THE STORY OF HUMANITY'S GREATEST INVENTION

HOW LANGUAGE BEGAN

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Preface

AROUND 1920 A RATTLESNAKE killed my great-grandfather outside of Lubbock, Texas. Walking home from church with his family across a cotton field, Great-grandfather Dungan was telling his children to watch out for snakes in the field when he was suddenly struck in the thigh. His daughter, Clara Belle, my grandmother, told me that he suffered for three days, crippled in pain and screaming, until he finally expired in his bedroom at the back of the house.

One did not have to be at the scene of the incident to know that, because it was a rattlesnake, it must have 'warned' my great-grandfather before striking. But, considering the outcome, there must have been a communication failure between Papa Dungan and the snake. My grandmother saw the snake bite her father and she talked about the event a great deal during my childhood. She often remembered the moments when the snake was 'warning' her father, as if the beast would use actual words if it only could. However, people who know that rattlesnakes communicate often confuse their tail shaking with language, leading them to anthropomorphise and evoke human terms, such as saying they 'tell' threatening creatures 'to stay away' by shaking the keratin-formed, interlocking, hollow parts at the end of their tail to produce a loud rattle. Though that action is not technically language, the snake's rattling carries important information nonetheless. My great-grandfather paid a heavy price for failing to heed that message.

Rattlesnakes aren't the only animal communicators, of course. In fact, all animals communicate, receiving and transmitting information to other animals, whether of their own or different species. As I will later explain, however, we should resist labelling the rattle of a snake 'language'. A rattlesnake's repertoire is splendidly effective, but for severely limited purposes. No snake can tell you what it wants to do tomorrow or how it feels about the weather. Messages like those require language, the most advanced form of communication earth has yet produced.

The story of how humans came to have language is a mostly untold one, full of invention and discovery, and the conclusions that I come to through that story have a long pedigree in the sciences related to language evolution – anthropology, linguistics, cognitive science, palaeoneurology, archaeology, biology, neuroscience and primatology. Like any scientist, however, my interpretations are informed by my background, which in this case are my forty years of field research on languages and cultures of North, Central and South America, especially with hunter-gatherers of the Brazilian Amazon. As in my latest monograph on the intersection of psychology and culture, *Dark*

Matter of the Mind: The Culturally Articulated Unconscious, I deny here that language is an instinct of any kind, as I also deny that it is innate, or inborn.

As far back as the work of psychologist Kurt Goldstein in the early twentieth century, researchers have denied that there are language-exclusive cognitive disorders. The absence of such disorders would seem to suggest that language emerges from the individual and not merely from language-specific regions of the brain. And this in turn supports the claim that language is not a relatively recent development, say 50–100,000 years old, possessed exclusively by *Homo sapiens*. My research suggests that language began with *Homo erectus* more than one million years ago, and has existed for 60,000 generations.

As such, the hero of this story is *Homo erectus*, upright man, the most intelligent creature that had ever existed until that time. *Erectus* was the pioneer of language, culture, human migration and adventure. Around three-quarters of a million years before *Homo erectus* transmogrified into *Homo sapiens*, their communities sailed almost two hundred miles (320 kilometres) across open ocean and walked nearly the entire world.

Erectus communities invented symbols and language, the sort that wouldn't seem out of place today. Although their languages differed from modern languages in the quantity of their grammatical tools, they were human languages. Of course, as generations came and went, *Homo sapiens* unsurprisingly improved on what *erectus* had done, but there are languages still spoken today that are reminiscent of the first ever spoken, and they are not inferior to other modern languages.

The Latin word *Homo* means 'man'. Therefore, any creature of the *Homo* genus is a human being. In two-word Latin biological nomenclature, a genus is the broader classification of which a species is a variant. Thus, *Homo erectus* describes a species – *erectus*, 'standing' – that is a member of the human, *Homo*, genus. *Homo erectus* thus means 'standing man'. This is the first species of humans. *Homo neanderthalensis* means 'Neander Valley man', based on the fact that its fossils were first discovered in the Neander Valley of Germany. *Homo sapiens* means 'wise man', and suggests, erroneously as we see, that modern humans (we are all *Homo sapiens*) are the only wise or intelligent humans. We are almost certainly the smartest. But we are not the only smart humans who ever lived.

Erectus also invented the other pillar of human cognition: culture. Who we are today was partially forged by the intelligence, travels, trials and strength of *Homo erectus*. This is worth stating because too many *sapiens* fail to reflect on the importance of earlier humans to who we are today.

My interest in language and its evolution is personal. All of my life, from my earliest years growing up on the Mexico–California border, languages and cultures have fascinated me. And how could they not? Incredibly, all languages share at least some grammatical characteristics, whether it be words for things, words for events or conventions for ordering and structuring sounds and words, or organising paragraphs, stories and conversations. But languages are perhaps even more unlike one another than alike. However easy or difficult these differences may be to discover, they are always there. Today, there is no universal human language, whether or not there was at some period in the remote past. And there is no mental template for grammar that humans are born with. Languages' similarities are not rooted in a special genetics for language. They follow from culture and common information-processing solutions and have their own individual evolutionary stories.

But each language satisfies the human need to communicate. While many people in today's world are tempted to spend more time on social media than perhaps they should, it is the pull of linguistic intercourse that is mainly driving them there. No matter how busy some are, it is hard for them to avoid entering into some 'conversation' on the screen in front of them to opine on issues about which they often know little and care less. Whether via water cooler conversations, or absorbing information from television, or discussing plays, or reading or writing novels, talking and writing bind humans ever more tightly into a community.

As a result, language – not communication – is the dividing line between humans and other animals. Yet it is impossible to understand language without understanding something of its origin and evolution. For centuries people have offered ideas about where and when language originated. They have wondered which of the many species of the genus *Homo* was the first to have language. And they have asked what language sounded like at the aurora of human history. The answer is easy. Language gradually emerged from a culture, formed by people who communicated with one another via human brains. *Language is the handmaiden of culture*.

How Language Began offers a unique, wide-ranging story of the evolutionary history of language as a human invention – from the emergence of our species to the more than 7,000 languages spoken today. Their complexity and range was invented by our species, later developing into local variants, each new linguistic community altering language to fit its own culture. To be sure, the first languages were also constrained by human neurophysiology and the human vocal apparatus. And all languages came about gradually. Language did not begin with gestures, nor with singing, nor with imitations of animal sounds. Languages began via culturally invented symbols. Humans ordered these initial symbols and formed larger symbols from them. At the same time symbols were accompanied by gestures and pitch modulation of the voice: intonation. Gestures and intonation function together and separately to draw attention to, to render more salient perceptually, some of the symbols in an utterance – the most newsworthy for the hearer. This system of symbols, ordering, gestures and intonation emerged synergistically, each component adding something that led to something more intricate, more effective. No single one of these components was part of language until they all were – the whole giving purpose to the parts – as far back as nearly two million years ago. Language was culturally invented and shaped and made possible by our large, dense brains.[1] This combination of brain and culture explains why only humans have ever been able to talk.

Other authors have labelled language an 'invention', only to qualify that reasonable assessment by adding 'but it's not *really* an invention. That is a metaphor.' But the use of the word 'invention' here is not a metaphor. It means what it says – human communities *created* symbols, grammar and language where there had been none before.

But what is an invention? It is a *creation of culture*. Edison alone did not invent the light bulb; he needed Franklin's work in electricity nearly 200 years before him. No one person invents anything. Everyone is part of a culture and part of each other's creativity, ideas, earlier attempts and the general world of knowledge in which they live. Every invention is built up over time, bit by bit. Language is no exception.

Introduction

In the beginning was the Word.

John 1:1

No, it wasn't.

Dan Everett

IT WAS A SULTRY MORNING IN 1991, along the Kitiá river in the Amazonian rainforest of Brazil, some 200 miles (320 kilometres) in a single-engined plane from the nearest town. I found myself fitting headphone mics on two slender, weather-hardened men, Sabatão (sa-ba-TOWN) and Bidu (bee-DOO). This time of day would usually find them in the jungle, armed with eight-foot blowguns and quivers of poisoned darts, hunting for peccary, deer, monkey, or other game indigenous to their Eden. But today they were going to talk to each other while I bothered with recorder controls and sound levels.

Before we began I explained to them, again, in a mix of their language, Banawá (ba-na-WA) and Portuguese, what I wanted. 'Talk to each other. About anything. Tell each other stories. Talk about the Americans and the Brazilians who visit the village. Whatever you want.' I had coaxed and paid them to be here because I was after the holy grail of the linguistics field researcher – natural conversation (interactive, spontaneous communication involving more than one person). I knew from my past failures that natural conversations were nearly impossible to record. This is because the presence of a field researcher with recording equipment affects the perception of the task and contaminates the result so severely that one usually gets only stilted, unnatural exchanges that no native speaker would accept as a real conversation. (Imagine if someone sat you down with a friend, fitted you with a headset mic and then cued you, 'Converse!')

But today, as I tested the sound quality of the recording I was making, I could barely contain my excitement. They began like this:

Sabatão:	Bidu, Bidu! Let talk today.
Bidu:	*Mmm.*
S:	Let talk in our language
B:	*Mmm.*
S:	Daniel likes our language very much.

B: *Yes, I know.*

S: I will talk. You can then tell a story about that jaguar.

B: *Yes.*

S: Let's remember how things were a long time ago.

B: *Yes. I remember.*

S: A long time ago the whites arrived. A long time ago the whites arrived in our village.

B: *Them I know.*

S: They found us. We will work with them.

B: *Yes. Them I know.*

Their conversation glided from topic to topic naturally for the better part of an hour.

Though I was several thousand miles from home, sweating profusely, swatting away wasps and blood-sucking flies, I nearly teared up after Sabatão and Bidu finished, forty-five minutes later. I thanked them enthusiastically for this verbal treasure they had provided me with. They smiled and left to go hunting with their blowguns and poisoned darts. I continued alone, transcribing (writing down every nuance phonetically), translating and analysing the recording. After a couple of days of hard work to make the data 'presentable', I turned over the recordings, my notes and the bulk of the remaining work of analysis to a graduate student who had accompanied me to the Amazon from the University of Manchester in England.

At the end of the day our research team – myself and three students – enjoyed an evening meal of beans, rice and peccary meat I had purchased from the Banawás. We sat around after the meal, discussing the jungle heat and bugs, the likes of which we'd never seen before, but especially we conversed about the recorded conversation of Bidu and Sabatão and how grateful we were to them. Conversations within conversations. Conversations about conversations.

Following the blink-of-an-eye Amazonian sunset, the Banawás came to visit, as is their custom. The four of us made Kool-Aid and coffee and opened a package of sweet biscuits for them. We first greeted the Banawá women. The female students handled most of the serving and greeting of the women as is culturally appropriate among the Banawás, who practise rigorous segregation of the sexes. Soon the men were allowed to sit down and we served more coffee, Kool-Aid and sweet biscuits. As we ate and drank, we chatted with the men, mainly answering their questions about our families and homes. Just like people everywhere do on a daily basis, we and the Banawás were building relationships and friendships through conversation.

Natural conversations of this sort are important to linguists, psychologists, sociologists, anthropologists and philosophers because they embody the complex, integrated whole of language in a way that no other manifestation of language does. Conversations are the apex of linguistic studies and sources of insight particularly because they are potentially open-ended in meaning and form. They are also crucial to understanding the nature of language because of their 'underdeterminacy' – saying less than what is intended to be communicated and leaving the unspoken assumptions to be figured out by the hearer in some way. Underdeterminacy has always been part of language.

As an example of underdeterminacy, look at the second line of the conversation between Sabatão and Bidu. Sabatão says to Bidu, 'Let talk in *our language*.' This is strange if one takes it literally, because *they are already speaking in their language*. In fact, these men would be hard pressed to carry on a natural conversation in Portuguese, because their knowledge of it is rudimentary, limited principally to bartering. Sabatão's words presume something unstated. Sabatão is using these words to indirectly let *me* know that they will not use any Portuguese to converse *because they know that I am trying to understand how they converse in their language* and *because they want to help me*. None of this is spoken. Though underdetermined by the words, it is implicit in the context.

Likewise, in the line 'Let's remember how things were a long time ago' there is shared knowledge of the general range of things they are trying to remember. What is up for grabs here? Rituals? Hunting? Relationships with other peoples? How long ago? Before the Americans came? Before the Brazilians came? A hundred generations? Both Bidu and Sabatão (or indeed any other Banawá) know what is being talked about, but this is not clear initially to someone from another culture.

Sabatão and Bidu are two of the eighty or so remaining speakers of Banawá, a language that has already helped the scientific community learn a great deal about human language, cognition, the Amazon and culture. Specifically, they have taught us about unusual sound structures and grammar, the ingredients and process for manufacturing poison for darts and arrows, their classification of Amazonian flora and fauna and their connections linguistically to other Amazonians. Such lessons naturally follow from working out the knowledge structures, values, linguistics and social organisation of different groups who, like the Banawás, have spent millennia mastering life in a particular niche.

Any community – whether it be the Banawás, the French, the Chinese, or Botswanans – uses language to build social ties between members of their community and others. Indeed, our species has been conversing for a very long time. All languages on earth trace their underdetermined, socially bonding, grammar-constrained, meaning-motivated expressions of thought back to early hominins, to *Homo erectus* and perhaps even earlier. Based on the evidence of *Homo erectus* culture, such as their tools, houses, village spatial organisation and ocean travel to imagined lands beyond the horizon, the genus *Homo* has been talking for some 60,000 generations – quite possibly more than one and a half million years. By now one would expect our species, after more than a thousand thousand years of practice, to be very good at language. And we would also expect the languages we have all developed over time to better fit our cognitive and perceptual limitations, auditory range, vocal apparatus and brain structures. Underdeterminacy means that every utterance in every conversation and every line in every novel and each sentence of any speech contains 'blank spots' – unspoken, assumed knowledge, values, roles and emotions – underdetermined content that I label 'dark matter'. Language can never be understood entirely without a shared, internalised set of values, social structures and knowledge relationships. In these shared cultural and psychological components, language filters what is communicated, guiding a hearer's interpretations of what another is saying. People use the context and cultures in which they hear language to interpret it. They also use gestures and intonation, in order to interpret the full meaning of what is being communicated.

Like all humans, the first *Homo* species to begin the long arduous process of constructing a language from scratch almost certainly never said entirely what was on their minds. That would violate basic design features of language. At the same time, these primordial hominins would not have simply made random sounds or gestures. Instead, they would have used means to communicate that they believed others would understand. And they also thought their hearers could 'fill in the gaps', and connect their knowledge of their culture and the world to interpret what was uttered.

These are some of the reasons why the origins of human language cannot be effectively discussed unless conversation is placed at the top of the list of things to understand. Every aspect of human language has evolved, as have components of the human brain and body, to engage in conversation and social life. Language did not fully begin when the first hominid uttered the first word or sentence. It began in earnest only with the first conversation, which is both the source and the goal of language. Indeed, language changes lives. It builds society, expresses our highest aspirations, our basest thoughts, our emotions and our philosophies of life. But all language is ultimately at the service of human interaction. Other components of language – things like grammar and stories – are secondary to conversation.

This point raises an interesting question about language evolution, namely who spoke first? Over the past two centuries a plethora of ancestors for humans have been proposed, from South Africa, Java and Beijing, to the Neanderthal Valley and Olduvai Gorge. At the same time, researchers have proposed several novel hominin species, leading to a confusing evolutionary mosaic. To avoid getting caught up in a morass of uncertain proposals, only three language-possessing species need to be discussed – *Homo erectus*, *Homo neanderthalensis* and *Homo sapiens*.

Few linguists claim that *Homo erectus* had language. Many, in fact, deny this. There is currently no consensus on when the first humans spoke. But there does seem to be some modern consensus on human evolution, the methods used and an overview of the evolution of our species' physical and cognitive abilities. In *The Descent of Man*, Charles Darwin suggested that Africa might be the birthplace of humans because it is also the location of most apes. He reasoned (correctly) that humans and apes probably are closely related, sharing a common ancestor. Darwin wrote these prescient remarks prior to the major discoveries of early hominins (hominin refers to the genus *Homo* and their upright ancestors, such as *Australopithecus afarensis*). Another group of relatives, the hominids, are the great apes. This group includes humans, orang-utans, gorillas, chimpanzees, bonobos and their common ancestor. The cast in the story of human evolution includes the offshoots of *Homo erectus*, up to modern humans. To understand the relationships between some of these different species and whether or not they spoke, one must learn what is known about them.

Part of the controversy of human origins is the number of species of *Homo* that existed, but it is still necessary to understand the potential cognitive abilities of all hominins (based on brain size, tool kits and travel) before moving on to the significance of hominin migration for the evolution of human language. One can focus on physiology or culture or both, yet some of the most interesting evidence comes from culture.

Symbols (the association of largely arbitrary forms with specific meanings, such as using the sounds in the word 'dog' to mean *canine*) were the invention that put humans on the road to language. And for this reason we must understand not only how they came about, but also how they were adopted by entire communities and how they were organised. One proposal I discard is arguably the most influential explanation of the origin of human language of all time. This is the idea that language resulted from a single genetic mutation some 50–100,000 years ago. This mutation supposedly enabled *Homo sapiens* to build complex sentences. This is the set of ideas known as *universal grammar*. But a very different hypothesis emerges from a careful examination of the evidence for the biological and cultural evolution of our species, namely the *sign progression* theory of language origin. This phrase means simply that language emerges gradually from indexes (items that represent things they are physically connected to, such as a footprint to an animal) to icons (things that physically resemble the things they are used to represent, such as a portrait for the real person) and finally by creating symbols (conventional ways of representing meaning that are largely arbitrary).

Eventually, these symbols are combined with others to produce grammar, building complex symbols out of simple ones. This sign progression eventually reaches a point in language's evolution in which gestures and intonation are integrated with grammar and meaning to form a full human language. This integration transmits and highlights the information that the speaker is telling the hearer about. It represents a crucial, though often ignored, step in the origin of language.

Because the evolution of language is such a hard problem, the earliest efforts to solve it predictably began rather badly. In place of data and knowledge, accounts relied on speculation. One popular idea was that all languages began with Hebrew, since it was believed that this was the language of God. Like this Hebrew-first speculation, many ideas were abandoned, although there were others that included kernels of good ideas. These have led, however circuitously, to the present understanding of language origins.

But a serious deficiency traced its way through all of these early efforts and a lack of evidence, in conjunction with an abundance of speculation, irritated many scientists. So in 1866 the Paris Linguistics Society declared that it would no longer accept papers about language origins.

The good news is that the ban has now been lifted. Contemporary work is somewhat less speculative and occasionally more firmly grounded in hard evidence than the work of the nineteenth and twentieth centuries. In the twenty-first century, in spite of the difficulties, scientists have finally managed to put together enough of the extremely small pieces of the language evolution puzzle to give a reasonable idea of how human languages came about.

Still, one of the greatest mysteries left to solve regarding the origin of language, as many have observed, is the ‘language gap’. There is a wide and deep linguistic chasm between humans and all other species. Communication systems of the animal kingdom are unlike human language. Only human languages have symbols and only human languages are significantly compositional, breaking down utterances into smaller meaningful parts, such as stories into paragraphs, paragraphs into sentences, sentences into phrases and phrases into words. Each smaller unit contributes to the meaning of the larger unit of which it is a part. For some, this language gap exists simply because humans are a special creature unlike any other. Others claim that the distinctiveness of human language was designed by God.

More likely, the gap was formed by baby steps, by homeopathic changes spurred by culture. Yes, human languages are dramatically different from the communication systems of other animals, but the cognitive and cultural steps to get beyond the ‘language threshold’ were smaller than many seem to think. The evidence shows that there was no ‘sudden leap’ to the uniquely human features of language, but that our predecessor species in the genus *Homo* and earlier, perhaps among the australopithecines, slowly but surely progressed until humans achieved language. This slow march taken by early hominins resulted eventually in a yawning evolutionary chasm between human language and other animal communication. Eventually, *Homo* species developed social complexity, culture and physiological and neurological advantages over all other creatures.

Human language thus begins humbly, as a communication system among early hominids not unlike the communication systems of many other animals, but more effective than a rattlesnake’s.

What if all eighty remaining speakers of Banawá died out suddenly and their bones were discovered only 100,000 years hence? Forgetting for now the fact that linguists have published grammars, dictionaries and other studies of the Banawá language, would their material culture leave any evidence that they were capable of language and symbolic reasoning? Arguably it would leave even less evidence of language than has been found for *neanderthalensis* or *erectus*. Banawá art (such as necklaces, basket designs and carvings) and their tools (including bows, arrows, blowguns, darts, poison and baskets) are biodegradable. So their material culture would disappear without a trace in much less than the 800,000 to 1,500,000 years that have passed since the appearance of the earliest cultures. Of course, it might be determined from soil usage that they had villages of a certain size, huts and so on, but it would be as difficult to extrapolate from the remnants of their artefacts that they had language, as it is to claim that many ancient hunter-gatherer groups did or did not have language. It is known that current populations of Amazonians have fully developed human languages and rich cultures, so care must be taken not to conclude prematurely that the absence of evidence about language or culture in the prehistoric record indicates that ancient human populations lacked these essential cognitive attributes. In fact, when we look closely, there is evidence that the earliest species of *Homo* did in fact have culture and did speak.

The solution to the mystery of human language origins begins with an examination of the nature and evolution of the only surviving linguistic species, *Homo sapiens*, or, as author Tom Wolfe puts it, *Homo loquax*: 'speaking man'. There are several unique perspectives that mark the path of the evolution of language.

First, human language emerges from the much larger phenomenon of animal communication. Communication is nothing more than the (usually intentional) transference of information from one entity to another, whether this be the pheromonal communication of ants to other ants, the calls of vervets, the tail positions and movements of dogs, the fables of Aesop, or the writing and reading of books. Language is much more than information transfer, though.

The second perspective on the evolution of language derives from an examination from both the biological and cultural vantage points. How did the brain, the vocal apparatus, movements of the hands and the rest of the human body, in conjunction with culture, affect and facilitate language evolution? Too many accounts of language evolution focus on one or the other of these, the biological vs the cultural, to the exclusion of the others.

A final, and necessary, perspective may strike some as curious. It is to look at language evolution as a linguistic field researcher would. That perspective leads to two fundamental questions: how similar are the human languages that are spoken today and what does the diversity of modern languages reveal about the first human languages? These perspectives offer a useful vision of evolutionary milestones that mark the path of the first language of *Homo* species.

There are still additional questions to answer. Are gestures crucial to human languages? Yes, they are. Is a vocal apparatus identical to that of modern humans necessary for human languages? No. Are complex grammatical structures required for human languages? No, but they are found in many modern languages for a variety of reasons. Do some societies communicate less or use linguistic communication less than others? It seems so. *Erectus* might have been in possession of language yet nevertheless valued taciturnity.

Part One

The First Hominins

1
Rise of the Hominins

> The hand of the Lord was on me, and he brought me out by the Spirit of the Lord and set me in the middle of a valley; it was full of bones. He led me back and forth among them, and I saw a great many bones on the floor of the valley, bones that were very dry …
>
> Ezekiel 37:1–2

CONTROVERSY IS OFTEN DIFFICULT to resolve. In June of 2011 a young mother, Casey Anthony, was on trial for the murder of her two-year-old daughter, Caylee Anthony. The prosecution supported its allegation that Casey murdered her daughter with evidence that her daughter's body had been stored in the trunk of Casey's car – a car only she had access to – for several days in 90-degree weather. They produced witnesses who claimed that they had smelled the stench of a decomposing body in the trunk of that car and also showed that there were bugs in the trunk typical of those that would have swarmed and multiplied in the hot sun on a dead body. Grisly evidence, to be sure. But it sounds convincing. Had the trial stopped there, perhaps a guilty verdict would have been rendered.

First, however, the defence needed to plead their case. Of course, they called their own witnesses, including a forensic expert who argued that the smell people reported could have come instead from a bag of garbage that Casey had left in her trunk for more than a week (no one was defending her hygiene). Moreover, the forensic witness claimed that the bugs found in the trunk of Casey's car were neither of the type nor in the quantity that would be expected if her car trunk had contained a decomposing body. Finally, after much more arguing back and forth between the experts and attorneys, the jury ultimately decided in favour of the defence. Twelve people found the defendant's story sufficiently credible to raise reasonable doubt about what happened to Caylee.

The problem of reasonable doubt that faces some juries is also common in science. But the difference is that scientists, unlike jurists, *thrive* on reasonable doubt. This is because, like doubt, they are trying neither to convict theories, nor to exonerate them. Rather, scientists want to *evaluate* theories, rejecting those that have *excess* reasonable doubt, even if only temporarily. In other words, doubt is an intellectual tool that allows scientists to narrow down the number of theories they need to concern themselves with.

It is unsurprising that disagreement between experts occurs. In fact, consensus among experts often seems rarer than disagreement. Every scientific advance usually originates as a dispute concerning the interpretation of evidence for vs evidence against some thesis. Science is not about finding a 'true' theory. It is about finding the best theory, as scientists grope their way towards understanding.

Much vaster and more complicated than any murder trial is the quest to understand the origin of humans and their languages. This effort requires a picture of the trajectory from the initial state of hominins to the current state, and is always going to be fraught with controversy and disagreement. Definitive knowledge is lacking even on such basic questions as the variability in the complexity of human reasoning across human species in the evolutionary record. There is not even consensus on the range of variation in the five 's's: smarts, speed, size, sex and strength among modern humans.

So why are such problems regarding the limits of human capacity relevant to understanding the species' evolution? Because specialists and laypeople alike fail to agree what new evidence means since they *interpret* any new discoveries or findings differently. Rather than naively anticipating agreement, one can hope instead for a weighing of alternative accounts. Most specialists are able to determine when one account has cast reasonable doubt upon another. But no one can tell someone which account to choose, nor can they predict which account someone will select. Scientific choices are intellectually, culturally and psychologically motivated.

Part of understanding human species surely must be to appreciate how humans came to achieve greater cognitive success than any other species. Humans are everywhere. Like cockroaches and rats, they are adaptable, multiply quickly and travel well. They are tough and resilient. They are clever. They can be territorial, diurnal, nocturnal, or crepuscular. They can be kind or vicious. Humans have become, for better or worse, lords of the planet. If the dinosaurs were still alive today, humans would kill them for trophies, or eat them, or put them in parks and zoos. They would be no match for *sapiens*. Humans, not they, are the apex predators of all time on this planet. This success has much to do with the fact that, though *sapiens* are small with soft skin, no claws or serious strength, they talk to each other. Because humans can talk they can plan, they can share knowledge, they can even leave knowledge for future generations. And therein lies the human advantage over all other terrestrial species.

So exactly what is this ability of humans – what is language? It isn't possible to talk about how some characteristic, such as language, evolved without at least some idea about what this characteristic is.

Language is the interaction of meaning (semantics), conditions on usage (pragmatics), the physical properties of its inventory of sounds (phonetics), a grammar (syntax, or sentence structure), phonology (sound structure), morphology (word structure), discourse conversational organisational principles, information and gestures. Language is a gestalt – the whole is greater than the sum of its parts. That is to say, the whole is not understood merely by examining its individual components.

Indeed, there are entire communities of linguists who identify themselves by the different subareas. There are pragmaticians, conversational analysts, syntacticians, morphologists, phoneticians, semanticists and so on. But none of them is studying language as a whole, only the parts they are interested in professionally. A syntactician is to language as an ophthalmologist is to the body. Both are necessary, but each is (understandably) tackling a very small piece of the pie.

What is the full pie supposed to be like, then? It is a communication system. And this is what the evolutionary and contemporary evidence points to – namely that the ultimate purpose and accomplishment of language is the building of communities, cultures and societies. These are built through stories and conversations, written or oral, each of which helps to establish and justify shared value priorities for cultures or individuals. Language, in fact, builds the knowledge structures that are peculiar to a particular culture (such as the colours recognised, the types of professions considered most attractive, medical understanding, mathematics and all of the other things humans know as members of a society). And language also helps to interpret the different social roles, such as father, boss, employee, doctor, teacher and student, that a culture recognises.

Grammar is a tremendous aid to language and also helps in thinking. But it really is at best only a small part of any language, and its importance varies from one language to another. There are tongues that have very little grammar and others in which it is extremely complex.

The course followed by humans on the path to language was a progression through natural signs to human symbols. Signs and symbols are explained in reference to a theory of 'semiotics' in the writings of Charles Sanders Peirce. C. S. Peirce was perhaps the most brilliant American philosopher in history. He contributed to mathematics, to science, to the study of language and to philosophy. He is the founder of two separate fields of study: *semiotics* – the study of signs – and *pragmatism* – the only uniquely American school of philosophy. In spite of his brilliance, he was never able to secure long-term employment because he was cantankerous and rebellious against social mores. Peirce's semiotics did not concern itself directly with the evolution of language. But it turns out to be the best model of the stages of linguistic evolution.

Peirce's theory indirectly predicts a progression of signs from natural signs (indexes), to icons, to human-created symbols.* This progression moves to an increasing complexity of types of sign and the evolutionary progression of *Homo* species' language abilities. A sign is any pairing of a form (such as a word, a smell, a sound, a street sign, or Morse code) with a meaning (what the sign refers to). An index, as the most primitive part of the progression, is a form that manifests an actual physical link to what it refers to. The footprint of a cat is an index: it indicates, makes us expect to see, a cat. The smell of a grilling steak brings the steak and the grill to mind. Smoke indexes fire. An icon is something that physically evokes what it refers to: a sculpture or portrait references its subject via a physical resemblance. An onomatopoeic word like ‘bam’ or ‘clang’ brings to mind those sounds.

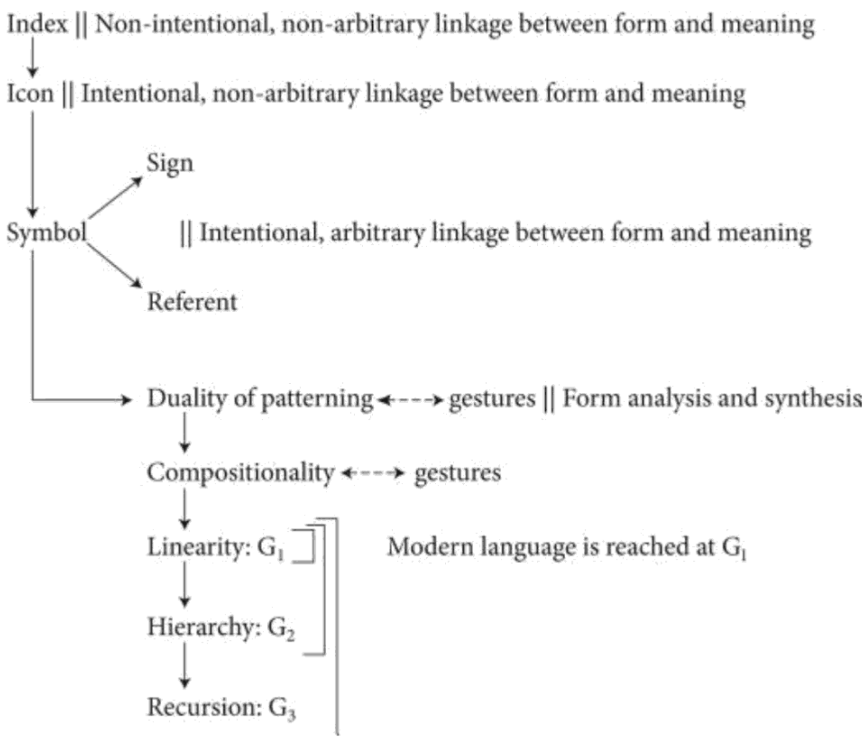

Figure 1: **The semiotic progression**

Symbols are conventional links to what they refer to. They are more complicated than other signs because they need not bear any resemblance to nor any physical connection to what they refer to. They are agreed upon by society. The numeral ‘3’ refers to the cardinality of three objects just as ‘Dan’ refers to someone of that name, not because the word ‘three’ bears a physical connection or resemblance to cardinality, nor because all people named Dan have any physical characteristic in common. This arbitrary, conventional association of form and meaning is exactly what renders symbols the beginning of language and evidence for social norms. Symbols are the original social contract.

Figure 1 gives us a view of the relative order of language evolution, following Peirce’s ideas closely (though putting the index before the icon).

Once humans had symbols, certain portions of those symbols became more meaningful than other parts. If I randomly choose to write an S as Ŝ or a P as 𝒫 in English prose, native English readers will disregard the embellishments, recognising immediately that the additions are irrelevant. But if I write S as P, then this will cause confusion. This is because the meaningful parts of symbols cannot be changed without obscuring their identity, though non-meaningful parts may change with impunity. Symbols are, therefore, not simplex atoms but contain ‘junk’ portions (the parts that are non-essential to their meaning) alongside crucial information. For Peirce this information was crucial for the ‘interpretant’ or meaning of the sign.

From symbols and interpretants, it is a short step for language to progress to the phenomenon known as ‘duality of patterning’, which organises smaller units into larger items. Duality of patterning enables the transition to the three levels of complexity – G_1, G_2 and G_3 – that distinguish the different types of grammars that human societies may choose to build their languages around, shown in Figure 1.

The hypothesis that language evolution followed the increasing level of complexity in Peirce’s signs is supported by the archaeological record. On the other hand, the jump from icon to symbol in this chart is ‘unnatural’. This step requires human invention. Evolution did not create symbols or grammars. Human creativity and intelligence did. And that is why the story of how language began must also be about invention rather than about evolution alone. Evolution made our brains. And humans took over from there.

Still, it is necessary to discuss much more than language itself to understand what happened. For that, one must link language’s development to the species’ biological development. According to the available evidence, *Homo sapiens*, like every family, fits into a particular set of relationships, usually referred to as a phylogenetic tree or clade (Figure 2). This is highly speculative, but it does give us a reference point. The lower branches among *Homo* species may turn out to be quite different than those given here.

All animals communicate, hence the arrow at Animal Kingdom. Not all animals have language, which only seems to emerge through the evolution of the genus *Homo*.

Like anything complicated and controversial, there are a number of ideas about how life began on earth.[†] One prevalent proposal is that a supreme deity created life. Any discussion of a theistic account of life and language must acknowledge that the origin of both is an important line in the sand for theists. One frequent theistic answer to the question of how DNA and subsequent forms of life evolved is the ‘watchmaker’ theory. Watches were, at the time of this metaphor, the highest technology known. For many reasons, discussions of philosophers and theists often revolve around the most advanced technology of the day. In this case, watches are intricate, complicated, hierarchical in structure and obviously designed. So if someone found a watch on a distant planet, the presence of that watch would indicate that somewhere there was a designer who had a purpose in mind for it, designed it and fabricated it. William Paley put it this way in his *Natural Theology* in 1802:

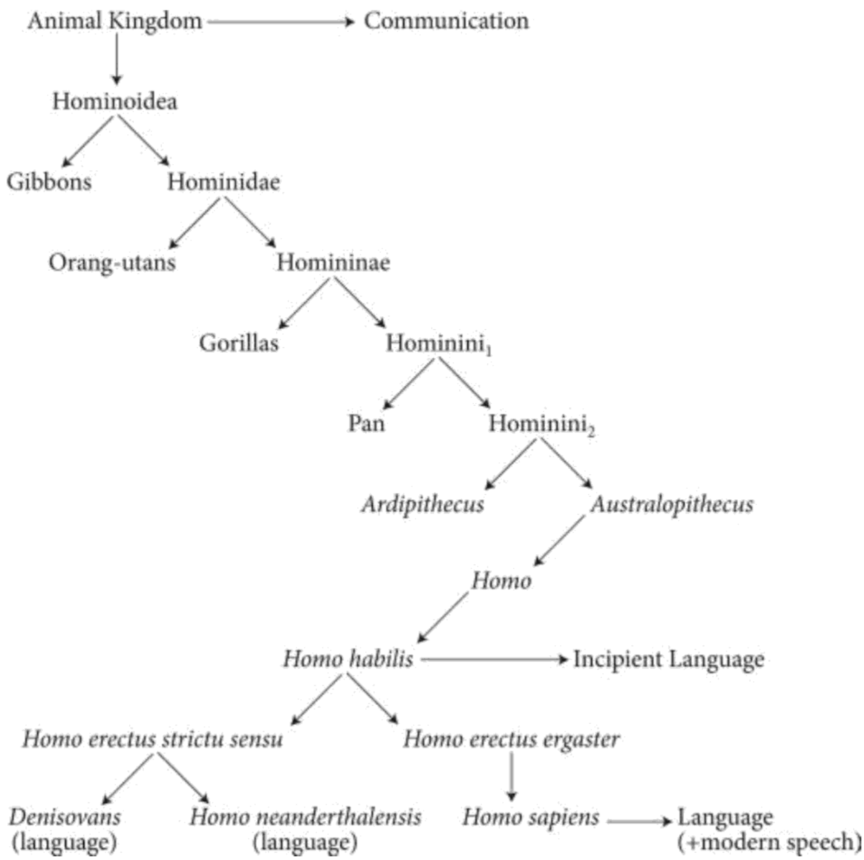

Figure 2: **The clade of humanity**

> In crossing a heath, suppose I pitched my foot against a stone, and were asked how the stone came to be there; I might possibly answer, that, for anything I knew to the contrary, it had lain there forever: nor would it perhaps be very easy to show the absurdity of this answer. But suppose I had found a watch upon the ground, and it should be inquired how the watch happened to be in that place; I should hardly think of the answer I had before given, that for anything I knew, the watch might have always been there … There must have existed, at some time, and at some place or other, an artificer or artificers, who formed [the watch] for the purpose which we find it actually to answer; who comprehended its construction, and designed its use … Every indication of contrivance, every manifestation of design, which existed

in the watch, exists in the works of nature; with the difference, on the side of nature, of being greater or more, and that in a degree which exceeds all computation.

Paley's argument for an 'artificer' precedes the work of Wallace and Darwin on evolution by natural selection by more than half a century. There are modern theologians and theistic scientists who consider this argument sound, substituting a complex organ such as the eye in place of the watch. But philosopher David Hume pointed out three serious problems with the watch analogy. First, the materials of the watch are not found naturally – the watch is built from human-made materials. This makes the analogy artificial. As Hume said, it would make much more sense to use something composed exclusively of organic materials, such as a squash, instead of a watch because one can observe that squashes come forth on their own.

Hume's second objection is that one may not use experiential knowledge to infer a conclusion about non-experiential knowledge. If you understand what a watch is, you also know that the watch was created. One could even observe a watch being made. Yet no one could have any direct experience with the creation of the world. Thus the conclusion that because a watch has a designer the universe also does is not only empirically unjustified but also illogical. Finally, Hume remarked that even if a watch did show that every complicated thing, the universe in particular, has a designer, this lesson would still have nothing to say about the nature of that designer. Such reasoning thus, even if it had not been shown to be invalid, supports no known religion or idea of a deity above any other.

Perhaps the most effective argument against the watchmaker analogy, however, comes from culture. No person can make a watch or its component materials by themselves. A watch is the output of a culture, not a designer. If the universe was designed, this design would have required a society, not a god, unless that god were far different than it is described in the major religions. More to the point, however, the theistic design argument for the universe fails because the science says so. There is a solid scientific foundation to evolutionary theory that is lacking in theistic accounts.

Evolution is a well-established *fact.* Only the explanations of how evolution happens or looks – natural selection, genetic processes and family trees – can be called theories. But evolution itself is not a theory. In order to understand the origin of language, the origin of life more generally must be considered in order to frame the discussion. And that requires evolution.

The earth is roughly 4.5 billion years old and probably began as a whirling cloud, cooling and solidifying, its waters gradually ending their cycle of rain and evaporation, reducing the surface temperature of our red planet enough to accumulate in turbulent, lifeless, hot oceans inhospitable to all life, in the Precambrian period's Archaean Eon. But phosphates, sugars, nitrogen were about in the oceanic stew, and from these the first carbohydrates and other building blocks of life were formed. At least, that is one possible explanation.

Another account offered by scientists is that replicating DNA wholly originated in space and was brought to earth by a meteorite or asteroid. This proposal for the origin of DNA is known as 'panspermia'. According to the proponents of this view, nucleotides are more easily formed in the cold and ice of comets. Our planet was like a giant ovum floating in space, fertilised by space dust, meteors and asteroids, the spermatozoa of the universe, which brought DNA to us. There is even some convincing evidence for this view. Meteorites regularly enter earth's atmosphere. Some of these might have brought DNA to earth from another part of the universe or solar system. Or perhaps meteors brought not DNA but nucleotides from other parts of space.

Whatever happened, nucleotides eventually joined together in the seas. Later, membranes began to form around them. Within those membranes nucleic acids, along with ribonucleic acid (RNA) and deoxyribonucleic acid (DNA) formed. At some point these acids took on the property responsible for all life – replication. From the formation of the earth until molecular life began to form took roughly 500 million years. Within another 500–800 million years, life forms large enough to be visible as fossils were produced.[‡]

From the beginning of this nucleotide soup, earth transitioned to the Proterozoic 'early life' period of the Precambrian. The foundation of life, DNA, again formed from sugars, phosphates and nitrogen.

Because of an understanding of DNA, it is known that a human and a dog are distinguished at the molecular level by the composition of their DNA and the ways in which their DNA is sequenced to form their genome. Genomes are thus the sum of the various DNA and RNA and their combinations. Fine-tuning a bit, canines and humans are not merely distinguished by the components of their DNA but by the *syntax* of their DNA. The hierarchy of DNA and units relevant to it is:

Chromosomes (carriers of DNA)

↓

DNA + histones[§]

↓

Genes (segments of DNA)

If one considers the earth from its beginning until today, 99.997 per cent of the planet's history had passed before the Pleistocene (2.8 million years ago), when *Homo habilis* (or Homo erectus, depending on classification) the first species of the genus *Homo*, emerged. Species such as *sapiens* arose even later. The period in which the earliest hominins gave rise to modern humans, began from the late Miocene (23–5.3 million years ago), through the Pliocene (5.3–2.8 million years ago) and the Pleistocene, up until the current age, the Holocene (11,000 years ago).

Humans enjoy a privilege unique among all other life forms that enables them to contemplate their origin. And yet, all human perspectives are culturally shaped. Therefore, along with superior mental powers, cultures not only guide humans' understanding of the world but also define what is worth looking at. Culture constrains how humans justify their reasoning. Science emerges from and is shaped by the values of culture, different social roles and the knowledge structures that have been sanctioned by society (that is, what knowledge is and how different components of our knowledge are related to one another).

Culture is one reason that different scientists take different views on the fossil evidence. It is not merely disagreement about the facts, though that too is important. Richard Feynman was one of the first to notice that results of physics experiments tended to be closer to published expectations than one would have otherwise expected. This points to one cultural effect in science known as 'confirmation bias'. Even though consideration is given only to science, there is no escaping from the shadow of cultural influences. Interpretations of much of the fossil record change regularly. My conclusions here are no different, although this difference makes them no better or worse than other conclusions until more data is brought to bear.

The accumulated scientific record built by *Homo sapiens*, through language and Western culture, concludes that humans are primates and that the roots of their genus are to be found in the origins of the primates. So, what are primates? And where did they come from?

The primate order, of which *Homo sapiens* is one species, arose more than 56 million years ago. Because evolution is gradual and continuous there are 'protoprimates' that precede the 'proper primates'. The earliest known protoprimate transitional fossil is *Plesiadapis tricuspidens*, which existed some 58 million years ago in North America.

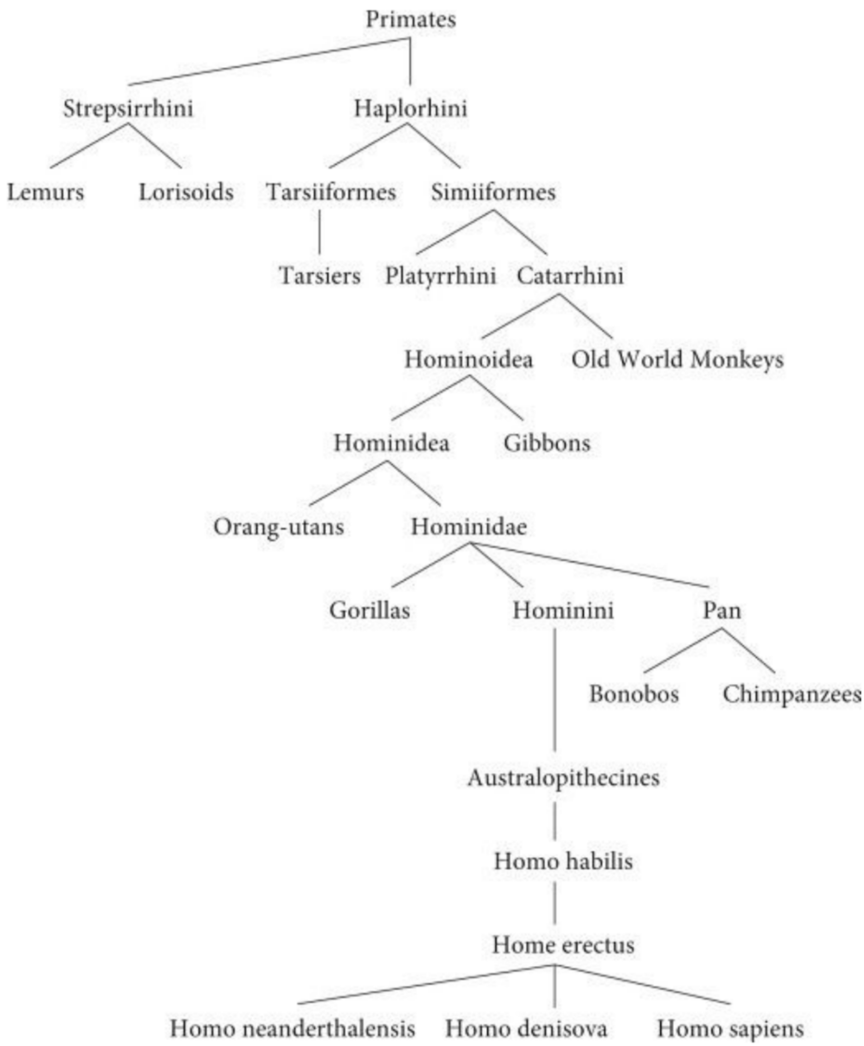

Figure 3: **Primate phylogenetic tree**

But the story of primate evolution begins in earnest with the first-known true primate genus, the *Teilhardina*, which were the precursors of all other primates, including us. The *Teilhardina* (named after the Jesuit theologian and palaeontologist Pierre Teilhard de Chardin) were small creatures, similar in size to modern marmosets. As these creatures developed and found separate niches, they formed varieties and eventually new species. From the new species came new genera.¶

Many primates break down into genera according to the shape or conditions of their noses. For example, the wet-nosed or strepsirrhine primates today are limited almost exclusively to the lemurs of Madagascar. Humans are counted among the haplorhini or 'dry-nosed' monkeys. The haplorhini in turn break down into the tarsiiformes and simiiformes – simians, or anthropoids – from which humans come. There is further subdivision into catarrhines (long noses) and platyrrhines (flat or 'downward' noses). All monkeys native to the New World have nostrils that point sidewards, while all Old World primates, including humans, have nostrils that point downwards. Figure 3 summarises the classification of humans among other primates.

Figure 3 shows the primate tree with humans as part of the infraorder catarrhini, as previously described. As well as being catarrhines, humans are also, along with all monkeys and apes, simians. The platyrrhines of the Americas evolved differently from their Old World relatives, producing no apes, only monkeys. No humans therefore evolved in the New World.

All primates can climb trees. Though I confess that I cannot climb as well as a woolly monkey, all humans possess, as primates, bodies designed at least partially for tree climbing. Some also stand out from other mammals for more important reasons than their climbing prowess: humans have large brains, a reduced sense of smell and stereoscopic – 3D – vision, all traits that have helped them become the rulers of a very real planet of the apes.

Evolution is the great procrustean bed of life, where species are stretched, chopped and otherwise modified to fit their niche. As evolution brought the primates forth from the 'great mammalian surge' that followed the end of the dinosaurs during the Cretaceous–Paleogene (K–Pg) extinction event some 66 million years ago, it launched another in a long line of cognitive leaps. Eventually, this long mammalian advance produced the hominids.

Most modern scientists use the term hominid, the singular form of the Latin word *hominidae*, men, to refer to all the great apes (the English form of the plural is hominids). There are a few who still prefer to use the word in its older sense, to refer not to all the great apes, but to the genus *Homo*. But most modern scholars reserve hominid to describe collectively the great apes and hominin (hominini), humans and all of their direct ancestors, beginning from the time that chimps and humans split into separate branches of the primate tree. Using two terms, hominid and *Homo*, does not increase the perceived complexity of human evolution; it simply helps to avoid ambiguity.

By contrast, Darwin's theory of evolution by natural selection is much less complicated. Indeed, part of its attraction and elegance is its very simplicity. It consists of three postulates:

First, the ability of a population to expand is infinite in principle, though the ability of an environment to support a population is always finite.

Second, there is variation within every population. Therefore, no two organisms are exactly alike. Variation affects the ability of individuals to survive and multiply as some produce more viable offspring in a given niche.

Third, somehow parents are able to pass their variation along to their offspring.[#]

Together, these three postulates have come to be combined as ‘descent by natural selection’. Darwin noticed during his famous trip aboard the HMS *Beagle* (1831–1836) that animals seemed adapted to fit their environment. And throughout his scientific career he also noticed how different creatures (such as his famous Galapagos finches) adapt rapidly to even small changes in their environments.

Ironically, while Darwin was proposing natural selection, a Czech monk, Gregor Mendel, was laying the foundations of genetic theory. Working with garden peas for seven years (1856–1863), Mendel developed two important principles of genetic research:

First was the principle of ‘segregation’, which is the idea that given traits are broken into two parts (known now as alleles) and only one of these parts passes from each parent to their shared offspring. Which allele is passed along is random.[**]

Second came the principle of ‘independent assortment’. By this principle the pairs of alleles produced by the union of the parents’ haploid cells form new combinations of genes, that are not present in either the mother or the father.

Though Mendel’s work eventually gained dramatic acceptance, there were still problems that were overcome only with the advent of modern genetics. First, as Thomas Morgan showed in his now famous work on fruit-fly mutations, genes are linked; that is they work in tandem in many traits. This is contrary to Mendel’s idea that each gene behaves independently, an idea that many geneticists had embraced prior to Morgan’s work. Morgan’s findings meant that the independent assortment of genes wasn’t right – *contra* Mendel. Morgan also brought to his research original and long-term interests in cell structures. Through this work it became clear that chromosomes were real entities in cells and not merely hypothetical gene vehicles.[1] Second, Mendel suggested that variation is always discrete, but in fact it is usually continuous. If one mates a 6'5" mother with a 5'2" father one will not get simply either a 5'2" vs a 6'5" child, but any height between those at minimum, among other possibilities. In other words, many (in fact most) traits blend. This is not captured in the simple interpretation of independent assortment from Mendel’s work on peas, in which all traits he worked on were discrete and, for the purposes of his research, unrelated.

Another crucial fact about evolution is that the targets of natural selection are phenotypes (externally visible physical and behavioural attributes, resulting from genes and environment), not genotypes (the genetic information that is partially responsible for the phenotype). Thus natural selection operates on (selects for survival) creatures based on their behaviour and overall physical properties. Genes underlie these properties and behaviours, but the phenotype is more than genes: it is partially produced by histones, environment and culture. The histones control the timing of the unfolding of genetic information and thus how the genes produce the phenotype.

When non-biologists think of evolution, they often conjure up ideas of new species, but, though that is one by-product of evolution, looking only at speciation as evidence is misleading. If a creation 'scientist' says that creatures can't transform into others, and that evolution must therefore be false, what they are actually disputing is *macroevolution* – evolution on a grand scale. However, macroevolution is not the only form of evolution. In fact, macroevolution is usually the accumulation of smaller evolutionary changes, perhaps as small as the mutation of a single allele, known as *microevolution*.

While microevolution is, by definition, less discernible, especially to observers with short human lifespans, it is where the real action takes place. As a result, if one can explain the small changes, the larger changes will follow by and large. Evolutionary scientists seek to understand biological change over time (evolution) in *all* of its forms. Macro- and microevolution are simply points along a vast continuum of modification by natural selection.

One of the ways in which micro- and macroevolution are stimulated is via mutation. Many mutations are neutral. Other mutations are fatal. But some mutations provide a survival advantage to their host organism. A change favoured by natural selection in a particular environment is advantageous if the mutated creature produces more viable offspring than creatures lacking the mutation.

Neutral mutations are important for evolutionary theory even though they are by definition neither harmful nor helpful to the survival of their host. As Linus Pauling, the only person in history to win two unshared Nobel prizes, one for chemistry and one for peace, and Emile Zuckerkandl, a pioneer in genetic dating, proposed in 1962, neutral changes occur at a constant rate over time. This constancy works like a molecular clock, one that can help determine when two related species diverged. Today it has become a vital tool in understanding evolutionary differences among creatures, even though they are not themselves responsible for those differences.

Mutations favoured by natural selection, however, are not the only way that evolution works. For anything as complicated as the whole of life on earth, it should not be surprising to learn that no one concept explains it all. There are other sources of micro- and macroevolution than natural selection. One of these is known as 'genetic drift'. Technically, in genetic drift there is a reduction in a population's genetic diversity. Imagine that the population of all humans is one thousand individuals from one hundred families. Now assume that the genes that produce photopigments in five families from this one thousand, say fifty individuals, are deficient. These individuals are 'colour-blind'. Next, imagine that these colour-blind individuals come to be shunned by the majority as undesirable for some cultural reason and that all fifty of them therefore decide to move elsewhere. Finally, suppose that the original population, the non-colour-blind individuals, are wiped out by disease or natural disaster after the departure of the colour-blind individuals. The colour-blind people are unaffected. This improbable but possible chain of events will result in a state where the only genes left among the species are the genes that produce colour-blindness. The colour-blind community may grow over time, producing many offspring and descendants, founding entirely new populations of humans. This scenario would result in significant changes to the human species, independent of natural selection.

Genetic drift is a naturally occurring reduction in genetic diversity that is produced by Mendel's principle of randomness in the selection of alleles. Again, this is not caused by natural selection because fitness plays no role in the result.

A special case of genetic drift is known as a population bottleneck. A population bottleneck is an alteration in the allele ratio produced by external causes, as in our example of ostracised colour-blindness sufferers. Such a bottleneck can include things like migration, where a migrating population is some sample of the main population wherein there is a different allele ratio than that found in the population as a whole. Population bottlenecks include any reduction of the genetic diversity of a population caused by external events. Take a disease that kills off one member of each family. Chances are that reduction left a different gene distribution in the overall population, thus producing a population bottleneck. This too can lead to a 'founder effect' – a subpopulation with a different distribution of alleles than the original population that in turn produces generations of viable offspring. In other words, if the original population of *Homo erectus* that left Africa had a different allele ratio than the population that remained in Africa, the former and latter populations would be separate founder populations for the ensuing generations.

Another form of evolutionary change is that effected by culture, a form known as the 'Baldwin effect', and particularly relevant to the evolution of human language. The Baldwin effect, first proposed in 1896 by psychologist James Mark Baldwin, was an important conceptual advance in evolutionary theory for at least two reasons. First, it underscored the importance of phenotypes (visible behaviours and physical characteristics) for natural selection. Second, it demonstrated the possible interaction of culture with natural selection. As a hypothetical example, let's suppose that a population of *Homo erectus* enters Siberia in the summer only to discover later that Siberia is cold in the winter. Now assume that everyone learns how to make winter garments from bear fur and that the most effective stitching of these furs requires manual dexterity that is extremely challenging or unavailable to the community as a whole – except for one lucky person who has a genetic mutation that allows him or her to bend their thumb to their forefinger in such a way as to produce a more effective, long-lasting stitch for bear fur coats. They therefore make more effective coats for their family. This in turn allows the members of their family to produce more offspring than the families of the stitch-challenged. Eventually, the mutation will increase the chance that the original mutant's 'dexterity genetics' will reproduce through their offspring who, in turn, out-survive (in winter at least) the offspring of the less dexterous stitchers. Over time, the dexterity gene will spread throughout the population.

The same genetic mutation in another environment would not have propagated throughout the population because it might not have provided any survival benefit. It would be in another environment simply a neutral mutation, of which there are many. This might happen if the coat-making phenotype is neutral in a warmer climate, such as Africa. We can say, therefore, that culture can turn neutral mutations into positive mutations. The Baldwin effect, also known as dual inheritance theory, brings culture and biology together and seeks to explain those evolutionary changes that can't be explained by either one on their own.

Now using our imagination once again, let's suppose that a woman is born during the time that humans are developing language. We will call this woman Ms Syntax. While the rest of the community says things like, 'You friend. He friend. She not friend,' Ms Syntax says, 'You friend and he friend but she not friend.' Or while everyone else is talking like, 'Man hit me. Man bad,' Syntax Lady might say, 'The man who hit me bad.' In other words, the syntax master has the ability to make complex sentences while the rest of the population can only form simple sentences. Could the entry of complex sentences into human language have been a mutation, spreading via the Baldwin effect or some other mechanism, such as sexual selection? This is unlikely. Language presents a different case than genes for physical skills.

The first reason for doubting that a mutation for syntax could spread through a population or be favoured by the Baldwin effect is that it is unlikely that complex sentences would provide a survival advantage, especially in light of the fact that there are languages spoken today, as we discuss later on, that lack such complex syntax. These latter languages have survived in the same world as languages that do have complex syntax. Moreover, even if it were discovered that the languages currently claimed to lack complex syntax did show such syntax in some cases, this discovery would only underscore the fact that speakers of these languages survive fine in an environment 99 per cent free of complex sentences.

More importantly for Ms Syntax, in order to be able to *interpret* complex sentences, one would need to be able to interpret complex syntax. Uttering complex sentences in a population that lacks the ability to do this – where, in other words, you are the only person that is able to interpret or produce complex utterances – would be like yelling a warning to a deaf, mute and blind person. One could argue that non-human primates can already do this, since they seem to be able to respond effectively to requests using complex syntax (the bonobo Kanzi comes to mind). But this is a far cry from actually being able to fully understand complex sentences. Following instructions given in recursive sentences, for example, might be a first step towards acquiring or evolving recursion, but only that. Ability to think in complex ways must precede talking in complex syntactic constructions or no one would be able to fully understand those utterances.

But how might such thinking arise? How could someone think in ways that they do not speak? One possibility is, perhaps, by planning events within events via images within images or even, as many speakers in the world seem to do today, by thinking in larger stories that, although they use simple sentences, weave together complex thoughts:

John fishes.
Bill fishes.
John catches fish.
Bill stops.
Bill eats John fish.
Bill returns.
John returns same time.

This story, completely composed of non-complex sentences, says that John went to fish and later, or at the same time – depending on which is inferred by the context – Bill went to fish. John caught fish before Bill. So Bill stopped fishing and ate fish with John. Bill decided to stop fishing and return home. John returned home with him. There are, in fact, many languages in which simple sentences are woven together in complex stories just like this.

Another example of complex thinking without complex sentences is intricate task performance or planning without talking at all, such as in weaving a basket with many parts. As the hypothetical fishing story has just shown, complex sentences are not required for complex thinking or storytelling. Complex thinking might make it possible to utter and interpret complex sentences, but it doesn't require them. The reverse, however, is not true. One must be able to compose complex meanings in order to interpret a complex sentence.

On the other hand, it is possible that complex syntax would spread through a population by sexual selection. Members of the opposite sex might like to hear the melodic cadences of complex sentences and so might mate more frequently with Ms or Mr Syntax, spreading the syntax genes. But this is unlikely. Complex sentences normally require words that indicate that they are complex. Those words, however, are largely unintelligible outside of the complex syntax they have arisen to signal. For example, 'John and Bill went to town in order to buy cheese' is a complex sentence, because of its clause-within-a-clause, 'in order to buy cheese', but also because of its coordinate subject noun phrase, 'John and Bill'. The word 'and' is not understandable apart from being able to think in complex syntax. Complex sentences themselves also require complex gestures and pitch patterns that would need to have come about separately and that are unlikely to have arisen owing to a single genetic mutation.

What seems more likely is that complex thinking was favoured by natural selection and thus was a genuine Baldwin effect because it enabled complex planning. It might – and probably would have – shown up later in the form of complex sentences in some languages. In any case, the fascinating conclusion is that natural selection would quite possibly have treated a gene for syntax in language as a neutral mutation, not subject to natural selection.

Recursion, which is a crucial aspect of human thinking and communication, certainly would have arisen early on in human cognition. This is the ability to think thoughts about thoughts, such as, ‘Mary is thinking that I am thinking that the baby is going to cry,’ or, ‘Bill is going to get upset when he finds out that John believes that his wife is being unfaithful to him.’ Recursion is also seen in the ability to break tasks down into other tasks, such as, ‘First build the spring. Then place the small spring inside a lock. Then place the lock inside another lock and a spring within the larger lock.’ And it is visible in complex syntax in sentences: ‘John said that Bill said that Peter said that Mary said that Irving said …’ It is not clear whether any non-human species is able to use recursive thought, nor whether *erectus* or *neanderthalensis* spoke recursively. But it would not have been necessary for them to have recursion to have language, at least according to the simple idea of language evolution as a sign progression and supported by some modern languages.

It is not difficult to imagine a scenario in which complex or recursive thinking might arise. Suppose that someone is born with the ability to think recursively. This ability to think (not necessarily speak) recursively would provide a cognitive advantage over other members of their community, enabling them to think more strategically, more quickly and more effectively. They might become better hunters, better defenders of the community, or makers of complex tools. This indeed could help them to survive and would in all probability make them more attractive than the competition to the opposite sex, leading to more mating and more offspring. It could also lead to children with the ability to think recursively. And soon this ability would spread throughout the population. At that point only would it be possible to speak recursively and therefore for this new property to be incorporated into the grammar of the community. In other words, there could never be a gene for recursive syntax, because what is needed is a gene for recursive thinking across cognitive tasks. Recursion is a property of thought, not language per se.

Thinking through the implications of these various sources of change in a species, it becomes clear that a single mutation in a particular behaviour such as language would be unable to guarantee that all humans possess the same genetics that they had at the time the original change was introduced. The genotype could have been altered by the Baldwin effect, by genetic drift, or by a population bottleneck.

Still, there is another force in evolutionary theory that can exercise a role in the spread and modification of languages over time. This is ‘population genetics’.

Population genetics is concerned with the distribution and frequency of alleles within an entire population. How do groups adapt to their environment? How are new species formed? How are populations divided or structured? Population genetics is one of the most challenging areas of evolutionary theory because of the mathematical sophistication it requires for its application – controlling many variables in many individuals and many links between variables and individuals simultaneously.

One of the pioneers in this field was a postdoctoral associate of Morgan, Theodosius Dobzhansky. Dobzhansky built a bridge between micro- and macroevolution. Basing his studies of populations in their natural habitats, Dobzhansky showed that these populations, however similar they were phenotypically, manifested large degrees of genetic diversity below the surface. Though this genetic diversity is unseen, Dobzhansky demonstrated that is it is always there and is crucial as particular subpopulations differ in their genetic make-up. This diversity renders each subpopulation subject to distinct phenotypic adaptations and speciation, given the right pressures and constraints on gene flow (frequency of mating between the subpopulations).

Dobzhansky was but one of many researchers who examined cross-breeding and genetic drift in small populations and how these could push populations away from one 'adaptive peak' – a kind of local equilibrium in which the environment and the organism match well for a period of time. The basic ideas of population genetics turn out to be crucial to the understanding of change in individual languages and groups of languages over time.[††]

An overview of the various subfields of genetics and evolutionary change leads to the recognition that fossils are not the only pieces to the puzzle of human origins. The resources of molecular biology are also needed for a full picture. As the genomes of a variety of primates are sequenced, we can begin to estimate dates at which the different lineages of primates diverged evolutionarily. Therefore, because we know that humans and chimpanzees share 96 per cent or so of their DNA sequences, closer than any other two primates, it then follows that there was a common ancestor of humans and chimps unshared by other great apes. Further work leads to the conclusion that this common ancestor split off from other great apes about 7 million years ago. Humans are thus one of the newer apes. From this lineage it is clear that all humans originated, as Darwin predicted, from Africa.

So we know quite a bit about early humans and the story of how life came to be on our planet. But how do we know this? More than DNA evidence is necessary. The reconstruction of the evolution of our species requires the sweat of hard fieldwork, finding, studying and classifying fossils. Here evolutionary theory takes on characteristics of an adventure novel. Who were these fossil hunters? What did they do for our understanding of human evolution? And how did competition and cooperation among them advance the science behind the evolution of human language?

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* I deviate slightly from Peirce here. For Peirce, indexes were more complex than icons, as used and elaborated by humans. But as used by non-humans and in evolution, I believe that indexes precede icons.

† This chart provides more detail than we will refer to elsewhere in this book. It should be seen as implicit in the primate chart of Figure 3.

‡ There are other hypotheses on the origins of life. One that is widely supported, though by no means universally accepted, is the so-called 'RNA world hypothesis'. According to this hypothesis, since the essence of life is self-replication and since RNA has this property, the presence of RNA would have preceded both proteins and DNA. DNA would have come later

to provide storage or memory capacity to the RNA and proteins would have eventually been synthesised, taking over some of RNA's functions, though of course RNA continues to be essential to life as we know it.

§ Histones are the packaging around DNA that controls how genes are activated and deactivated.

¶ *Genera* is the plural of *genus*, which is a set of species sharing an immediate common ancestor.

Unfortunately Darwin's ideas about how traits are 'passed along' differ greatly from what we now know to be true about genetics, which is hardly surprising given that he died before modern genetics had been developed.

** We now know something that Mendel did not, namely that individual alleles are selected by the process of *meiosis*, in which a *haploid* cell (a cell with only half of the normal number of chromosomes for a particular species) is formed. Two haploid cells (ovum and sperm) are contributed, one by each of the two parents, before reproduction begins.

†† In addition to Dobzhansky's work, that of many others was also important. This work led to what came to be known as the 'new synthesis' in biology and among its leading researchers were Ronald Fisher, especially in his 1930 book, *The Genetic Theory of Natural Selection*, and Sewall Wright, as in his 1932 concept of 'adaptive landscape'.

2
The Fossil Hunters

> What we do see depends mainly on what we look for … In the same field the farmer will notice the crop, the geologists the fossils, botanists the flowers, artists the coloring, sportsmen the cover for the game. Though we may all look at the same things, it does not all follow that we should see them.
>
> John Lubbock

THOUGH DARWIN INITIALLY SEEMED WRONG in his Africa-first hypothesis, the first evidence that he might be right came from a German geologist, Hans Reck, shortly before the First World War. Not only was Reck the first European to behold the Olduvai Gorge in Africa’s Great Rift Valley, his team was the first to recognise a hominin fossil there.

As confirmation of Darwin’s theory and for palaeontology more generally, the Great Rift Valley is vital and famous in the study of human evolution because of the fossil riches preserved by its unusual geological properties. The term originally described a 3,700-mile trench running from Lebanon to Mozambique, a fascinating geological formation that emerged from the splitting of the earth’s crust. However, most researchers today understand ‘Great Rift Valley’ to refer to something smaller, to the part of East Africa where new tectonic plates are forming and literally beginning to tear the African continent apart. To find such a place anywhere on earth is to find a time-machine. Descending through the geological layers in the Rift Valley is like travelling back through history to prehistory, a journey of several million years. Even though the interpretations of finds in the valley are often complicated by mixing and corruption of fossil sites by tectonic upheaval, flooding, volcanic activity and so on, the Great Rift Valley has been and continues to be of inestimable importance for evolutionary theory.

When he was there in 1913 to study the earth’s geological history and to excavate fossils, the twenty-seven-year-old Reck recognised this. And his work paid off. Near the end of three months of hard work, in the formidable East African equatorial heat, a crouching skeleton was discovered in one of the oldest layers of the gorge. Reck recognised that the remains he had discovered were of a Pleistocene *Homo sapiens* who probably had drowned there some 150,000 years ago.

The year was an ominous one, of course. Soon the ‘War to End All Wars’ began and palaeoanthropological research was suspended in order to carry out the sinister work of mass killing. For that reason, not much else was to come from Olduvai until the arrival of Louis Leakey more than twenty years later.

Leakey was a controversial researcher who energised palaeoanthropology in much the same way that Chomsky did linguistics and Einstein physics (though Leakey did not lead as a theoretician). He shook up his field by grandiose claims that attracted publicity both to the field and to Leakey himself. Along the way he and his family discovered some very important fossils in East Africa. Louis also fostered research on primates in their natural habitat, recruiting and encouraging researchers such as Jane Goodall (chimpanzees), Dian Fossey (gorillas) and Birutė Galdikas (orang-utans) to undertake their own field research.

After both advancing the earlier research of Hans Reck and eventually working alongside Reck himself, Leakey and his team discovered artefacts such as Olduwan and Acheulean tools, a skull of *Paranthropus boisei*, then called *Zinjanthropus*, and *Homo habilis*, among many others. Leakey and the headline-making publicity he received attracted many scientists to palaeoanthropology. Whatever his shortcomings, he earned his place as one of the innovators and founders of the field of palaeoanthropology.

More importantly, the findings of Leakey and other palaeoanthropologists have provided incredible insights into the evolution of our species. We now know that the human skeleton evolved over the last 7 million years or so, from the first likely hominins. Some of the features that distinguish us from other species include bipedalism, encephalisation, reduction of sexual dimorphism, hidden oestrus, greater vision and reduced sense of smell, smaller gut, loss of body hair, evolution of sweat glands, parabolic U-shaped dental arcade, development of a chin, styloid process (a slender piece of bone just behind the ear) and a descended larynx. These traits have become important to the classification and understanding of the place of different fossils in the hominin line.

One of the adaptations of human skeleta to the world around them came as evolution provided a novel form of locomotion. Humans are the only primates that walk upright. Other primates favour crawling or tree-swinging to get about. But to walk habitually (unlike a chimp, an orang-utan, or a bear that can walk upright only occasionally and for brief periods), our skeleta needed to change from the basic primate model to support this upright posture. One example of its many changes is found in the hole at the bottom of our skulls, called the foramen magnum. This is the aperture through which our spines connect with our brains. When this is found at the back of the underside of the cranium, we know that the creature did not walk upright regularly, because it would have been extremely uncomfortable. The spine would emerge nearly parallel to the ground for a creature on all fours, but awkwardly incline the head if the creature walked upright.

Another important milestone, the human head and brain, was achieved by a long process of encephalisation, the gradual process by which our brain cases got larger. Hominin brain case volume increased from about 450cm^3 for australopithecines to *sapiens*' 1,250cm^3. The heads of hominins show larger and larger brain cases until the appearance at *Homo sapiens* (*neanderthalensis* had even bigger brains than *sapiens*, averaging about 1,400cm^3 for males). Sapien skulls are large, rounded and delicate compared to the smaller brain cases and thicker skulls of our hominin ancestors. Gone are the special ridges at the top of hominin skulls to anchor muscles for chewing, along with the heavy brow ridges that perhaps shaded our eyes from the sun. In their place came a larger brain. And our heads developed accordingly, to give room and horsepower for thinking.[1]

Male and female bodies also grew more similar in size – that is, our sexual dimorphism was reduced. Although human males are roughly 15 per cent larger than human females on average, this size difference is smaller than that of any other primate species. The reduction of sexual dimorphism in the primate line has social implications. When males and females become more similar in size, this correlates, among primates, with pair-bonding, or monogamy. Male primates spend more time helping females feed and raise children. This is particularly important for human primates, since our children require a longer time to mature.

In some Western, industrialised cultures as much as one-third of a person's overall life expectancy is 'childhood' – the length of time required to reach autonomous adulthood. If males and females bond for life or simply in order to raise children, then the male will no longer need to battle other males for mating access. This reduces the pressure for males to have larger physical size, longer canines and other features for fighting. Battle is no longer necessary in order to pass our genes along to the next generation.

Along with bipedalism and reduced sexual dimorphism came a greater reliance on vision. Humans can see further than other primates, and most other creatures, which enables them to run faster towards a visible goal. Moreover, beginning with the arrival of *Homo erectus* humans acquired the capability of 'persistence hunting', running down game until it tires and the hunter kills it with a stone axe or club, or until it dies of exhaustion and overheating. Persistence hunting is seen even today in societies such as the Gê communities (Mebengokre, Kĩsedje, Xerente, Xokleng and others) in the savannah regions of the Brazilian Xingu river basin.[*]

Evolution is also the ultimate economiser. With humans' greater dependence on vision came a loss of acuity and range in their sense of smell. If one portion of the brain gets bigger or better, another part very often grows smaller in the course of evolution. Here, the ability to smell degenerated as the vision region of human brains grew. Today the portion of the brain available to vision is roughly 20 per cent. (Fortunately, if someone is born blind, the vision region can be enlisted for other functions – evolution is often an efficient, no-waste process.)

Other changes to human physiology, not all with an immediately obvious intellectual benefit, might also have enhanced our species' intelligence. In the course of evolution, the length of the gut of hominins shrank. Intestines and digestive processes required fewer and fewer overall calories, enabling *Homo* bodies to shift more of their energy resources to their growing, ever-hungry brain with its expanding cranium. But natural selection does not receive all the credit for this change. Cultural innovation also played a role.[2] *Homo erectus* learned to control fire as long as one million years ago. As pre-*erectus* hominins learned to eat cooked food, the fats and proteins that they then ingested were much easier for their digestive system to break down. Whereas until this time, hominins, like other primates, needed larger guts in order to break down the large amounts of cellulose in their diet, as hominins learned to cook they were able to eat more meat and consequently able to consume more energy-rich food and to reduce significantly their dependence on uncooked plants that were much harder to digest. This fire-enabled dietary change facilitated natural selection's ability to produce larger brains in hominins, because their digestive organs required less energy and less space in the human body, while at the same making it possible to consume far more calories far more quickly (assuming the availability of meat). Cooking also altered our faces. It rendered the massive jaw muscles of pre-*Homo* hominins redundant and made our faces less prognathous. This in turn reduced the burden on the cranium to offer supporting structures, such as the mid-sagittal crest of the australopithecines, that arguably impeded the growth of the human brain case.

There are critics of this change-through-fire hypothesis. They hypothesise that *Homo erectus* was a scavenger and a hunter, finding rich sources of meat from carrion and fresh kills of its own long before controlled fire. Whatever the reasons, this reduction in gut size represents the movement to modern human anatomy. When encountered in the fossil record it is therefore a clue that the species represented by the particular fossil could be further along the evolutionary line to *Homo sapiens*.

Other important physiological changes needed for us to become modern humans included our upright posture and its by-products. As humans stood erect and walked habitually upright, their bodies became more efficient at thermal regulation. Moreover, since an upright body's surface areas are less exposed to direct sunlight than a quadruped's, hair became less necessary for humans. As a side benefit of shedding body hair, it became easier for humans to cool their bodies. They also evolved sweat glands in conjunction with the hair loss, making thermal regulation much more efficient. In hot, dry climates, the absence of hair and the production of perspiration allowed humans to cool off more quickly than many other animals. And sexual selection may have further sped up hair loss if people preferred less hirsute mates. This was all important to sustaining the human metabolic rate, so crucial for our intensely calorie-consuming brains.

Another characteristic of modern humans is their parabolic dental arcade.

The evolution of human dentition has many causes and effects and dentition is important to fossil classification. *Homo* species' teeth shrank relative to their overall body size. Its canines in particular became smaller, which is important because this meant that *Homo* males no longer needed the larger teeth of other primates in order to fight for mating rights.

As the human dental arcade became more parabolic in shape, their faces came to possess more space for the articulation of different consonants and greater resonance for vowels, making a larger array of sounds available for human speech.

In order to summarise the output of human evolution in relation to other primates and to better understand the fossil record, a review of the primate phylogenetic tree on page 24 above is important.

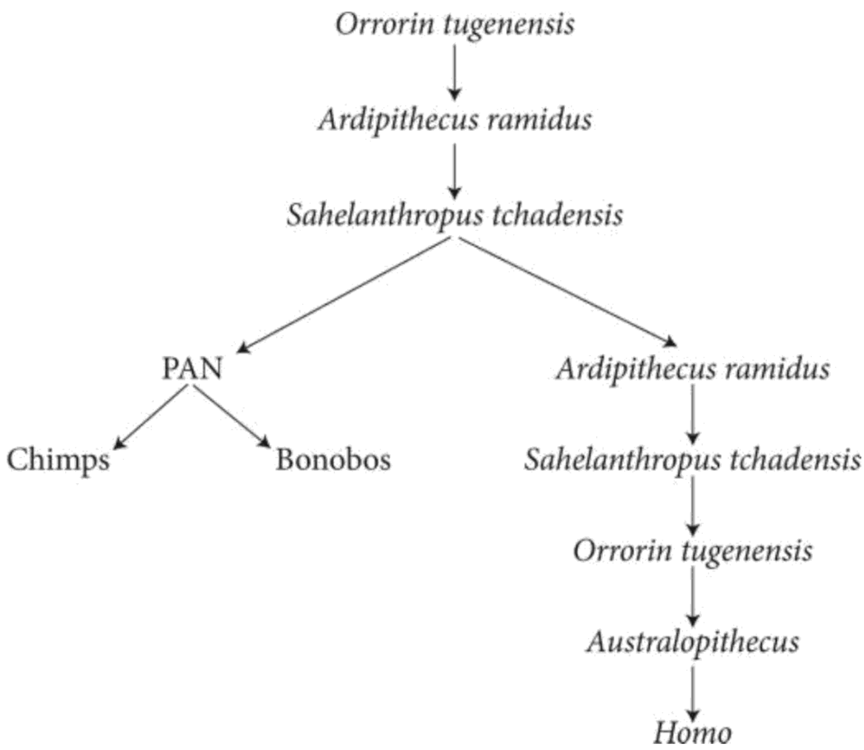

Figure 4: **The hominin family tree**

Taking discoveries in order of the age of the fossils found, the first 'node' in the primate tree that links to humans (and chimps) is quite possibly *Sahelanthropus tchadensis*, literally Man of Chad of the Sahel area ('sahel' being cognate with Sahara, which gives name to what is today the largest desert on earth). *Sahelanthropus* is a potential direct link between humans and chimps but the more likely hypothesis is that it, like *Orrorin tugenensis* and *Ardipithecus*, was one of the first hominins as in the lower right portion of Figure 4. The repetition of the names above and below the split indicates the two major hypotheses regarding these hominin fossils. It lived some 7 million years ago. Though we have only parts of the cranium, mandibles and teeth of *Sahelanthropus*, it is important to the fossil record of the evolution of *Homo sapiens* because it represents several distinct but equally important possible clues to human evolution. It could even be the 'node' in the phylogenetic tree from which chimpanzees and humans split (Figure 4).

Before concluding the discussion of the rise of hominins, it would be useful to compare what is emerging about the cognitive and communicational abilities of other great apes in order to more effectively reflect on the nature of the different evolutionary paths – if any – to language.

Mammals are the most intelligent creatures of the animal kingdom. Primates are the most intelligent mammals and humans are the most intelligent primates. Therefore, humans are the most intelligent animals. This may not be saying much. After all, our intelligence is the reason we murder one another and fight wars. Our brains are a mixed blessing. Jellyfish get along quite nicely without brains.

Nevertheless, human language is possible only because of this greater intelligence. Humans are the only creatures known that use symbols and cooperate to communicate more effectively. And unlike other animals, when humans communicate they almost never say all that they think, leaving their hearer to infer meaning.

There are some prerequisites, or what are often called 'platforms', needed for language.[3] Two of those are culture and 'theory of mind' – an awareness that all people share cognitive abilities. Culture is an important topic, but right now it is worth discussing the theory of mind, because this also helps gauge an area of cognition where humans are regularly claimed to have something that no other animal has – the ability to 'read' the minds of others. Although actually being able to see or hear the thoughts of others is science fiction, there is some truth to the idea that humans can guess what others are thinking and then use this knowledge as a key to communication.

To cognitive scientists such as Robert Lurz, mind-reading is 'the ability to attribute mental states, such as beliefs, intentions and perceptual experiences, to others by the decidedly mundane and indirect means of observing their behaviours within environmental contexts'.[4] An example of this might be to see a man with two bags of groceries standing outside the entrance to a house feeling around with his free hand in his pockets. A person with a knowledge of locks and keys and the custom of locking one's house should be able to guess that the person is searching for his keys and that he plans to unlock and then enter the house. Even for this seemingly simple scenario, there is a huge amount of cultural knowledge being drawn from. Amazonians who lack locks and keys might not have a clue as to what the man has his hands in his pockets for. And yet all humans will most likely recognise that the man has an intent, a purpose or a goal; that his actions are not random. That's because all humans have very similar brains, which is in essence what the theory of mind is. Folks with autistic spectrum disorder might not understand this, because there is reason to believe that some forms of this set of ailments are caused by a lack of this kind of awareness.

Language works only because people believe other people think enough like they do to understand what they want to tell them. When one says what one is thinking, they do so believing that their hearer will be able to understand, infer conclusions about and match our words to their own experiences. Therefore, the question that arises is whether humans alone in the animal kingdom have this ability. If other creatures possess it, what does that mean for their systems of communication, their cognition and the evolution of human language?

Studying animal behaviour (just like studying the cognitive abilities of human infants before they can speak) is extremely hard because of the danger of overinterpretation. To take an example from my Amazonian field research, consider the Amazonian horsefly. The bite of this nasty little creature hurts more than most because they (the females only) suck blood by lacerating the skin. What's worse is that the locations of the bites itch for a good long time afterwards. Hiking through the jungle is almost always rewarded with multiple bites from these pests, along with their partners in crime, mosquitoes, wasps and smaller species of blood-sucking flies. One thing about horseflies, though, is that they seem to know where you are not looking!

On a certain level, it often seems as though Amazonian horseflies must have minds that can figure out human behaviour. While it is true that they seem to use a strategy for choosing a location on the body (clothes are no impediment as they can easily bite through denim jeans and cotton T-shirts) based on an interpretation of other animals' behaviour, should one then say that horseflies have a plan for sucking blood that is based on interpretation of their victim's perceptions? Doubtful.

An alternative explanation could simply be that the flies are genetically programmed to bite the relatively darker areas of a victim – the shaded part of their appendages. A shaded part of your body will also be one in which the visibility will be much reduced. People often anthropomorphise and interpret as cognitively designed actions what are in all likelihood physically determined.

Getting back to primates and animals more generally; there are many rigorous studies that avoid overinterpreting animals' behaviours.[5] One of the most problematic issues in the lengthy conversation in science about whether animals have cognitive abilities in any way similar to those of humans is the profoundly circular assumption that cognition requires language, human language at that, and that therefore animals cannot have cognition because they lack language. This is simply declaring by fiat that humans alone have cognition, before research has been conducted. Such ideas are misguided by their anthropocentric framing of the questions.

These views derive from the work of René Descartes in the seventeenth century, who believed that only humans 'think therefore they are'. Descartes's views arguably set back studies of human cognition because they discouraged comparative evolutionary studies of mentality. They also affected non-human studies by simply declaring that animals lacked mental lives.

In Descartes's view, non-humans possess no consciousness, no thought and no feelings. Additionally, his view that human minds are disconnected from bodily experience led instinctively to his linguistic-based theory of cognition, namely that only language users think.

But as philosopher Paul Churchland aptly puts it: 'Among many other defects, it [the account that only humans think because thinking requires language] denies any theoretical understanding whatever to nonhuman animals, since they do not traffic in sentential or propositional attitudes.'[6]

Any view of cognition that ignores non-human animals ignores evolution. Whether we are talking about the nature of ineffable knowledge or any other kind of cognitive or physical capacity, our account must be informed by and be applicable to comparative biology if it is to have any explanatory adequacy. Animal cognition helps understand the importance of evolutionary theory and comparative biology in the understanding of our own cognition. It also allows for tremendous insight into how the bodies of both humans and other animals are causally implicated in their cognition.

The main problem with disregarding animal cognition is that, in doing so, we are essentially disregarding what cognition might have been like among our ancestors *before* they got language. Their prelinguistic state was the cognitive foundation that language emerged from. If there is no cognition before language, à la Descartes and many others, the problem of understanding how language evolved becomes intractable.

Of course, there are those who claim that language did not evolve gradually, so we wouldn't expect to find its roots in any other species. According to such researchers, the grammatical core of language 'popped' into being via a mutation, bringing forth a linguistic Prometheus whose X-Men genes spread quickly throughout the entire species.

On the other hand, there are those who work experimentally to address the question of whether primates have beliefs and desires and whether other primates are capable of 'mind-reading'. For both questions the evidence so far answers tentatively 'yes' – there does seem to be some form of these abilities in other primates.

So humans may not be alone in the world of thinking and interpreting others. But if other primates, such as chimpanzees with their 275–450cm^3 brains, are capable of reading the intentions of other creatures, as well as holding beliefs and desires, then surely the 500cm^3-brained primates of the genus *Australopithecus* or the 950–1,400cm^3-brain-sized species of *Homo* had even more well-developed powers of cognition and social understanding.

Animals and fossils strongly support the idea that humans got their unique abilities by baby steps. And our debt for this knowledge goes back to the fossil hunters. The painstaking work of collecting fossils and attempting to piece together cultural and anatomical evidence for the origins of our species takes physical fortitude – to withstand the heat, sweat, remoteness and occasional danger of palaeontological field research. It is a cut-throat, competitive enterprise at times, with mudslinging from all sides.

But in spite of the hard, painstaking field research of palaeontologists, on 1 January 1987 an article appeared in the journal *Nature* which threatened to wrest all the glory, power and science from the palaeoanthropologists and transfer it to lab-coat-wearing geneticists. The paper, 'Mitochondrial DNA and Human Evolution', co-authored by Rebecca L. Cann, Mark Stoneking and Allan Wilson, argued that genetic evidence clearly established that the DNA of all current *Homo sapiens* traces back to a single female's mitochondrial DNA about 200,000 years ago in Africa.

This was a bombshell. Could it really be that three people in a comfortable laboratory put an end to the controversy surrounding the 'recent out of Africa' vs 'multiregional' hypotheses? To review, the former claimed that *Homo sapiens* originated in Africa and migrated out, replacing other *Homo* species across the globe. The latter suggested that all modern humans evolved in separate lineages from the various sites of *Homo erectus* around the world.

It turned out that the multiregional hypothesis was shown to be largely incorrect. When it first became public, the 'Mitochondrial Eve' theory was met by criticism from the proponents of the multiregional hypothesis, among others. But it has held up well to scrutiny and is now accepted widely by palaeoanthropologists, biologists and geneticists. The lab workers beat the field workers on this one.

Before one can grasp the significance of Mitochondrial Eve for language origins, however, it is necessary to review the science behind the conclusions. This is the theory that underlies the notion of a molecular clock on which the Mitochondrial Eve story is based. Originating sometime in the early 1960s and first published in a paper by Linus Pauling and Emile Zuckerkandl, the molecular clock idea came about after noticing that changes in amino acids across species are temporally constant. Thus, knowing the differences in amino acids between two species can tell when these species split from a constant ancestor.

As with most scientific discoveries, several people soon added to these ideas. Then in 1968 Motoo Kimura published a now famous article, 'Evolutionary Rate at the Molecular Level', in *Nature*. Kimura's paper laid out the basic ideas of a 'neutral theory of molecular evolution'. The neutral theory here is non-Darwinian, meaning that, rather than natural selection, Kimura placed the responsibility for most evolutionary change on genetic drift produced by random, neutral variations in organisms. Since these changes do not affect the survivability of an organism, it is able to pass on its genes normally to viable and fertile offspring.

Applying the molecular clock to mitochondrial DNA collected from humans around the world led to the proposal that all living *Homo sapiens* come from a single woman (called ‘Lucky Woman’ or ‘Mitochondrial Eve’) in Africa, about 200 millennia ago. In other words, only one woman from the past produced an unbroken line of daughters up until the present, thus transmitting her mitochondrial DNA to all living humans.

The genus *Homo* thus arose in Mother Africa. But if life was so good in Africa, why, when and how did our *Homo* ancestors leave there?

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* Humans are able to run down game for several reasons. First, unlike any quadruped, humans are able to breathe hard while running. Second, humans’ lack of fur, their perspiration, and their upright posture (with its greater surface area exposed to evaporation of perspiration) allow them to cool far more efficiently than quadrupeds. A human running after a horse, other things being equal, will eventually catch it.

3

The Hominins Depart

> We travel, some of us forever, to seek other states, other lives, other souls.
>
> Anaïs Nin

THE GREATEST HUNTER. The greatest communicator. The most intrepid traveller. Perhaps the greatest distance runner on earth, *Homo erectus* was the unsurpassed marvel of its time. No other creature has ever contrasted more starkly with all the animals that had ever lived. *Neanderthalensis* and *sapiens* were born from and first lived in the shadow of *erectus*. We were not new. They were. *Sapiens* are just the improved model of *Homo*. *Erectus* was the first to journey. They were the original imagination-motivated travellers.

Of course, travel itself did not begin with *Homo*. Many species move from one environment to another. Migration sets up competition with the local species. The genus *Homo* is no different. Yet so early did *Homo* begin to travel that, although they originated in Africa, their first fossils were found not there but in Asia – in Indonesia and China. Later, the fossils of other *Homos* were discovered in Europe – in Spain, France and Germany. How did these fossils come to be in these places? It seems like a nearly impossible task for humans to actually walk around the world. But they did. And for *Homo*, with its nearly unprecedented endurance, the trip wasn't as hard as it sounds.

Initially *erectus* and other *Homo* species were hunters and gatherers. As such, they needed to move frequently as they exhausted the edible flora and fauna of a given region in a relatively short period of time. Hunter-gatherers usually move a bit further each day from their original village. They may sometimes return to an established camp, but as food becomes ever scarcer in the area surrounding the original village, hunter-gatherers move to establish new settlements closer to their fresher sources of proteins and plant foods.

The average forager travels just over nine miles (fifteen kilometres) per day. Assume that they move communities around four times per year and that each new village is a day's foraging from the last village. That is thirty-seven miles (sixty kilometres) per year. How long, at that rate, would it take an *erectus* community to travel from Africa to Beijing or Indonesia, both locations where *erectus* fossils were found? Well, if one divides 10,000 kilometres (roughly the distance from East Africa to where *erectus* fossils have been found in China) by sixty (the number of kilometres *erectus* would, under my extremely conservative calculation, move in a year), then it would take only 167 years for *erectus* to traverse Eurasia, moving at a normal pace. But if *erectus* populations had other reasons to travel, such as to escape hostile neighbours or climatic events such as flood or drought, they might have moved even more quickly, potentially reducing the time needed in the extreme case to as little as a year. Likewise, if they moved more slowly due to, say, the discovery of rich food supplies in a place along their route, then a larger period of time would elapse. It was, in any case, easily within the grasp of *erectus* to settle large regions of the world within only a thousand years, a trivial amount of time from an evolutionary perspective.

In the course of their earliest journeys, *erectus* populations would never have encountered any other humans. They were the first to arrive at every destination. They had all the natural resources of the world before them, with all the land they saw at their disposal. *Homo erectus* men and women were the greatest and most fearless pioneers of our species.

Throughout modern history there have always been refugees and migrants, people fleeing wars or famine, looking for a better life, or just satisfying their own wanderlust. The genus *Homo* – both *sapiens* and their ancestors – has always been the wandering kind. But unlike any other species, *Homo* species probably all talked about their migrations. And their conversations about travel made the trips more enjoyable. Humans don't migrate like other mammals. We *sapiens* plan our trips, review them, celebrate them and lament them. And *erectus* seems no different, from what we can tell from the fossil record.

This conscious movement to the unknown was but one of the cognitive capabilities that emerged in humans on their long path to becoming sapient. Their new-found consciousness was a state of mind that exceeded mere animal awareness. Gradually our ancestors' consciousness came to include self-referential reflection: not only did their thinking include 'I am aware of *x*' but also 'I am aware that I am aware of *x*'. This is 'conscious consciousness' and it would have facilitated their travel as well as their thinking about the symbols that were already emerging from the growing complexity of their cultures. *Homo* species in all probability began their perambulation with self-conscious purpose. *Erectus* would have been the first creature in history to be self-conscious. And the first to imagine. (Imagination is the knowing consideration of 'what is not but could be'.)

Homo erectus would have initiated the sharing of values that is unique to human societies. Social roles began to emerge as communities discovered that different community members were better at some things than others. These ancestors began to remember and to organise the knowledge they were gleaning from the world around them and from each other. And they taught their children these things. This is inferable from the ever-improving tools, homes, villages and societal organisation that have been found in the fossil record. Humans were getting smarter. They were becoming cultured. They had crossed the communication-language threshold.

There were changes in *Homo erectus* that no other species in the history of the planet had undergone. *Erectus*'s achievement of self-conscious cognition quite possibly enabled them to (eventually) talk about, characterise, contextualise and classify their emotions – love, hate, fear, lust, loneliness and happiness. Our ancestors in all likelihood also began *to keep track of* their kith and kin on their travels. And this growing knowledge, as it emerged from their evolving culture and travels, would have eventually *required* them to invent language of some sort (with their relatively enormous brains). And increasing culture placed evolutionary pressure on *erectus* to evolve ever more effective and efficient linguistic abilities, accompanied gradually by the brains, bodies and vocal apparatuses necessary to exploit those abilities fully. At the same time, at the interstices of culture and language, *erectus* would have been developing what can be referred to as 'dark matter of the mind' – tacit, structured knowledge, prioritised values and social roles. Dark matter is crucial to the interpretation and arrangement of human apperceptions (experiences that affect our development, stored in our unconscious that create individual psychologies).

The emerging psychologies of *Homo erectus* would have interacted with their community to produce culture. *Erectus* followed the more hospitable and passable swathes of East Africa until they emerged from the continent, initially in the Levant and then on across Eurasia and to islands across the sea. They were the Argonauts of the Pleistocene. And as they arrived they were more sophisticated than when they left. They were also better fed.

Hunting prowess and the advantages of a meat diet fuelled *erectus* travel. The hunt provides much more than fat and flesh. Hunter-gatherers eat the skin, bones and offal. They consume nearly the entire animal head to toe. They eat the bones by splitting them and scraping out the marrow. Then they shave bone fragments off that are so thin that they can be eaten without difficulty or they are boiled and consumed. And then, after eating this large quantity of animal protein and calcium, they can rest for a day or two before needing to hunt again, depending on the size of the animal killed. Like modern hunter-gatherers, *erectus* also controlled fire. It not only killed better than other creatures, it ate better and healthier. And it transformed its body and its brain. Fire would have been tremendously helpful during the trip, allowing them to travel further in a day, chat around the campfire at night and build strong ties of community.

Anyone who has accompanied hunter-gatherers as they pursue game for several miles without rest knows the joy of talking about the hunt at night around the fire. Sometimes they sleep near their kill because they are too tired to make their way back to their village. Then, the next day, after again eating very well, *erectus* bands might have bundled up their leftovers with vines or have simply tossed large portions of the animal, such as a leg or hindquarter, across their shoulders as they headed back to their families. If their families were already with them, perhaps they remained a bit longer near the latest kill site. They may have tarried a day or so, then explored further around their new campsite, after consuming all of the meat from the previous day. Perhaps they relocated their village to the site where they successfully killed the game, especially if it had more abundant edible plants or more game.

How easy was it to travel around in Africa at the time of *Homo erectus*? During this period, roughly 2 million years ago, Africa was climatologically very different from today. The so-called ‘Sahara pump’ was active then. The current Sahara desert was then non-existent. Instead, all of North Africa was covered in lush forests that stretched across the Middle East and on through Asia. Flora and fauna were rich throughout large swathes of the world that are today barren deserts. This ecological-climatological fecundity dramatically contrasts with today’s North African climate and it clearly supported the exploration and nomadism of *Homo erectus*. Major changes in human genes were also happening at this time, changes that I suspect would have facilitated the expansion of *Homo erectus*’s geographical range, even without the Saharan pump.

Erectus was truly marvellous. But in spite of the admiration they richly deserve, these people were not the equals of *Homo sapiens*, not even of *neanderthalensis*. They were simply the first habitually upright hominins and the first humans. They were the first interpreters of their own visions, as they were the first bearers of culture and the earliest storytellers of our planet. They were the progenitors of both *neanderthalensis* and *sapiens*. Their skulls and bodies were becoming more modern, though they still had prognathous jaws, making them look somewhat ape-like (Figure 5).

What is really known about *Homo erectus*? Did they really have language or were they just grunting cavemen? Like most areas of human endeavour, ignorance outstrips knowledge. There is much to learn about these ancestors before they and their role in the evolution of the genus *Homo* is fully understood.

On the other hand, less is known than one would like about a lot of things that researchers hazard informed hypotheses about. So this should not stay anyone from considering ideas that are supported, however shakily at present, by the facts. For whatever reason, a subset of the *erectus* people decided to leave Africa about 1.8 million years ago. Their travels began only a couple of hundred thousand years after they first appeared. Not long after that (in geological time, very quickly: only about 200,000 years), confirmed evidence shows them in South Africa, the Middle East, modern-day Georgia, Europe, China and Java.

Homo erectus evolved in the Pleistocene from australopithecines. Their bodies got bigger. Their brains got bigger. Their societies grew more complex. Their technology developed quickly. Why did this transformation emerge during the Pleistocene? Why not later or earlier? Is this a mere coincidence? Most think not. The Pleistocene posed the problem of survival as it had never been posed before for hominins. Its rapid climate variations, advancing and receding glaciers, changes in flora and fauna were among the challenges it forced hominins to adapt to.

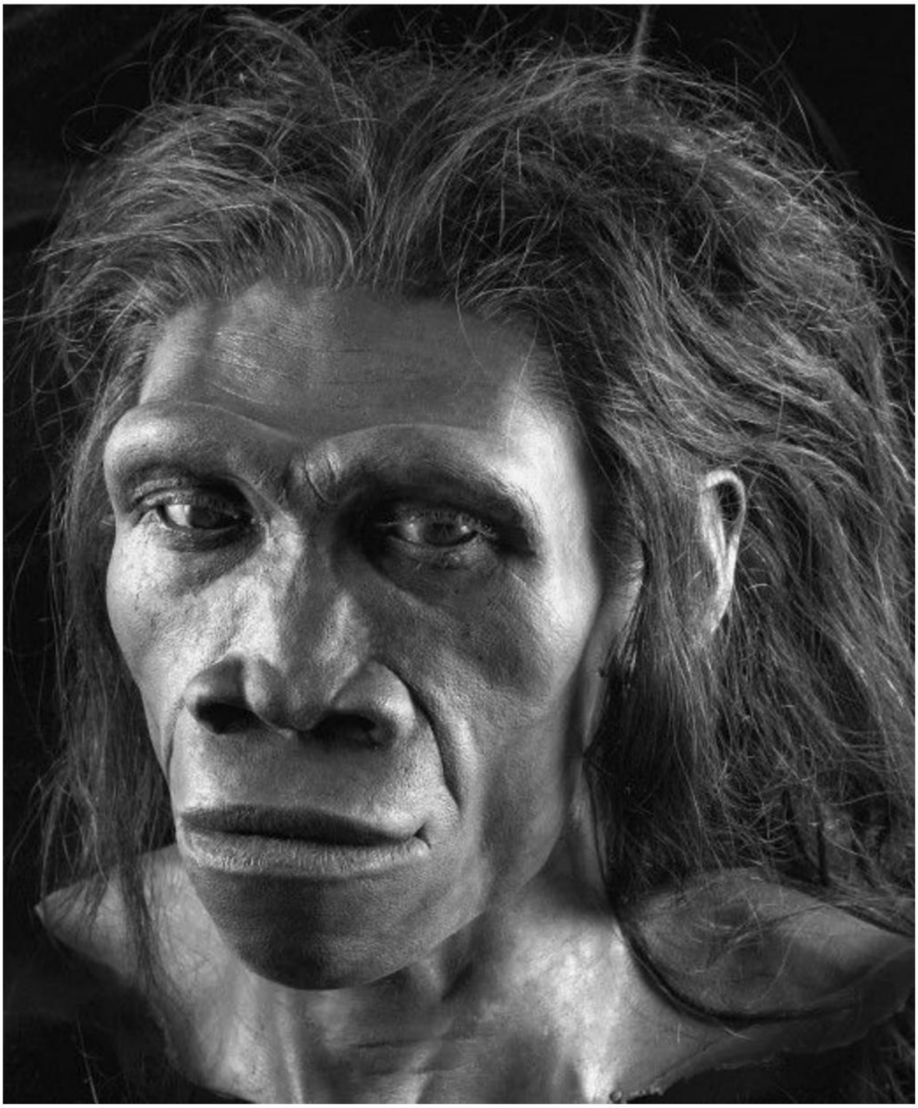

Figure 5: ***Homo erectus* (artist's impression)**

According to some classifications, there were, soon after and before *erectus*, other species of *Homo* co-existing or existing in close succession – *Homo habilis*, *Homo ergaster*, *Homo heidelbergensis*, *Homo rudolfensis* among others. But, again, most of these various species of *Homo* are ignored here, with the focus kept on *Homo erectus*, *Homo neanderthalensis* and *Homo sapiens*. Most other *Homo* species are murky, maybe nothing more than variants of *Homo erectus*. However, the story of human language evolution changes in no significant way, whether *erectus* and *ergaster* were the same or different species.

Remaining with this simplified inventory of species of *Homo*, *Homo erectus* was in all probability well on the way to inventing language by roughly 1.9 million years ago. They used tools. This brain size resulted from many pressures – the advantages of improving tools, the need for better communication to keep track of social relationships, travel and the need to cope with a rapidly changing environment. As the climate became more arid and colder in East Africa, *erectus* trekked to the south of the continent.

It is no coincidence that the greatest changes and innovations in human physiology, cognition, sociality, communication, technology and culture (dwarfing any of today's inventions and developments) occurred during the Pleistocene. Glacial sheets covered the northern hemisphere many times during this period. Some pre-*Homo* hominids adapted physiologically to the greater aridity of the environment. *Paranthropus*, a genus of 'robust' australopithecines contemporary with *erectus*, grew bigger teeth, with thicker enamel in order to eat seeds that became larger and harder to crack during this time.

But *erectus* relied on culture to solve problems posed by their volatile environment. Instead of their teeth, *erectus* used rocks for cracking seeds, thereby adding cultural pressure to evolve more and more intelligence to make better tools. This was what I call the 'first cultural revolution', where our ancestors changed culturally in order to answer the ever new challenges of their environment.

It was during this time, over 2 million years ago, that a common set of stone tools, the Olduwan tool kit (flaked rock tools named for the site of their earliest discovery, by the Leakeys in the Olduvai Gorge), first appeared in the archaeological record. This tool assemblage may (or may not) have been used by australopithecines initially. Similar but non-identical tools can even be used by chimpanzees and other non-human apes (in ways quite distinct from human usage), though a great deal of practice is required. Regardless of its first users, however, this tool kit was widely employed by *erectus* and other *Homo* species. The arrival of tools signifies that culture is beginning. And the birth of culture has implications for language evolution and physiological adaptations during this time.

Figure 6: **Olduwan tool kit**

The Olduwan tool kit shown in Figure 6 was made by a process of flaking, which began rather simply but eventually led to quite complex skills.

Though occasionally it is said that animals such as otters, chimps and orang-utans have ‘culture’ based on their use of tools, real culture is far more than merely this. Likewise, culture is more than the *transmission* of tool technology or other knowledge from one generation to another by imitation or overt teaching. Culture attaches values, knowledge structures and social roles to humans and their creations. This means that even tools have meaning. Because of this they bring to mind for the member of a culture the tasks they perform, even when those tasks are not currently under way. A stone axe on the ground can elicit memories of the times they have been carried on trips. It can also bring to mind a previous user.

Cultural implications thus surpass mere tool use in cognitive complexity. When an orang-utan uses a stick as a spear to catch fish in Borneo, or a chimp uses a chair to climb up over a fence, or an otter uses a stone to open a shellfish – even if their offspring learn to use these from them – this does not mean that they possess culture. They are using (perhaps even transmitting) tools in the absence of culture. Impressive as tool use is, culture goes beyond this by *contextualising* artefacts. This is what enables tools originating in a particular culture to evoke meanings even when they are not being used. A member of a culture that uses shovels or scissors knows what shovels or scissors are for even in the absence of their associated activities. The tools alone will bring those activities to mind. Outside of culture, tools evoke no abstract connections to values, social roles, or knowledge structures. One can tell the difference only by examining the evidence that tools emerge from a system rather than from a one-off or idiosyncratic invention, as perhaps a chance usage by a single family or individual. We might question whether the tool plays a part in distinguishing social roles or relative to other tools, or attempt to determine its value relative to other tools of the culture. Is it used only by some people or by everyone? Does it have a specialised purpose?

Other evidence of incipient culture among *Homo erectus* populations is one previously mentioned, namely that *erectus* adapted physiologically to a relatively rare way of life among animals – pair-bonding – a social structure in which males and females mate long term wherein the male feeds and protects the female and their offspring in exchange for near-exclusive sexual access. Pair-bonding is inferred not only from the archaeological record of *erectus* villages but also from smaller *erectus* canine teeth and reduced sexual dimorphism between males and females. Pair-bonding plus tools is evidence for family units and cooperation.

This view of human cooperation in *erectus* is strongly supported by the archaeological record. As *erectus* wandered through the Levant, near the Jordan between the Dead Sea to the south and the Hula Valley to the north, they came to stop at the site known today as Gesher Benot Ya'aqov. At this site, going back at least 790,000 years, there is evidence for Acheulean tools, Levallois tools, evidence of controlled fire, organised village life, huts that housed socially specialised tasks of different kinds and other evidence of culture among *Homo erectus*. *Erectus* may have stopped here on the way out of Africa.

Erectus technology was impressive. They built villages that manifested what almost appears to be central planning, or at least gradual construction under social guidance, as in Gesher Benot Ya'aqov. This is clear evidence of cultural values, organised knowledge and social roles. But such villages are just one example of *erectus*'s technological and organisational innovation.

Another may be seen in the routes they followed. As specialists have mapped out the travels of *Homo erectus* around the world an interesting observation comes to light – *erectus* seems to have deliberately travelled to geologically unstable areas. *Erectus* followed a route known as the Plio-Pleistocene Tethys (the former coasts of an even more ancient ocean), which provided a natural geographic path, along with geological instability.*

Whether it ultimately turns out to be correct or not, the idea that geology played a major role in the routes of the migration of *Homo erectus*, rather than simply random wanderings about the earth, offers clues to the species' thought processes. All humans make decisions and they marshal evidence for those decisions. It would be extremely surprising if *Homo erectus* did not have reasons for going left or going right as they travelled. Though culture also played a role, the Plio-Pleistocene Tethys offers a simple possibility – namely that *erectus* followed the 'lie of the land'. There were geological conditions favourable to the route that *erectus* chose. If this is correct it is an interesting finding. However, before we can definitively interpret the routes of *erectus* as based on culture and cognition vs simple hunting like any other animal, we would need to compare their routes of migration to those of other animals that left Africa. And then we'd have to determine whether *erectus* was simply following other animals or whether they were being guided by hunger rather than cultural values or knowledge structures.

However, the possibility that *erectus* was travelling based at least partly on culturally guided or otherwise intelligent decision-making is supported by other finds in the record. One of the greatest surprises in archaeological history – and there have been many – was the discovery of Acheulean tools on the Indonesian island of Flores in 2004. This find was preceded somewhat by a discovery in 1957 by Theodor Verhoeven, a Dutch archaeologist and missionary, of bones of Stegodontidae, an extinct family of Proboscidea (relatives of mastodons, mammoths and elephants), on the same island. The stegodonts, like modern elephants, were very good swimmers. Elephants have been observed to swim for as long as forty-eight hours, in a herd, across African lakes. They are known to have swum as far as thirty miles (forty-eight kilometres) at sea (which is further than the distance to Flores would have been 750,000 years ago).

Flores sits among the lesser Sunda Islands of eastern Indonesia. The fifteen-mile (twenty-four-kilometre) strait separating Flores from the closest land, the source of the Stegodontidae, would not have presented a great swimming challenge to the large mammals, who pursued floating plants across the strait. But the tools later discovered near charred bones of these creatures do present an enigma. How did they get there? These tools are nearly 800,000 years old. And there is no period during which the island was connected to any other land. It has always been isolated by deep water. *Erectus* somehow got to Flores. How?

Unlike the Stegodontidae, they could not have swum there. Even had they spotted the island on the horizon and decided to visit, the currents would have made swimming there impossible. The greatest waterflow in the world is known as the 'Pacific Throughflow', and it flows around the islands of Indonesia, including Flores. These currents would defeat all but the most elite athletes. Yet there is evidence of a relatively large *erectus* population on the island. A founding population would need to include a minimum of fifty individuals. And it is unlikely that they all set out paddling logs or attempting to swim across treacherous currents, even though they may have witnessed stegodonts doing such a thing. They must have had a motive to go, certain that there would be plenty of food there.

The idea that a founding population crossed the straits piecemeal, without planning, is implausible – fifty or more 'shipwrecks' as it were, within a short time, where everyone survived. They would have had to arrive during a short period to guarantee survival and this would have required an unfeasible amount of coincidence. It is, of course, possible that a flotilla of logs was launched, of which fifty or more made it to the island. But, while that would not lessen the intent and adventure of *erectus* in crossing to Flores, it would provide a poor explanation for the settlements on Socotra and other islands described below, an island out of sight, requiring a sense of imagination and exploration for a large *erectus* population to arrive within a time frame short enough to guarantee their survival. Moreover, archaeologist Robert Bednarik and others have provided extensive and convincing evidence that *Homo erectus* built watercraft and crossed the sea at various times in the lower Palaeolithic era, around 800,000 years ago (and three-quarters of a million years before *Homo sapiens* made sea crossings). Bednarik has even built and sailed replicas of the kinds of bamboo rafts that he believes *erectus* would have constructed, fabricating water containers from bamboo and using techniques that would have been within the reach of *Homo erectus*.

Many archaeologists have provided evidence of *erectus* technology that, while not surprising for *sapiens*, force the reconsideration of the common view that *Homo erectus* could do little more than grunt to communicate and had no actual words. Further examples of *erectus* technology and art include decorations, bone tools, stone tools, evidence of adding colour to art, wooden artefacts, backed knives, burins (stone chisels) and protoiconic palaeoart.[†]

Given all of this evidence, it is nearly certain that *erectus* had developed culture. But ‘culture’, once again, means more than that they built tools or that they passed down the knowledge of how to build and use these tools to subsequent *erectus* generations. Culture entails symbolic reasoning and projecting meaning on to the world, meaning that is not about things as they are, but as they are interpreted, used and perceived by members of the community that uses them. Culture transforms ‘things’ into symbols and meaning. And if *erectus* had symbols, it had language.

The case for *erectus* culture is further strengthened when one learns that Flores is not the only island to which *erectus* voyaged. And although there are no remains of actual million-year-old wooden or bamboo boats that they might have employed, evidence that they inhabited isolated islands neither accessible by swimming nor visible from shore suggests very strongly that they intentionally journeyed miles across the open sea. This conclusion seems warranted, in spite of the fact that the oldest boats we have physical evidence of are dugout canoes from the Upper Palaeolithic, only a few thousand years old.

As recently as 2008, Russian researchers found very primitive stone tools on the isolated island of Socotra, more than 150 miles (240 kilometres) off the Horn of Africa and 240 miles (400 kilometres) off the coast of Yemen. And the timeline is roughly the same as it was for Flores – these discoveries are estimated to be from 500,000 to 1 million years old.

One can imagine the inspiration for the voyage to Flores – witnessing a herd of Stegodontidae swimming there. But this cannot explain the innovation, confrontation of the unknown and abstract thinking that were manifested by the *Homo erectus* population that sailed to Socotra, Crete, Flores and other islands. Indeed, on that voyage they seem to have been *exploring*, which requires a form of abstract thinking that goes beyond the here and now, the observable, to the *imagined*. And evidence of imagination is evidence for abstract thinking. Taken together, the currents *erectus* had to overcome to reach Flores and the challenge of the unknown on the voyage to Socotra establish clearly that *erectus* cooperated for a common goal, utilising innovative technology. Such accomplishments imply the ability to communicate at a level more advanced than any creature until that time.

Of course, it is possible that erectus never intentionally sailed, but that they built rafts for fishing close to shore and were blown off-course to islands (or death) in the open sea. This likely happened at times. Modern sailors suffer the same fate occasionally. Yet even this possibility would be evidence that Homo erectus had enough language to build rafts. But this 'blown off course' suggestion fails to explain the settlements we see on various islands, from the Sea of Flores and the Gulf of Aden. For each viable settlement and subsequent cultural development, at least 40–50 Homo erectus men, women and children would have had to have arrived almost simultaneously.

But what kind of language did *erectus* speak? What minimal form of communication would it have needed? The answer seems to be something like what I refer to as a 'G_1 language'. This is a language in which symbols (words or gestures) are ordered in a conventional way when spoken (such as subject-verb-object, as in 'John saw Mary'), although, somewhat contradictorily, the interpretation of the symbols in this agreed-upon order can be very loose. Thus, 'Mary hit John' might mean in the first instance that Mary hit John, but might have other meanings available according to the context, such as 'Mary was hit by John' or 'Mary bumped into John' and so on. The context in which the words are uttered as well as what the speaker and hearer know about Mary and John, in conjunction with general cultural knowledge and the agreed-upon word order, will determine the interpretation intended. A G_1 language is nevertheless a real language. It is not some 'protolanguage' (qualitatively different from a 'real' language). Such a language can actually express everything needed by a particular culture and is 'expandable' to fit additional needs if the culture becomes more complicated. Think again of examples like 'No shirt. No shoes. No service.' This can mean quite a few things, but members of American culture at least interpret the phrase as an admonition from a business establishment, even though there is little in the words themselves that indicates such a thing. Culture serves as a filter on what the meaning is. Grammar is another partial filter. So in this case, 'Mary hit John' might mean that Mary hit or bumped into John, but it would be harder for it to mean that John bumped into Mary because of the word order imposed by the grammar, which acts as a (weak) filter on the possible meanings of the sentence. Whenever the grammatical filter is less fine-meshed, as in a G_1 language, the role of culture in aiding the meaning becomes even greater, though it is always present in all languages.

The archaeological evidence leads to the conclusion that *Homo erectus* possessed creative thought and culture. In other words, in spite of scepticism from some researchers, *erectus* spoke, was creative, and organised its communities by principles of culture. The cultural evidence is otherwise inexplicable. *Erectus* were seafarers and manufacturers not only of technologically interesting hand tools, from Lower Palaeolithic Olduwan tools to Upper Palaeolithic Mousterian tools, but also vessels able to cross large bodies of water. *Erectus* communities, such as the one Gesher Benot Ya'aqov, developed cultural specialisation of tasks. And *erectus* controlled fire, as evidence from several *erectus* sites suggests.

Once again, though, *erectus*'s speech and language may have differed significantly from those of modern humans, yet *erectus* languages nevertheless would have been full languages. So long as they possessed symbols, ordering of the symbols and meanings partially determined by those components in conjunction with context they had language. And it seems clear for various reasons that they would not only have spoken their language but also have used gestures as aids to communication. Neither gestural languages nor music nor controlled use of pitch (as in singing) would have come first (see chapter 10 below). Simple (G_1) languages emerged with grammar, which, accompanied by pitch modulation and gestures, produced the most effective communication system the world had ever seen. This is the minimum form of language possible.

Erectus speech, however it sounded, is an important but secondary question. *Homo sapiens*' still bigger brains, longer experience with language, a more developed vocal apparatus and so on, give us huge advantages. They mean that *sapiens*' languages are more advanced, in the sense of having larger vocabularies and probably more complex (hierarchical and or recursive) syntax. Nevertheless, the upshot is that there is no need to suppose that erectus spoke a subhuman 'protolanguage'.

A protolanguage by definition is not a fully developed human language, but rather merely a 'good enough' system for very rudimentary communication. But the kind of language that *erectus* would have used would have been good enough not only for *erectus* but also for modern *sapiens*, depending on the needs of individual cultures, because a G_1 language can communicate almost as well as a G_3 language.

Erectus travelled almost the entire world, though based on current evidence never made it to America, Australia or New Zealand. But they made it to many other places. Here is a brief summary of *erectus* sites and time ranges:

Middle East
Gesher Benot Ya'aqov (790 thousand years ago)
Erq al-Ahmar (1.95 million years ago)
Ubeidya (1.4 million years ago)
Bizat Ruhama (1.96 million years ago)

Italy
Pirro Nord (1.6 million years ago)

Turkey
Dursunlu (before 1 million years ago)

Iran
Kashafrud (before 1 million years ago)

Pakistan
Riwat (before 1 million years ago)
Pabbi Hills (before 1 million years ago)

Georgia (before 1 million years ago)

Spain (before 1 million years ago)

Indonesia (around 1 million years ago)

China (before 1 million years ago)

It bears repeating that, in their daily life, *erectus* communities had to care for children and strategise together. They needed to plan things like what to do today, where to hunt, or which men stay with the women and children and which go to find food. They needed to share information about signs ahead, about evidence of animals in the vicinity, or how to care for their sick, even if that amounted to little more than feeding them. It is, of course, speculation to imagine how they did these things or how well *erectus* communities understood or planned what they were doing, how they cared for each other, or how they conducted their daily lives. But by using the examples of current hunter-gatherer populations, along with the intelligence that *erectus* needed to have based on archaeological evidence, these suggestions are probably not too far off.

Erectus communities also had to learn to evaluate others and deal with them. There would be cheaters and laggards on the journey. Perhaps murderers. There would have been injured people. They would have desperately needed to work together. These pressures developed their intelligence and cultural connection more each day, along with their values and priorities.

Erectus did not simply walk single-file or run randomly around the world. They were organised. They were smart. They were a society of cultured humans. And they must have had language.

And yet what is language after all? With all this discussion of the language of *Homo* species, it is time to examine the nature of human language in more detail.

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* In a web-based discussion (http://www.athenapub.com/13sunda.htm) authors Roy Larick of

the Shore Cultural Centre, Euclid, Ohio, Russell L. Ciochon of the Department of Anthropology, University of Iowa, and Yahdi Zaim of the Department of Geology, Institute of Technology, Bandung, Indonesia, claim that:

Fossils representing very early *Homo erectus* populations are now known from the highland Rift Valley of East Africa, the Caucasus Mountains that mediate southeast Europe and southwest Asia, and from the intensely volcanic slopes of the Sunda subduction zone. Circum-Mediterranean archaeological sites representing these groups may be present in northern Algeria (Ain Hanech), Andalusian Spain (Orce), and the Negev (Erq el Amar). Late Olduvai subchron archaeological sites are also known on the Himalayan fore slope (Riwat, Pakistan), and in southern China (Longgupo). The Plio-Pleistocene carnivores associated with humans are also known from Greece (Mygdonia Basin).

The commonalties among these sites call for a new interpretation of early *Homo erectus*. All these sites fall into the transcontinental Tethys geotectonic corridor, the grand suture at the southern margin of the Eurasian continental plate with southward extensions into the East African Rift and the Sunda subduction zone. A global time marker immediately precedes and overlaps with all sites, the Olduvai subchron (1.96 to 1.79 mya [million years ago]). With the corridor and the subchron, we can begin to talk about Homo erectus biogeography as neither African nor East Asian, but as Plio-Pleistocene Tethys.

† Backed knives ‘were made by steeply trimming one edge of a blade by pressure flaking. This design allowed the user to apply pressure against the blunted edge with an index finger for cutting with the opposite sharp edge. Experiments have shown that a backed knife made of stone can skin an animal about as fast as a steel knife.’ (www.lithiccastinglab.com/gallery-pages/aurignacbackedknifeag7large.htm)

4

Everyone Speaks Languages of Signs

> … by 'semiosis' I mean … an action, or influence, which is, or involves, a cooperation of three subjects, such as a sign, its object and its interpretant …
>
> Charles Sanders Peirce (1907)

WHAT IS LANGUAGE? Is language indeed something that *Homo erectus* invented? It is worth restating the basic principle: language arises from the convergence of human invention, history, physical and cognitive evolution. The inventions that would have moved humans towards the languages spoken today were first icons and then symbols.

The archaeological evidence in fact supports the order predicted by the sign progression of C. S. Peirce – indexes would have come first, followed by icons and then symbols. We find indexes earlier than icons and icons earlier than symbols in the prehistoric record. Moreover, indexes are used by perhaps all creatures, icons recognised by fewer creatures and symbols used habitually only by humans. Although Peirce in fact believed that icons were simpler than indexes, he primarily had in mind the human elaborations to indexes, not – in my opinion – how the signs are found in nature per se.*

Newspaper headlines, store regulations, movie titles and other unusual forms of modern language are occasionally reminders of how simple language can be. There are some famous examples of languages reminiscent of possible early languages in the movies:

You Jane. Me Tarzan.
Eat. Drink. Man. Woman.

And in store signs:

No shirt. No shoes. No service.
No ticket. No wash.

These examples can even be found on billboards: *You drink. You drive. You go to jail.*

In spite of their grammatical simplicity, we understand these examples just fine. In fact, one can construct similar sentences in any language that will be intelligible to all native speakers of the language, as in these examples from Brazilian Portuguese.

Olimpiadas Rio. Crime, sujeira.
Olympics Rio. Crime, dirt.
Voce feio. Eu bonito.
You ugly. Me pretty.
Sem lenço. Sem documento.
Without handkerchief. Without document.†

Such phrases are interesting because they prove that humans can interpret language even when it isn't structured grammatically. *Homo erectus*'s language might have been no more complicated than these examples, though quite possibly it was more intricate. What all of these examples show, however, and what would have also held for the language of *Homo erectus*, as for all of the languages of *Homo sapiens*, is that language works fine when it is underdetermined. In understanding language or people or cultures, context is crucial. It is necessary to take a holistic perspective on interpretation. What was the organism, its connection to the environment, and the thing it invented like? These are the questions that flow from a holistic perspective on the invention and evolution of language.

This idea is explored in detail by anthropologist Agustin Fuentes of the University of Notre Dame in Indiana. He makes a case for an 'extended evolutionary synthesis'. What Fuentes means by this is that researchers should not talk about the evolution of individual traits of species, such as human language, but instead that they need to understand the evolution of entire creatures, their behaviours, physiology and psychology, their niches, as well as their interaction with other species. Fuentes asserts that a full picture of human species engages the biological, the cultural and the psychological simultaneously as part of this extended evolutionary synthesis-based understanding. At the same time, Fuentes claims that current models of what culture is and how it interacts with the human psyche and body are poorly developed, at least in the sense that there is no broad consensus on what culture is. But there do seem to be components of culture and ways that such culture interacts with us. Many of the very traits and properties of the environment that we want to explain as part of language evolution are poorly defined, lacking widespread agreement on their meanings among the majority of specialists. For a theory of language evolution an understanding of the roles of society, culture and their interaction with individual cognitive functions is vital. Yet there is little agreement as to what any of these things mean. Although our bodies are a bit better understood, there are vast spaces of disagreement even about our physical make-up.

In order to better understand the factors of our environment that affect our evolution, it might help to start by defining the social environment, beginning with the elusive idea of ‘culture’. A theory of culture underlies an understanding of language evolution. In fact, there can be no adequate theory of language evolution without a sound theory of culture. One idea of culture (mine) is the following:

> Culture is an abstract network shaping and connecting social roles, hierarchically structured knowledge domains and ranked values. Culture is dynamic, shifting, reinterpreted moment by moment. The roles, knowledge and values of culture are only found in the bodies (the brain is part of the body) and behaviors of its members.[1]

Culture is abstract because it cannot be touched, or seen, or smelled – it is not directly observable. However, the *products* of culture, such as art, libraries, political roles, food, literature, science, religion, style, architecture and tolerance or intolerance, are non-abstract, visible and tangible. Culture as a dynamic force is found only in the individuals of a society. Members of any society share a culture when they agree on a range of values and the relative priority of all the values that they hold. Members of a culture in turn share knowledge and social roles. One observes values and knowledge applied or examples of expectations from different social roles in action through individual members of the society. This is culture in action.

Each modern human, as did every *Homo erectus*, learns their place in society, what is more or less important as members of that society, as well as the knowledge common to all the members. And they teach these things by word and example to their offspring. All humans, past and present, learn these things. As do other creatures.

Nowadays, a very different theory of the origin of language than what I am urging here is popular among some. This is the idea that language is a disembodied object, along the lines of a mathematical formula. In this view, language is little more than a particular kind of grammar. If that kind of grammar, a hierarchical recursive grammar, is not found in a communication system, then that form of communication is not a language. Proponents of this idea also maintain that grammar ‘popped’ into being some 50–65,000 years ago via a mutation. This suggestion, even though very widely accepted, has surprisingly little evidence in its favour and turns out to be a poorer fit with the facts than the idea that language was invented, but subsequently changed gradually through all *Homo* species, to fit different cultures.

Though language is best understood as an invention, the mutation proposal is very influential. The theory comes from the work of Noam Chomsky, who began publishing in the late fifties and is, according to some, now the leading linguist in the world. But Chomsky’s view that language is a recursive grammar, nothing more nor less, is a highly peculiar one. Already in 1972, a review in the *New York Review of Books* by American philosopher John Searle noted how strange Chomsky’s conception of language actually is.[2]

This view is unusual because we know that languages need not have intricate grammatical structures. Some might instead merely juxtapose words and simple phrases, allowing context to guide their interpretation, as in the examples that begin this chapter. The main problem with the idea that language is grammar boils down to a lack of appreciation for the source and role of meaning in language. The view here, to the contrary, is that grammar is helpful in languages, but that different levels of complexity are to be expected among the languages of the world, including the extinct languages of *Homo erectus*. Moreover, complexity can vary tremendously from language to language. In other words, language is not merely a synonym for grammar. It is a combination of meaning, form, gestures and pitch. Grammar aids language. It is not itself language.

Language, whatever its biological basis, is shaped by psychology, history and culture. I try to show what this means in Figure 7.

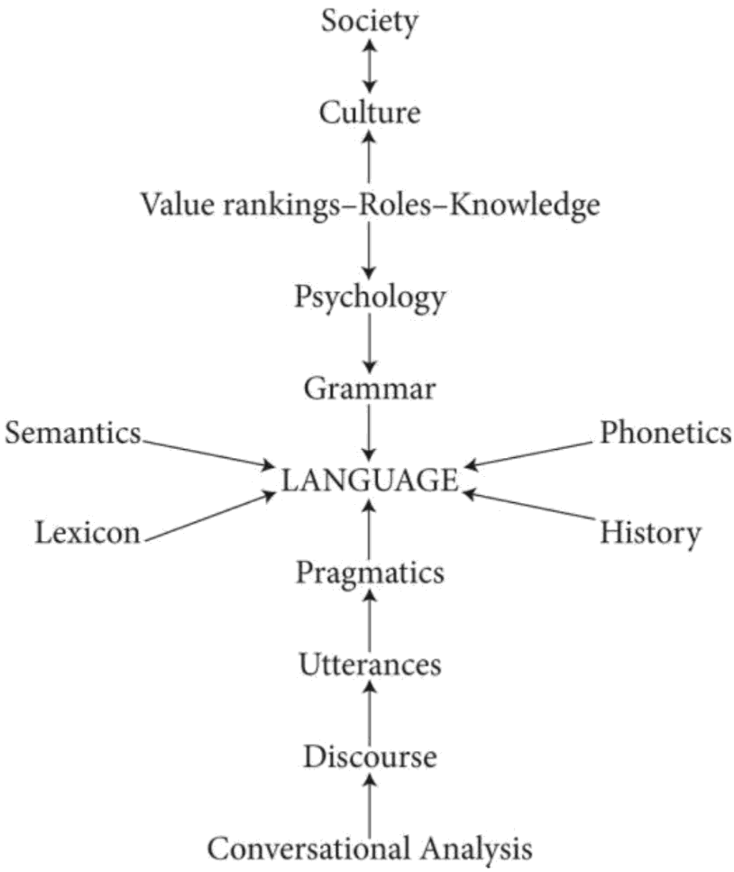

Figure 7: **Language is a nexus**

In order to get down to the nuts and bolts of how language itself actually evolved, there are two alternative views of development that must be distinguished. These are *uniformitarianism* vs *catastrophism*.

Uniformitarianism is the idea that the way things work now is the way they worked in the past. That is, the forces that operate in the world today are the same forces that have shaped the world since it began. Uniformitarianism does not deny the possibility of cataclysmic or catastrophic events playing roles in history and evolution. After all, uniformitarian scientists accept that there was a great dinosaur extinction event around 65 million years ago, when an asteroid crashed into the Yucatan. But it says that catastrophic change is not the main driver of evolutionary theory and that catastrophes should not be proposed as explanations without very clear evidence.

Catastrophism, on the other hand, appeals to major upheavals, such as Noah's flood or elevated rates of mutations, as frequent explanations for the origin and development of life on earth. Niles Eldredge and Stephen Jay Gould proposed that a great deal of evolutionary change is brought about by sudden macroevolutionary jumps that they called 'saltations'. Saltational models might be accurate for some examples of evolutionary change. But they always require additional evidence.

Uniformitarianism rather than catastrophism is taken to be a foundational truth in most scientific disciplines. In physics, few question the assumption of uniformitarianism. Physical laws show no evidence of having changed during the universe's natural history at least subsequent to the 'Big Bang'. And in geology, Charles Lyell's 1833 work, *Principles of Geology*, is known in part for its advocacy of uniformitarianism in earth history studies. By assuming uniformitarianism, a model of natural selection is expected to account for the transformation of ancient life forms into modern life forms via gradual, homeopathic, 'baby steps'.

In the case of language evolution, there are good reasons to reject catastrophism-based views such as Chomsky's. Reasons include its poor account of the genetics involved and its failure to account for the influence of culture on language emergence. Moreover, this catastrophism view fails to account for the fact that mutations for language are superfluous because language evolution can be explained without them. Invoking mutations without independent evidence is unhelpful. In fact, the idea of language as a mutation simply offers no insights at all that help to understand the evolution of language. That is to say that language evolution can be explained without mutations, based instead on gradual, uniformitarianist

First American Edition 2017

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Production manager: Anna Oler
Jacket Design by Steve Attardo

The Library of Congress has cataloged the printed edition as follows:

Names: Everett, Daniel Leonard, author.
Title: How language began : the story of humanity’s greatest invention / Daniel L. Everett.
Description: First American edition 2017. | New York : Liveright Publishing
Corporation, a division of W. W. Norton & Company, [2017] |
Includes bibliographical references and index.
Identifiers: LCCN 2017025673 | ISBN 9780871407955 (hardcover)
Subjects: LCSH: Language and languages—Origin. | Human communication. | Semiotics. |
Psycholinguistics.
Classification: LCC P116 .E73 2017 | DDC 401—dc23
LC record available at https://lccn.loc.gov/2017025673

Liveright Publishing Corporation
500 Fifth Avenue, New York, N.Y. 10110
www.wwnorton.com

W. W. Norton & Company Ltd.
15 Carlisle Street, London W1D 3BS