant experts, who have in most cases kindly offered corrections or extensions of my initial attempts (see the Acknowledgments for details).

A pluralistic, multi-component perspective

The central assumption of my approach is that language must be viewed as a composite system, made up of many partially separable components.

Many of these components are widely shared with other animals (such as the capacity for hearing, memory, basic cognition, and vocalization), but a few differentiate humans from our nearest primate cousins (such as vocal learning or complex syntax). Crucially, each of these necessary components of language may conceivably have its own evolutionary history, and rely upon quite separate neural and genetic mechanisms. Although language is a system characterized by seamless interaction between these multiple components, "Language" is not a monolithic whole, and from a biological perspective may be better seen as a "bag of tricks" pieced together via a process of evolutionary tinkering. To the extent that this multi-component perspective is correct, any attempt to single out just one aspect of language as "core" or "central" is a mistake.

A second central aspect of my approach follows from this: I rely on data from a broad array of animal species to inform and test theories of language evolution. Some of the subcomponents of human language are shared with unexpected species. For instance the human capacity for complex vocal learning, allowing children to learn the words of their community's language, is shared with many birds, whales and seals, but not with chimpanzees or indeed any other primate. Investigating such traits demands a very broad comparative approach, encompassing a wide range of species, each chosen with a particular subcomponent of language in mind. The reader will thus find not only detailed discussion of chimpanzees and other primates here, but also whales, birds, honeybees, seals and deer. An exclusive focus on primates alone is misguided, and risks overlooking many species with important lessons to teach us about human language.

Nonetheless, I fully accept the uniqueness of human language: despite relying on a broad suite of biological mechanisms shared with other species, language in its full human form remains unique to our species. Human language gives us the ability to express anything we can think, and to communicate these thoughts via a set of mutually comprehensible signals. Although all animals communicate, this boundless expressivity sets our species off from all others. The fact that humans, alone on our planet, have this particular capacity is no more surprising to evolutionary biologists than other unusual features like the elephant's trunk, bat echolocation, or "radar" in electric fish. All of these "unique" traits, however, share components with other organisms, and language is no different. Based on current understanding of animal communication and cognition, *some* aspect(s) of language must be unique to our species. It remains possible that *every* subcomponent of language is shared with one species or another, and our species is simply the only one lucky enough to integrate them all. More likely, most

components are shared, but a few core aspects of the human language capacity remain unique to our species. These are empirical questions, and resolving them requires a close look at the similarities and differences between human language and animal communication and cognition.

The final principle guiding my writing has been optimism about our ability to empirically resolve many current debates. This optimism runs directly counter to the common idea that there are no data relevant to language evolution. It is true that language does not fossilize, and we have no time machines. But this does not entail that the study of language is unscientific, and more than our lack of videotapes of the Big Bang renders cosmology unscientific, or any other historically grounded science from geology to paleontology. We need to rely upon indirect evidence in all of these fields, and available data already put serious constraints upon attempts at modeling language evolution. More importantly, powerful new tools today provide an ever-increasing fund of data that will allow us to actually test hypotheses about the biology and evolution of language. To mention only two, modern non-invasive brain imaging allows us to test models about cognitive "modules" and their relationships. We shall see that such data are directly relevant to Darwin's "musical protolanguage" hypothesis. Similarly, molecular genetic techniques, applied to modern humans, allow us to estimate the times at which genes involved in speech swept through populations of our extinct ancestors. Eventually, as more about the genetic basis for language is learned, this approach may allow us to determine the order in which different components of language evolved in our species. The existence of such new tools opens up the exciting prospect, in the coming decades, of scientifically resolving debates that have dragged on for centuries or even millennia.

Despite reviewing a substantial amount of factual knowledge, this book is as focused on open questions as it is on answers. My goal is to provide the reader with the theoretical tools and factual database to help answer such questions, and offer an invitation to join in the broad, collaborative, interdisciplinary exchange that I firmly believe is necessary for progress. I hope that the reader emerges conversant with several different perspectives or hypotheses about language evolution, and a desire to test them by gathering new data. Such data could be as accessible as observing one's own child acquire language, or searching the Internet for unusual sentence structures; or it might involve multi-million dollar grant proposals in molecular biology or neuroscience. The point is that many questions that can, in principle, be answered have not yet even been asked. I will count myself successful if

this book spurs many such new questions, and at least a few answers, in the
future.

Plan of the book

The first half of the book is introductory, offering tutorial reviews of evolu-
tionary theory, linguistics, animal cognition, animal communication, and
human evolutionary history. By providing an introduction to the main
issues and hypotheses, along with concise tutorials on necessary back-
ground material, and reviewing the relevant data, I aim to provide a syn-
thetic, comparative overview of the data and disciplines that enter into
this rapidly growing field. Specialist terms are used only when necessary
(e.g. formant, homology, recursion, transcription factor, epigenesis) and
are both explained where first used, and assembled in a glossary. Although
I obviously cannot do justice to these many academic disciplines in a single
book, the goal of the introductory chapters is to equip readers to explore
further, and ultimately to evaluate current models of language evolution
themselves. These chapters provide the antidote to any belief that there are
no data relevant to language evolution, and although the connections may
at first seem quite indirect, all of these data will be put to use later in the
book.

The book starts with a survey of evolutionary theory, summarizing the
basic principles used in contemporary biology to judge the validity and
plausibility of evolutionary hypotheses. Language evolution poses some
unique problems, and may even turn out to require additions to contem-
porary evolutionary theory, but we should not prejudge this issue. Rather,
we should employ standard evolutionary logic, well-tested in many dif-
ferent organisms and traits, and only deviate from such logic if the facts
require it. Although some theorists seem to believe that language evolution,
almost by definition, breaks the normal rules of evolution, I will con-
clude that this intuition is misguided, and that contemporary evolutionary
theory already possesses the conceptual resources to handle, and indeed
strongly constrain, theories of language evolution. Furthermore, once
these constraints are taken seriously, many aspects of contemporary evo-
lutionary scenarios ("evolutionarios") of language evolution are seen to be
inadequate.

Turning next to language itself, I attempt to tease out the separate subcom-
ponents of the language faculty that needed to evolve since our divergence

from chimpanzees. I will enumerate a suite of different mechanisms involved in language: summarized under the "three S's" of signal, structure, and semantics. I situate each of these in the traditional subdisciplines of linguistics (phonetics, phonology, syntax, semantics, and pragmatics), but in each case the system in question requires further subdivision to reach the grain of actual biological mechanisms. Chapter 3 doubles as an introduction to linguistics, and a classification of the mechanisms involved in modern human language. Given this preliminary breakdown of mechanisms, we turn in the remaining introductory chapters to studies of animal cognition and communication, investigating which of these many mechanisms are shared with other species, and which appeared to evolve separately in the human lineage. We will pay careful attention to chimpanzees and other primates, but we will also examine more distant relatives (such as birds or seals) because parallel (or "convergent") evolution of human-like traits has much to teach us about the evolution of such traits. This is particularly the case for phonology and syntax, where the study of other species suggests some possible revisions to the traditional view of the phonological and syntactic subsystems. I conclude that each traditional subdivision includes multiple mechanisms, many of them shared with other species. But in each case, at least one subcomponent appears to have evolved in humans since our divergence from the chimpanzee lineage.

In the next section, I provide a whirlwind tour of human evolution, starting from the beginning of life and the first cells. This introduction to our long ancestry shows that most of human biology, including many aspects of behavior and cognition, has very deep roots, long predating our split with chimpanzees about 6 million years ago. I will discuss our last common ancestor with chimpanzees, in detail, and then review the fossil evidence concerning our hominid ancestors. These introductory chapters provide the factual background and key data enabling the reader to evaluate, in a balanced, well-informed manner, current debates.

The second half of the book systematically introduces and evaluates current theories about language evolution, reviewing the many current hypotheses about the stages through which humans passed in our route from our last common ancestor (LCA) with chimpanzees, which lacked language, to modern *Homo sapiens*, which has it. Although this aspect of biolinguistics is sometimes seen as hopelessly speculative, I will argue that the comparative and linguistic data reviewed in the earlier sections allow us to evaluate, and sometimes reject, hypotheses. Constructing viable hypotheses for language evolution that cover this full timespan, and deal adequately with all core components of language without unjustified assumptions, is

far from trivial. Furthermore, by considering the hypotheses of different scholars side-by-side, we can see how various combinations of current proposals might work together synergistically to provide greater explanatory coverage. Most fundamentally, this approach in many cases allows *predictions* to be made that can be tested with the ever-increasing flow of data on brain development, animal communication, evolutionary theory, neurolinguistics, and comparative genomics.

I start with a detailed description and analysis of the biology and evolution of speech. Although speech is but one of the suite of components making up language as a whole, the physical tangibility of the speech signal has led to an extensive body of research and clear scientific progress in the last decades. I will discuss the reconfigured anatomy of the human vocal tract ("the descent of the larynx") in detail, because this feature has played a central role in many discussions of language evolution. However, I will conclude that peripheral vocal anatomy is not a controlling factor in the biology of language, and that vocal tract configuration has been over-emphasized in discussions of language evolution. This negative verdict leads to a positive conclusion: that the human speech capacity is grounded in *neural* changes. The trajectory of this line of research, starting with early work of Philip Lieberman and colleagues in the late 1960s, offers an excellent illustration of the power of the comparative method to test hypotheses and resolve debates about language evolution. The speech chapters will demonstrate the value of the comparative, multi-component approach adopted throughout this book.

Next, I address the evolution of other components of language, including syntax and semantics, using the core notion of a "protolanguage" to structure the analysis. All modern theories of language evolution posit one or more intermediate systems, "**protolanguages**," that represent evolutionary precursors to language in its full, modern sense. Most contemporary scholars agree on the explanatory necessity for protolanguage: language did not spring into being all at once, like Athena from Zeus's brow, but developed in stages, each one of them serving some function of its own. However, there is strenuous disagreement about the sequence in which the components appeared, and the nature of the protolanguages they served. Proponents of **lexical protolanguage** suggest that language started with isolated, meaningful spoken words: speech and semantics came first, and syntax last. In contrast, proponents of **gestural protolanguage** suggest that language started in the manual modality, and that syntax and semantics preceded speech. Finally, proponents of **musical protolanguage** argue that speech initially arose as complex learned vocalizations, more like song than speech, and that semantics was added to this system later.

Since protolanguages constitute hypotheses about what a system could have been like, before it was linguistic, the very notion of a protolanguage requires that we abandon preconceptions about one "core" or central aspect of language. An open-minded attitude towards different hypotheses about protolanguage thus goes hand in hand with the multi-component approach. I will stress the testable empirical consequences of each hypothesis, particularly those that would allow us to distinguish between them. Although sometimes denounced as mere fairytales, such evolutionary scenarios are valuable in the study of the biology and evolution of language precisely to the extent that they drive us to gather new data – data that might not otherwise be seen as interesting or worthy of collection. Although we may never know for certain whether *Homo erectus* sang, or if Neanderthals communicated in sign language, posing these questions explicitly can lead to a better empirical understanding of the relations between speech and sign, syntax and semantics, or language and music in modern humans, an understanding of independent scientific value. Furthermore, as the genetic bases for these different systems become better understood, there is a real possibility that some of these debates can be answered more definitively by "fossils" left in the human genome which allow us to discover the sequence of the selective events that drove different evolutionary components to fixation (Enard *et al.*, 2002; Carroll, 2006). Because this exciting possibility remains speculative at present, I think phylogenetic hypotheses must always be viewed circumspectly and seen as generators of questions, and possible answers ("intuition pumps") rather than as ends in themselves. Like all scientific hypotheses, they are proposals to be interrogated, knocked down, and rebuilt, not beliefs to be defended. I will conclude that no one of these models, alone, can fully account for language evolution, and that a successful theory will need to selectively integrate insights from each. This last part of the book provides far more questions than answers, but I will conclude with a summary and prospectus that strikes a cautiously optimistic note about the future of this aspect of biolinguistics. But let us now dive into the theory and data that can help constrain our hypotheses.