THE LANGUAGE PUZZLE

THE LANGUAGE PUZZLE

How We Talked Our Way Out of the Stone Age

STEVEN MITHEN

Profile Books

First published in Great Britain in 2024 by
Profile Books Ltd
29 Cloth Fair
London
EC1A 7JQ

www.profilebooks.com

1 3 5 7 9 10 8 6 4 2

Typeset in Dante by MacGuru Ltd
Printed and bound in Great Britain by
Clays Ltd, Elcograf S.p.A.

A CIP catalogue record for this book is available from the British Library.

ISBN 978 1 80081 158 4
eISBN 978 1 80081 159 1

To Sue Mithen
for all her wise words

Contents

Preface

How, when and why language evolved have been enduring questions since the time of Plato, and most probably long before. Although always of interest, I avoided addressing these questions directly in my two previous books about the evolution of the human mind, *The Prehistory of the Mind* (1996) and *The Singing Neanderthals* (2005). Several other scholars were putting forward fascinating ideas and theories about language but they were neglecting other aspects of the evolving mind that I wanted to address, notably creative thought and music. As much as I tried to avoid language, however, I kept being drawn towards it as the most fundamental aspect of the modern mind.

Proposals for how, when and why language evolved continued to be published throughout the last two decades. While I read and applauded many accounts, none appeared satisfactory. Some drew primarily on evidence from one discipline, such as linguistics or anthropology, but could be readily discounted by evidence from another, such as archaeology or psychology. Others dealt with one aspect of language while neglecting others or provided elegant scenarios for how language evolved but entirely lacked a chronology for when that occurred. Hypotheses came and went with considerable speed, often reflecting the pace of new discoveries about the past, the brain and language itself. I suspected any contribution I could make would be of similar transient value. But I continued to think about the language questions, discussed them with my colleagues and students, and read in as many subject areas as I could manage. The questions were never far from my mind as I undertook my excavations to find Stone Age artefacts, the makers of which had been silenced by the passage of time.

Around 2020, I began to suspect that embedded in the recent research of linguists and archaeologists, of computer scientists and anthropologists, of philosophers, psychologists and geneticists were the fragments of a comprehensive account for language evolution. An account that could build the necessary bridges between disciplines and would stand the test of time despite the inevitability of new discoveries and new ideas. Finding those fragments from within so many disciplines was only half the challenge. The other half was working out how they join together. That was a puzzle and my solution has become *The Language Puzzle*.

Acknowledgements

The Language Puzzle has had a long gestation. I feel I should thank everyone I've spoken to ever since acquiring my own first words. For the sake of brevity, I will be selective.

I would like to thank Giovanni Bennardo for inviting me to talk at the workshop on 'Cultural Model Theory: Shaping a New Anthropology' that took place in May 2022 at Northern Illinois University. Preparing for and participating in that workshop helped me formulate my thoughts about how language may have evolved. I met the linguist Stephen Levinson at the workshop, whose work I greatly admire. He encouraged me with an offhand remark after my presentation saying, 'I think you may have something there.' My conversations with Stephen made me realise how little I knew about language, as he was evidently aware, and sent me on a journey into as much linguistics as I could manage. I hope it has been sufficient.

The University of Reading and its Department of Archaeology have always provided a stimulating and enjoyable place to work, with tremendously supportive colleagues. Rob Hosfield, my Head of Department, kindly read my chapters about archaeology and human evolution, correcting some matters of fact, and providing me with more to think about. Annemieke Milks did likewise while answering my queries about prehistoric hunting and kindly appeared in my office brandishing a two-metre replica of a Neanderthal spear to literally prove a point.

I am grateful to Andrew Franklin of Profile Books for asking me to write a book about farming and then acquiescing to my request to write about language instead. He provided great encouragement and helpful editorial advice, as did Janice Audet from Basic Books. The team at Profile Books have been exceptionally helpful and supportive. I am grateful to Philippa Logan for excellent copy-editing and to Rachel Becker for preparing the figures, both patiently coping with my persistent tweaking.

I am also indebted to my twin brother, Richard, who was the first person I ever talked to and whose wise words of advice, about this book and other things, are greatly valued. Nick, my son, drew my interest to the Enlightenment and the enduring value of its debates about language. I am also grateful to Heather, my daughter, for our discussions about children's minds. Words cannot express my gratitude to Sue, my wife. She patiently listened to my ideas, read and commented on my text, discussed and debated with me. Most of all, Sue shared her own joy of words, inspiring me to find my own.

1

INTRODUCTION: THE PUZZLE OF LANGUAGE

By choosing to read this book, I suspect you know at least 50,000 words and say around 16,000 words a day. Thousands more will pass through your mind, either heard from others, as you are reading, thinking what to say or musing to yourself.[1] You are good at words, speaking between 120 and 200 words a minute and reading them at twice that speed.[2] When speaking, writing or using sign language, you effortlessly create unique sequences of words. These convey meanings beyond those of the individual words themselves, meanings that others can understand with equivalent ease despite never having heard or seen that string of words before. You might even be able to do this in another language, perhaps several. How so? How can you remember and manipulate so many words? That is a puzzle.

We have a love of words. Think crosswords, Scrabble and texting. Think chatting to a friend, listening to a story, sharing a joke or hearing a speech by the orator of your choice – Churchill, Obama or Mandela. Moreover, we are never satisfied with the words we have, frequently changing their meanings and inventing new ones. Think tablets, clouds and surfing. Think Covid, Brexit and, if you can, trequartista. That was one of the 2,000 new entries to the *Oxford English Dictionary* in 2022. In case you didn't know, it means an attacking football player who operates in the space between the midfielders and the strikers and whose primary role is to create opportunities for teammates to score.[3]

Now you have at least 50,001 words. Where do you keep them all? How do you know which ones to use, and how to combine them to make a statement or ask a question that someone else will understand?

Just as we love words, we know their power and may fear their consequences. We know how a few ill-thought-out words can damage a relationship and flunk an interview; how eloquent politicians can sway a crowd; how words can abuse and offend; how words can rouse people to hatred, violence and war. We tolerate and suffer the consequences of such words because of our unbounded desire to talk and listen to what others have to say.

Your lexicon love affair began in childhood. Before reaching the age of one, you were likely saying your first words and knew the meaning of several hundred. Within your second year, you had started combining words into simple sentences while learning new ones at an average rate of nine a day.[4] That rate continued unabated into your adolescence, maybe even learning two or more languages at once. How were you able to acquire language at such pace?

The answer is that you had your parents, carers, family and friends for help. You inherited a genetic predisposition to acquire language from your biological parents, which was realised by growing up amid people who were continuously using words, whether spoken or signed. Your parents had done likewise, helped by their own parents, family, friends and wider community. And so on, back through the generations. But how did it begin?

And when?

A long time ago. It must have been after 6 million years ago, the date when we shared a common ancestor with the chimpanzee. Although there are word-like qualities to chimpanzee barks and grunts, these are insufficient to characterise their vocal communication as a form of language. Unlike tool making, walking on two legs and complex patterns of social relations, language has remained stubbornly aloof from the primate world, becoming the last bastion of human uniqueness. With no antecedent in the animal world, explaining how language began has become the mother of all puzzles.

We need to solve that puzzle to explain language today – how you can extract meaning from this sentence and (hopefully) tell others about the interesting book you are reading. Equally, we need to solve the language puzzle to know about our past. I suspect you have heard about the Neanderthals of the Ice Age, and Lucy who left her footprints in Tanzania 3.7 million years ago. Anthropologists describe their bones, archaeologists their tools and biologists can tell us about their genes.[5] As fascinating as all that is, without knowledge about their language our ancestors will always remain ill defined, providing us with little understanding of the past. Did Lucy and the Neanderthals have words? If so, did they also have rules for how they could be strung together to make meaningful utterances? Or did they merely mumble and howl? We need to know. Otherwise, they will forever remain as nothing more than objects for scientific study, rather than acknowledged as sentient beings from our distant past.

Whenever language of the type we have today emerged, my proposition is that it enabled the most fundamental social, economic and cultural event of the human past: the origin of farming at *c.*10,000 years ago. That put an end to millions of years of hunting and gathering and was effectively the end of the Stone Age because metallurgy was soon discovered within the new farming communities.[6] The beginning of agriculture was not just the turning point of human history but also the crossroads for planet Earth. Farming rapidly led to towns and cities; ancient civilisations and empires soon followed; then came the industrial and digital revolutions, followed by globalisation. Marvellous things have been achieved – the music of Bach and men on the Moon. But the first farmers also ignited the slow-burning fuse of our present-day climate crisis and agriculture is responsible for extensive environmental degradation and loss of biodiversity.

Although the first farming communities are dated to 10,000 years ago, they were the outcome of a long, slow process of change in the way people thought about and acted in the world. That process began as soon as fully modern language evolved and was spurred on by climatic events that followed the peak of the last glaciation at 20,000 years ago. While archaeologists have focused on the impacts of climate change, they provide only half the story for the origin of farming.[7] The other half is language, when it evolved and its impact on the human mind and behaviour. Without that we would still be living as Stone Age hunter-gatherers.

Solving the puzzle

Understanding the origin of language has been described as the hardest problem in science.[8] Attempts to solve it began when Plato asked about the origin of names, and possibly long before. Today we have a plethora of theories, hypotheses and ideas. But there is no agreement.[9]

Some argue for a sudden emergence of language from a genetic mutation at 100,000 years ago, while others suggest phases of 'protolanguage' or a slow emergence of language over millions of years;[10] some propose language evolved from singing, while others promote social bonding, storytelling, tool making and hunting;[11] some cherry-pick a feature of language and claim its evolution was the transformative event, such as 'displacement' (the ability to talk about the future and the past) or 'recursion' (the way in which we can embed multiple clauses into a single utterance).[12] No one seems to agree with anyone else.

There have been two constraints on reaching consensus.

The first is the sheer complexity of the task, because language is such an all-encompassing, brain, body, social and cultural phenomenon. The second is that critical pieces of the evidence have been missing.

With regard to the first constraint, many academic disciplines are required to explain how we create and use language today, and even more to explain how this remarkable capacity evolved.

Linguistics is essential because it defines the nature of language, as is psychology because language is a product of the human mind, drawing on a host of mental processes including memory, perception and attention. Neuroscience digs deeper by examining how language is generated by the brain, while genetics considers how inherited genes interact with our environment to enable linguistic capabilities to develop and evolve. Anthropology is required because language users must be placed into their social and cultural context. Palaeoanthropology does likewise for our human ancestors, along with reconstructing their anatomy and its linguistic implications from skeletal remains. Archaeology is essential for inferring linguistic capabilities from stone artefacts and other human debris. Ethology is also required because studying chimpanzees and other non-human primates in captive and wild settings provides insights into the pre-linguistic foundations of language that were likely present in our earliest ancestors.

Each of these disciplines has its own body of data, theories, methods and terminologies. Each has one or more essential pieces of the language puzzle to contribute. Despite academics' willingness to collaborate, research within each discipline is often pursued in relative isolation, partly because of outdated educational and university structures and partly because of the intellectual challenge required to cross disciplinary boundaries. A consequence is that theories about language evolution often suffer from disciplinary dissonance: ideas proposed from one discipline, such as linguistics, invariably conflict with evidence from another, such as archaeology.[13]

The second constraint has been missing puzzle pieces; conversely, what had been thought to be important pieces did not belong at all. New research has lifted this constraint. Key discoveries have been made by archaeologists when digging in the ground, psychologists listening to children, computer scientists simulating language change, ethologists watching apes, and linguists taking language apart. The pile of new puzzle pieces from their work has been added to by geneticists decoding human genomes and neuroscientists peering inside the brain. The new evidence caused old ideas to be questioned and then discarded, notably dedicated language centres in the brain, specialised genes for language, and the notion of Universal Grammar – the idea that we are born with a ready-made and specialised mental toolbox for language acquisition. As these were removed, even older ideas acquired a new lease of life: twenty-first-century human genomics has almost caught up with Epicurean ideas about language of the fourth and third centuries BC.

A revolution in our understanding of language is underway. We now appreciate the extent of linguistic diversity throughout the world and understand how children learn the meaning of words; we are beginning to grasp how language relies on neural networks that extend throughout the brain, these constructed by complexes of interacting and multifunctional genes. Chimpanzee calls are no longer dismissed as uncontrolled outbursts; we have new insights into the material culture, behaviour and cognition of our extinct relatives and ancestors.

Biological and cultural evolution have become entirely entwined.[14] The present is now recognised as a key to the past. Just as the geologist Charles Lyell had used contemporary processes of sedimentation and erosion to explain geological strata within his *Principles of Geology* of 1830, and just as Charles Darwin had used those of inheritance, reproduction and competition to explain biological evolution in his *Origin of Species* of 1859, so too can we use linguistic change in the present to inform about that of the distant past and explore its long-term consequences.[15]

The Language Puzzle collects together all the old and new pieces of evidence and attempts to solve the puzzle. As with a jigsaw, the only way to start is by connecting pieces into a series of fragments, each a mini puzzle in itself. The edge pieces must come first to provide the overall frame of the puzzle and to hint what its middle may contain. Once the frame is complete, fragments of its interior can be assembled, ideally with each providing a satisfying picture. When all have been completed, they can be joined to reveal the bigger picture – in our case the when, the why and the how of language evolution.

Chapter 2 provides half of the jigsaw frame, with an overview of human evolution during which language evolved, introducing the species, cultures and climatic periods that feature prominently in the following chapters.[16] It begins with the last common ancestor between humans and chimpanzees that lived 6 million years ago. Humans, members of the *Homo* genus, first appeared on the African savannah 2.8 million years ago and evolved into several different species that flourished in Africa, Europe and Asia, before contracting to its sole survivor at *c.*40,000 years ago: *Homo sapiens*, the species to which we all belong. Quite why only *H. sapiens* remains is much debated. Some argue this is because we alone have language, a proposition to be tested in this book.

The jigsaw frame is completed in Chapter 3, which reviews what we need to explain: the nature of language as we know it today. This covers the nature of words and the rules by which they are combined to generate meaningful utterances, whether spoken, signed or written; how words and rules vary between languages; and the causes of such linguistic diversity.

The frame guides us to twelve further fragments of the language puzzle. The first is what the vocalisations of apes and monkeys can tell us about the foundations of language in our earliest ancestors (Chapter 4). There are two fragments that draw on the fossil evidence: what can we learn about language evolution from changes in the vocal tract (Chapter 5) and from changes in the size and shape of the brain during human evolution (Chapter 11)? Three fragments relate to past behaviour: the linguistic implications from how our ancestors made stone tools (Chapter 7), made signs and symbols (Chapter 15) and used fire (Chapter 10). Critical pieces of the puzzle come from language itself: the distinction between different types of words (Chapter 6), how language is shaped by its transmission from generation to generation (Chapter 8), how infants learn language (Chapter 9), the constant change in the meanings, roles and pronunciations of words (Chapter 13), and how language impacts on perception and thought (Chapter 14). The genetics of language contributes to our knowledge of language today and its past evolution (Chapter 12).

To assemble these fragments, I describe the work of linguists, anthropologists, philosophers and scientists of every hue who have found the puzzle pieces – the evidence. I will bring you their breakthrough moments: the experiments, discoveries and insights that have transformed our knowledge of language and how it evolved. Although the above list might suggest that I switch randomly from one subject area to another, the fragments follow each other in a logical order, as each indicates the next fragment to assemble so that the bigger picture can emerge.

With the frame and twelve interior fragments complete, the final challenge is piecing them together to solve the language puzzle. How does the evidence about the vocal tract and the brain connect to that about stone tools and the use of fire? How does our understanding of language acquisition by children influence that of language evolution by human ancestors? Was language always a tool for thought or was that a recent innovation? The concluding chapter reveals the big picture: how language evolved and its monumental impact on the lives of our ancestors and the history of the planet. It solves the puzzle of why we all love words.

2

A BRIEF HISTORY OF HUMANKIND

Our evolutionary story begins between 8 and 6 million years ago (mya) with an ape living somewhere in Africa.[1] That was the last common ancestor (LCA) for humans (*Homo*) and the chimpanzees (*Pan*), our closest living relative. We know the approximate date that our lineages diverged by the extent of difference between the human and chimpanzee genomes and the rate at which genetic mutations occurred to create that difference. Although some chronological uncertainty remains, throughout this book I will cite a date of 6.0 mya (6 million years ago) for the LCA (Figure 1).

It is commonly assumed that the LCA had strong similarities to present-day chimpanzees, some preferring to cite the long-limbed bonobo (*Pan paniscus*) that live in female-dominant societies and others the more conflict-ridden, male-dominated groups of the common chimpanzee (*Pan troglodytes*). Whether either type is a suitable model for the LCA is debated because, as with *H. sapiens*, both are products of a further 6 million years of evolution and likely possess derived features – those evolving after the time of the LCA. Unlike *H. sapiens*, however, chimpanzees have remained in the same type of closed canopy forest habitat as occupied by the LCA and maintained a similar brain size of 350–400 cubic centimetres (cm^3). For these reasons, the extent of evolutionary change within the lineage leading to present-day chimpanzees appears quite limited. It is not unreasonable to suspect that the LCA had used vocalisations similar

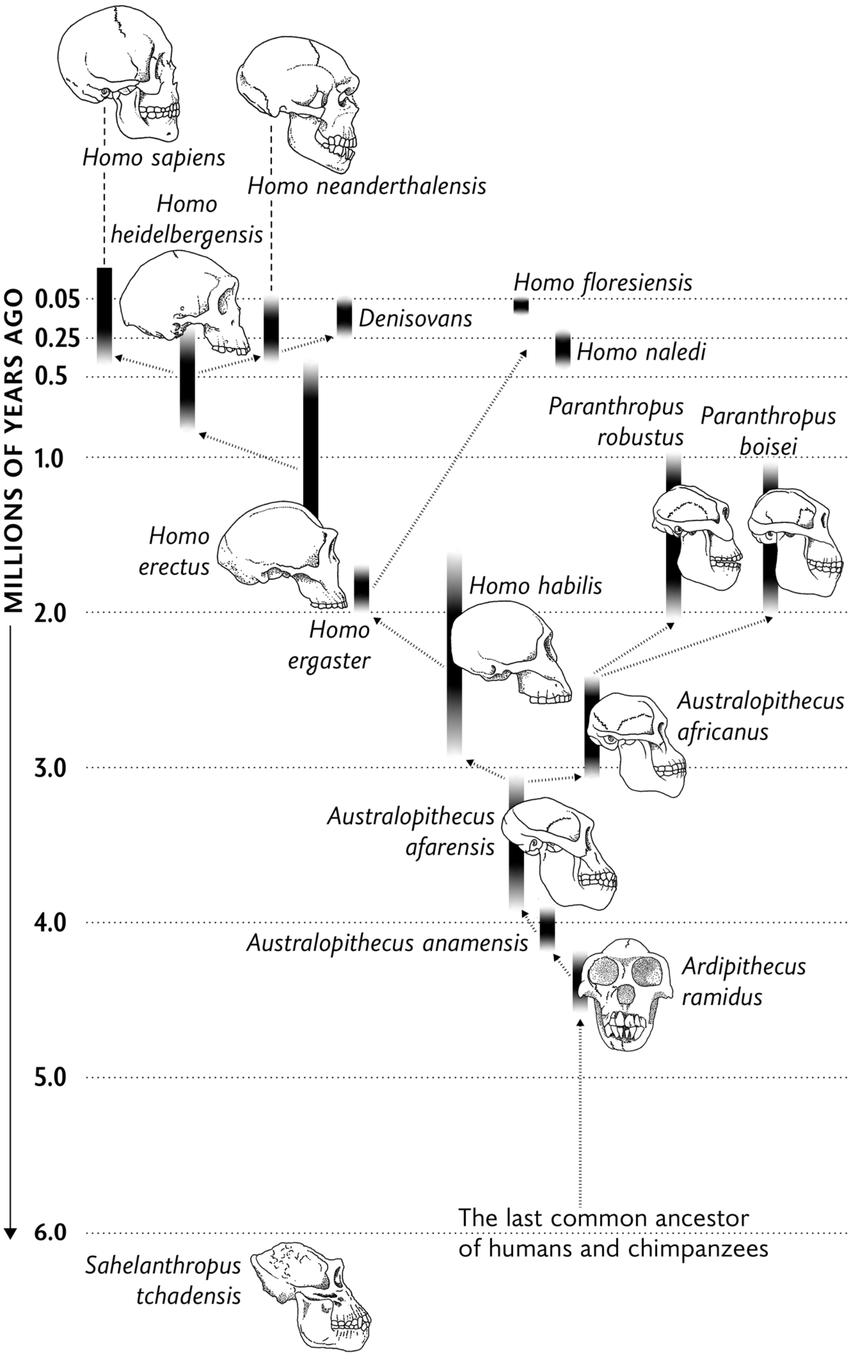

Figure 1 Key hominin species referred to in the text from six million years of human evolution

to those of chimpanzees. We will explore whether these have language-like qualities in Chapter 4.

The fossilised remains of at least four types of ape are known from Africa within the time frame of the LCA, or soon after. The oldest is *Sahelanthropus tchadensis*, coming from Chad in the north of central Africa, dating to between 7.2 and 6.8 mya, and once living in an open, savannah-like environment. The best preserved and most abundant specimens represent *Ardipithecus ramidus* from Ethiopia. These date to between 4.4 and 4.2 mya, by which time eastern Africa was thickly forested. Both species had a brain size of 300–350 cm^3, displaying anatomical similarities to the earliest *Homo* and present-day chimpanzees; they also had significant differences, removing them as viable candidates for the LCA – the fossil remains of which have yet to be discovered.

The fossil record markedly improves after 4.3 mya with as many as ten different types of ape known from eastern, central and southern Africa. These are collectively known as australopiths, some of which remain in the fossil record until 1 million years ago. They evolved during a period of increased aridity, with a shift from forested to open environments with scattered woodland.[2] The australopiths share several features with *Homo*, including bipedal locomotion, reduced facial projection and smaller teeth than those of earlier apes and present-day chimpanzees. Although the australopiths share a brain size of between 400 and 500 cm^3, there is considerable variation in body size and anatomy. That variation reflects different types of behavioural adaptation with each species having its own niche in the African landscape. The australopiths, early and all later members of the *Homo* genus are grouped together and called hominins.

Some australopiths became especially robust, with large cheekbones, facial muscles and molars reflecting an adaptation to chewing large quantities of dry and coarse plant material. These are sometimes placed into their own genus of *Paranthropus*. Other australopiths remained of a slender build, exploiting a greater diversity of foods, although still chewing tough plants. The earliest of these, dating to between 4.2 and 3.8 mya, is *A. anamensis*, which has chimpanzee-like features of a relatively narrow jaw and large canines. This species likely evolved into *A. afarensis*, known from between 3.7 and 2.9 mya, with the best-preserved specimen popularised as 'Lucy'. Although fully bipedal, Lucy's pelvis remained distinctive from that of *Homo*, and her relatively long arms, curved fingers and toes are characteristic of the much older *Ardipithecus*. Nevertheless, *A. afarensis* is regarded as the most likely direct ancestor of the earliest human.

The earliest humans

The earliest human is termed *Homo habilis*, the name coined by Louis and Mary Leakey, who found a distinctive set of fossils from Olduvai Gorge, Tanzania, in the 1950s and 60s. These were designated as representing a new species based on a larger brain, smaller molars and more human-like hand bones than the australopiths – although the diversity of that group had not been defined at the time of their discovery. Louis Leakey was undoubtedly influenced by stone artefacts from Olduvai that he believed were associated with the fossils, and hence the name 'handy man'.

Today we have fossils from Ethiopia, Kenya and South Africa that are also classified as *Homo habilis*, placing its earliest occurrence at 2.8 mya and providing this species with a brain size that ranged from 550 to 800 cm^3, together with a considerable degree of post-cranial anatomical variation.[3] It seems doubtful that *H. habilis* is a species at all; some call it a 'waste bin' for an assortment of unrelated fossils. Those with a larger brain, flatter face and larger teeth are sometimes placed into a separate category of *Homo rudolfensis*.[4]

Whether the *H. habilis* remains represent one or two species is the tip of a taxonomic iceberg issue that pervades the whole of human evolution: how do we recognise a species from skeletal remains alone, especially when we are aware that males and females will differ in size, and all species exhibit a degree of variability in their morphology? An even more profound question is how a new species can be identified from skeletal remains alone.

The traditional biological view defines species as reproductively isolated from each other – members of different species are unable to produce fertile offspring. This is now known to be invalid because more than 10 per cent of primate 'species' engage in interbreeding. That has also been demonstrated for recent human 'species', with genomic evidence for interbreeding between *Homo sapiens* and *Homo neanderthalensis*, despite their considerable anatomical differences. With no resolution to these issues, fossils are grouped together on the grounds of morphological similarity and designated as 'species' without any agreed meaning for that term. Not surprisingly, anthropologists will arrange fossils into different groups, with some proposing a lot more and others far fewer species to have existed in the past.

Homo habilis/*rudolfensis* appears in the fossil record at broadly the same time as the first stone tools, known as the Oldowan culture. These tools were flakes removed from nodules, and the nodule remnants, which are referred to as cores. However, the earliest known stone tools pre-date the earliest known *Homo habilis* fossils and hence they may have also been made by one or more types of australopiths.[5] Whether making such tools has implications for linguistic ability will be considered in Chapter 7.

While the stone nodules, flakes and cores were likely used for a variety of tasks, including cutting plants and pounding roots, their key role was the removal of meat, fat and marrow from animal carcasses, as evident from cut marks and distinctive fractures on the bones from archaeological sites. The carcasses had most likely been scavenged from carnivore kills, with the sharp flakes being critical for quick access in the face of competing scavengers such as hyenas and vultures. Scavenging may have started by picking over carcasses after the hyenas and vultures had finished and developed into aggressive scavenging by throwing rocks and shouting to chase off those competitors before they had taken the best bits of meat and fat.

The open savannah would have been a dangerous place, requiring *H. habilis* to live and work in larger groups than its forest-dwelling ancestors to defend themselves from predators and to work cooperatively when scavenging, gathering plant foods and collecting stone nodules. The need to live in larger groups has been invoked as a selective pressure for brain enlargement: to provide the cognitive skills for negotiating the complexities of social life, including selecting mates and food sharing.[6] Such brain growth would have been fuelled by the relatively high calorific return from meat, marrow and fat, while enhanced cognition from that larger brain would have facilitated learning how to knap nodules to make the required flakes. The resulting positive feedback loop between group size, technology, diet, brain size and cognitive ability may have been critical for the incipient stages of language, an idea to be explored further in Chapter 11.

At around 1.8 mya, a new species designated as *Homo erectus* appears in the fossil record of eastern Africa, with the earliest specimens sometimes called *H. ergaster*. This is larger than earlier *Homo*, with a stature and bodily proportions approaching those of modern humans and a brain size reaching 1,250 cm^3. The brain is not only larger but has some changes in shape that may relate to language, as considered in Chapter 11. An almost complete juvenile specimen, popularly known as the 'Nariokotome boy', provides an unparalleled record of post-cranial anatomy indicating a fully bipedal lifestyle. That had likely gradually evolved under several selective pressures including reaching to collect fruit, using hands to make and carry tools, reduced exposure to the sun, and needing to move swiftly across the savannah. The shoulder bones of *H. erectus* also have a modern-like appearance, suggestive of selective pressures for long-distance and accurate throwing, probably of both branches and rocks. This may have been to chase off hyenas from desirable carcasses or for hunting small game.

H. erectus fossils are widespread not only within Africa, from the far north to the south, but also beyond. An important collection comes from Dmanisi, Georgia, dating to between 1.85 and 1.77 million years old, showing a considerable degree of variation in body and brain size. *H. erectus* is securely dated in China and Java at 1.6 mya. It had spread into southern Europe by 1.5 mya but archaeological traces are sparse with the earliest European fossils coming from Gran Dolina, Atapuerca, in Spain, dating to 850,000–780,000 years ago. While some attribute these to *H. erectus*, others suggest a descendant called *H. antecessor*.

The out of Africa record is likely to derive from multiple dispersals, with *H. erectus* moving as part of the large mammal communities that responded to changing climate – travelling north during warmer and wetter periods and retreating to Africa when the climate became relatively dry and cold. Such changes arose from repeated 100,000-year-long cycles from cold (glacial) to warm (interglacial) periods within the Quaternary Ice Age that had begun at 2.6 million years ago. During the glacial periods, ice sheets expanded in high latitudes and mountainous regions, sea level fell, and low latitudes suffered drought; during the interglacial periods, the ice retreated, sea level rose, and grassland and then forest spread over what had been tundra and steppe. Within both the glacial and interglacial periods, there were further fluctuations as the climate became warmer or colder for shorter periods of time. Some of these were abrupt and intense, causing major disruption to ecosystems and human habitation. One intensely cold period happened at 1.1 mya and forced the extinction of *H. erectus* in Europe. When the climate relented, there was a new dispersal into that region at *c.*900,000 years ago.[7]

There have been eight major glacial–interglacial cycles during the last 780,000 years. The planet is currently in a warm, wet and notably stable interglacial period that began at 11,650 years ago and is named the Holocene. Some argue that the Holocene has already ended because of the intensity of human impact on the planet. They propose that a period known as the Anthropocene has started, either with the industrial revolution at *c.*1800 or the dropping of the atomic bomb in 1945. What is certain, however, is that the planet is now being artificially warmed by human action, with unknown consequence for the future of our species and all others on the planet.

Broadly contemporary with the appearance of *H. erectus* in Africa is a new stone technology called the Acheulean that involved making bifaces: large flakes or nodules that were flaked on each alternate face to create tear-shaped tools, otherwise known as handaxes. These are considerably more difficult to make than Oldowan choppers and flakes, exhibiting a deliberately imposed form that often shows marked symmetry. Whether handaxes and the out of Africa dispersals of *H. erectus* have implications for evolving language are considered in Chapter 7.

Handaxes and other bifaces with a straight edge known as cleavers are found throughout Africa, Asia and Europe for over a million years, sometimes in huge numbers at single locations. They are markedly rare from East Asia, possibly reflecting the dispersal to that region before the development of this technology and/or the use of other materials such as bamboo.[8] Handaxes and similar bifacial tools are absent in Europe before *c.*700,000 years ago. Their appearance after that date might reflect a further dispersal of *H. erectus* or a descendant species into that region.

The lifestyle of *H. erectus* appears similar to that of earlier humans with a mix of hunting, scavenging carcasses and gathering plant foods. Cooking has been proposed to reduce the effort and time of digesting raw foods, thereby releasing metabolic energy to enable an expansion of the brain, but evidence for the use of fire is sparse until *c*.400,000 years ago. That too may have implications for an evolving language capability, as will be explored in Chapter 10.[9]

Importantly, the anatomy of *H. erectus* had evolved in ways that likely changed the nature of social life from that of *H. habilis* times. The anatomical requirement for bipedalism required a narrow pelvis which led to a relatively short gestation period for a mammal the size of *H. erectus*. As such, offspring were born 'premature', with brain growth continuing at a foetal rate for the first year of life. This introduced a new developmental phase called childhood, one absent from the chimpanzee life course and we assume that of *H. habilis*. The role of childhood for the evolution of language is likely to be profound and its significance pervades this book, with its role in modern humans considered in Chapter 9.

The 'muddle in the middle'

This phrase refers to the most problematic period of human evolution, which occurred between 1 million and 350,000 years ago.[10] The fossil record becomes especially fragmented and diverse, defeating efforts to create coherent groups of fossils that might represent single species. While some anthropologists prefer to name just three or four species, no less than nineteen have been proposed by others. Unfortunately, this is also a critical period of human evolution because it ends with the presence of *H. neanderthalensis* in Europe and *H. sapiens* in Africa, both with evolved vocal tracts and large brains suggestive of advanced language capabilities – although not necessarily of the same type – as will be covered in Chapters 5 and 11.

The most recent African fossil attributed to *H. erectus* dates to *c*.780,000 years ago. Later specimens tend to have larger brains, a more rounded skull and smaller teeth than *H. erectus*, but it is difficult to draw a clear dividing line between *H. erectus* and descendant species. A sparse number of scattered and fragmentary African fossils have been designated as *H. rhodesiensis*, a name coined in 1929 but now rarely used. These and other fossils are now designated as *H. heidelbergensis*, a name derived from a 600,000-year-old jawbone discovered at Mauer near Heidelberg, Germany, in 1907. *H. heidelbergensis* has also been used for several other specimens in western Asia and Europe, implying this species had an extensive range but without providing any clarity as to where it evolved.

A marked lack of consensus about which fossils to designate as *H. heidelbergensis* suggests this 'species' might, like *H. habilis*, be a waste bin of unrelated fragments.[11] A recent proposal has been to discard the term altogether, placing the so-called African *H. rhodesiensis* and *H. heidelbergensis* fossils into a new species called *H. bodoensis* and to re-designate *H. heidelbergensis* from Europe as early *H. neanderthalensis*.[12]

A large collection of human fossils from another location at Atapuerca, Spain, called the Sima de los Huesos (Pit of Bones), represents at least twenty-eight individuals dating to *c.*450,000 years ago. These have been classified as *H. heidelbergensis*, although some wish to call these early Neanderthals. Similar taxonomic uncertainty hangs over further fossil remains from Europe, coming from Swanscombe and Boxgrove in England, Arago Cave in France, and Petralona Cave in Greece. The only region where there is broad consensus is East Asia with the designation of all fossil specimens to *H. erectus*.

The difficulties of classifying fossils dating to between 1 million and 350,000 years ago might reflect genuine taxonomic diversity arising from the ongoing climatic cycles that caused populations to fragment, become isolated and adapt to varying local conditions, or go extinct (or very nearly so). Indeed, we seem very lucky to be here because our Africa-based ancestors went through a severe contraction between 930,000 and 813,000 years ago. This is estimated to have wiped out 99 per cent of its members, leaving a breeding population of a mere 1,300 individuals – our ancestors survived by a whisker. It may have been from this calamity that the new species of *Homo heidelbergensis* emerged at around 800,000 years ago.[13]

With such changes in population numbers and distributions, it is surprising that stone tool technology remains largely consistent throughout this time, with the making of handaxes, cleavers and Oldowan-like flakes and cores in ever-changing frequencies and proportions throughout all regions.

While broadly consistent, there is a trend for handaxes to be more refined after 700,000 years ago, becoming thinner and displaying higher degrees of symmetry. By 500,000 years ago, they are found at relatively high latitudes in Europe, possibly associated with an early use of fire and the hunting of big game using spears.[14]

Homo sapiens, *H. neanderthalensis* and the Denisovans

After 350,000 years ago, the fossil record is better resolved. Fossils from Africa are primarily attributed to *Homo sapiens*. This species is distinguished by a suite of features including a relatively light physique, large brain (now reaching 1,100–1,700 cm^3), vertical forehead, a chin, flat face and, for the more recent specimens, a relatively spherical cranium referred to as being globular, reflecting the shape of the brain inside. The processes by which the cranium and brain evolved are referred to as 'globularisation'.[15] The skulls excavated from Jebel Irhoud, Morocco, and Omo in Ethiopia, dating to 300,000 and 195,000 years ago respectively, have elongated and flat crania/brains, despite being attributed to *H. sapiens* because of their facial features and teeth.[16] A group of *H. sapiens* fossils dating to between 130,000 and 100,000 years ago, primarily from the caves of Skhul and Qafzeh, Israel, have some degree of globularity. The fully globular shape, however, is found only in fossils dating to after 100,000 years ago, most of which date to *c.*35,000 years ago and later (reflecting the sample available from the fossil record).

Globularisation appears, therefore, to have evolved gradually between 150,000 and 35,000 years ago, representing a different development pathway for the human brain compared with that of all previous types of humans. At least one other type of human was present in Africa, a diminutive species with an intriguing mix of human and australopith traits designated as *H. naledi* dated to between 330,000 and 240,000 years ago from South Africa. A similar localised evolutionary development occurred in Southeast Asia where a notably small type of human is found on Flores, Indonesia, dating to between 100,000 and 60,000 years ago. Designated as *H. floresiensis* this is likely a dwarfed form of *H. erectus*, although some claim it is derived from an early dispersal of a small-sized *Homo* or even australopith out of Africa. Either way, *H. floresiensis* and *H. naledi* are fascinating finds because they demonstrate the trend in human evolution was not always towards a larger brain.

Between 350,000 and 45,000 years ago, the fossil record in Europe is relatively abundant with all specimens attributed to *H. neanderthalensis*, other than two finds that might represent brief incursions of *H. sapiens*, dating to c.210,000 years ago at Apidima Cave in Greece, and c.54,000 years ago at Mandrin Cave in France.[17] *H. neanderthalensis* is defined by a suite of features that contrast with those of *H. sapiens*, including a relatively flat cranium and projecting face, prominent brow ridges and large nasal cavities and eye sockets. Its brain size is equivalent to that of *H. sapiens*, although it has a different shape and structure, the implications of which will be considered in Chapter 11. The Neanderthal suite of features evolved gradually, with traces present in the Sima de los Huesos collection of 450,000 years ago and becoming well defined within the later Neanderthals after 100,000 years ago. Regarding the body, the Neanderthals were shorter and more robust than *H. sapiens*, with barrel-like chests and substantially more muscle. Their bodies reflect the combined influences of a more physically demanding lifestyle and evolution in a colder climate than that of *H. sapiens*, requiring 100–350 more calories per day for fuel.[18]

Neanderthal fossils are found not only in Europe but also in western Asia and far to the east, with specimens in central Asia and Siberia.[19] While covering an extensive region, the population would have been fragmented by geographic barriers, with evidence that it fell into three main demographic clusters: western Europe, southern Europe and western Asia.[20] Neanderthals responded to their environmental conditions with a mix of big game hunting primarily using thrusting spears, plant gathering and exploiting the sea shore. They sometimes buried their dead. This should not be surprising given the need for close social ties within and between social groups, and hence inevitable grieving at the loss of a parent, child, relative or friend.

Our knowledge of *Homo sapiens* and the Neanderthals has been transformed during the last decade by palaeogenomics that extracts ancient DNA from skeletal remains. The first complete human genome was derived in 2003, and that of a Neanderthal in 2010. Comparison of their genomes has indicated that the two species shared a common ancestor between 800,000 and 600,000 years ago, usually designated as *H. heidelbergensis*. Palaeogenomics has also identified a further descendant, usually referred to as the Denisovans that diverged from the lineage leading to the Neanderthals at around 400,000 years ago.[21] The Denisovans occupied much of central and East Asia, evolving a physiology and lifestyle for cold environments, such as boreal forests and high altitudes, in contrast to the Neanderthal preference for more temperate, grassland environments.

The genomic revolution has also revealed several episodes of interbreeding, between *H. sapiens* with Neanderthals and

Denisovans, and between the Neanderthals and Denisovans.[22] Most of us today have between 2 and 4 per cent of Neanderthal DNA, and those in East Asia also have up to 5 per cent of Denisovan DNA. Chapter 12 considers the significance of such interbreeding for the evolutionary history of the three species and their linguistic capabilities.

Interbreeding arose from the mobility and interaction of populations, influenced by the ever-changing climate conditions that sometimes caused the ranges of the human types to overlap.[23] The earliest known movement of *H. sapiens* out of Africa had occurred by 180,000 years ago, documented by a specimen from Misliya Cave, Israel, and potentially by 210,000 years ago if a claimed *H. sapiens* fossil at Apidima Cave, Greece, is indeed that species.[24] A later dispersal, likely a response to a period of warmer and wetter climate that lasted between 130,000 and 115,000 years ago, resulted in *H. sapiens* in the caves of Skhul and Qafzeh in Israel at between 120,000 and 90,000 years ago. It is likely they overlapped with Neanderthals in that region, represented by remains from other caves in Israel – Tabun and Amud – dated to between 80,000 and 55,000 years ago, but with archaeological traces suggesting an earlier presence. Both *Homo sapiens* and Neanderthals used the same types of stone tools, methods of hunting and patterns of mobility. They may have interbred and exchanged cultural knowledge such as about tool making. These early dispersals of *H. sapiens* from Africa were not sustained with their lineages becoming extinct. The earliest *H. sapiens* presence in East Asia is heavily contested, with some arguing this occurred between 120,000 and 80,000 years ago, while others maintain a more conservative estimate of 65,000 years ago.

At around 350,000 years ago, humans of all species in Africa, Asia and Europe had shifted from the use of hand-held to hafted tools, notably stone points attached to shafts for use as spears. Handaxes became less prominent, being replaced by flakes and blades detached from prepared cores – carefully shaped nodules enabling flakes of a predetermined shape and size to be detached. This is referred to as Middle Palaeolithic technology in Europe, and the Middle Stone Age in Africa. Why this shift occurred has been little discussed by archaeologists. Chapter 7 will consider whether it was enabled by an evolving language capability, one that had crossed a threshold that allowed new technology to develop.

The use of fire became habitual after 400,000 years ago, with the first appearance of managed hearths. This was followed by the first body adornments and decorated objects, both appearing after 200,000 years ago. Neanderthals in Europe collected red ochre, used minerals that produced black pigment, made body adornments from birds' feathers and talons, and, in rare circumstances, made incisions into stone and pieces of bone. *H. sapiens* in Africa and in western Asia were similar, although their body adornments were made from shell beads and they made much greater use of red ochre, this becoming intense after 100,000 years ago when the first engravings were also made on stone. Chapters 10 and 15 consider the implications of fire and the new interest in signs and symbols for language capabilities. The extent of these developments in southern Africa after 100,000 years ago has led *H. sapiens* from after that date to be designated as 'modern humans'.

Modern humans and their global diaspora

After 70,000 years ago, modern humans dispersed out of Africa, as documented by the fossil, archaeological and genomic records (Figure 2). Unlike earlier migrations, their journeys were swift, sustained and extensive, implying goal-directed exploration rather than a mere response to environmental change. One route out of Africa was northwards, via the Rift Valley into Southwest Asia – present-day Occupied Palestinian Territories,

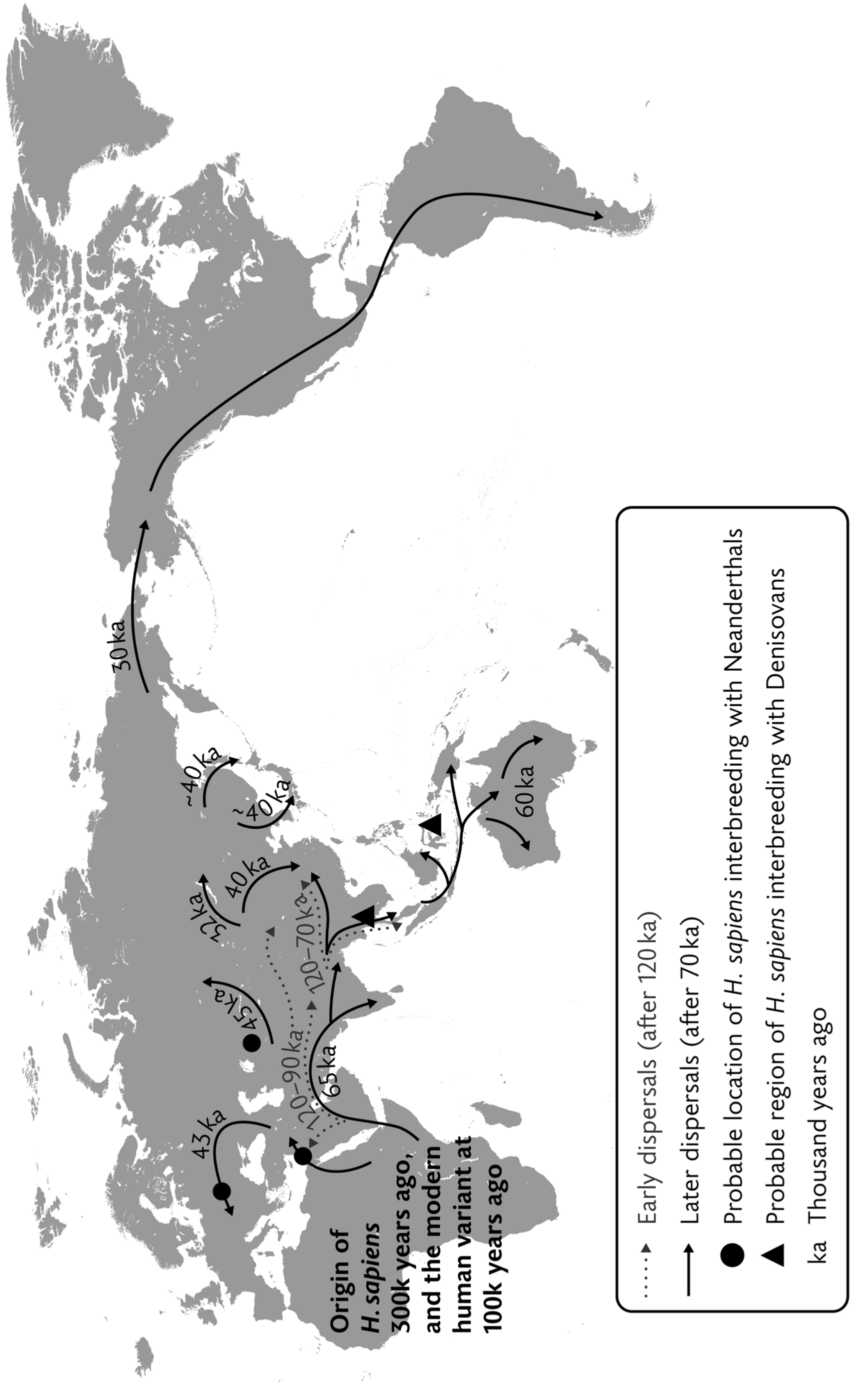

Figure 2 Early and later dispersals of *Homo sapiens* from Africa

Israel, Jordan and Syria. Here they encountered Neanderthals, with whom they shared the same landscape for several thousand years, sometimes at a distance and sometimes so close that there was interbreeding. It was in this region that a new technology emerged soon after 50,000 years ago involving the production of long flint blades, which provided the basis for Upper Palaeolithic technology that would be taken into Europe after 45,000 years ago.[25]

Another route out of Africa was by crossing the Bab el-Mandeb Strait from eastern Africa into Arabia. From there a coastal route was followed into south and southeastern Asia, where interbreeding with Denisovans occurred and the earliest known figurative art was made at *c.*40,000 years ago: a hand stencil and the painting of a pig-like animal on a cave wall in Indonesia.[26] Boats were constructed that took modern humans into Australia by 60,000 years ago.[27] The modern humans spread throughout Asia, with a confirmed presence in China at 45,000 years ago and contested claims for an even earlier date.[28] They reached the far northeast, crossed the Bering Strait into North America, and swiftly spread south, colonising a diverse range of environments including the Amazon rainforest to reach Tierra del Fuego by at least 10,000 years ago.

The modern human colonisation of Europe has been documented in considerable detail. It is possible that there was at least one incursion before 50,000 years ago, represented by claimed modern human remains and artefacts at Mandrin Cave in France.[29] It was not until 41,000 years ago, however, that modern humans established themselves throughout Europe, their presence denoted by a material culture quite different from that of the resident Neanderthals: the new Europeans used tools from long blades, made extensive use of bone and ivory, wore beads and pendants, carved animal and human-like figurines from ivory and stone, and made flutes from hollow bird bones.

In my 1996 book *The Prehistory of the Mind*, I characterised this new material culture as reflecting cognitive fluidity: the ability to blend knowledge and ways of thinking about different entities of the world to devise new types of tools, personal ornaments and art objects. Beads and pendants became highly variable in their raw materials, shapes and colours, suggesting that they were intended to send specific social messages to specific types of people. The design of tools for hunting now integrated knowledge of raw materials with an understanding of the physiology and behaviour of the prey being hunted to create a series of specialised weapons. This was often expressed by carving animals into the tools themselves, such as an ibex depicted on the end of a spear thrower from the Ice Age site of Mas d'Azil, located in the Pyrenees where ibex was the targeted prey. Human and animal forms were sometimes blended into a single carved figurine or image painted on a cave wall, such as the 'lion man', a figure carved from mammoth ivory between 40,000 and 35,000 years ago, with the head of a lion and the body of a man. This all reflects a new way of thinking, one that enabled a degree of creativity and innovation never previously witnessed in humankind (Figure 3).

Africa also experienced a wholesale technological change after 40,000 years ago. As in Europe, blade technology became prominent, with small blades being chipped to form microliths, which were set into wooden or bone handles. New tool types emerged including arrow heads, fishing equipment and polished bone points. Beads made from marine shell and ostrich eggshell become widespread, along with engraved decoration on bone and wood.

The Neanderthals, Densiovans, *H. erectus* and *H. floresiensis* became extinct by or soon after 40,000 years ago, leaving *H. sapiens* as the sole remaining member of the *Homo* genus. When seeking to explain why that is the case, academics from many disciplines have suggested *H. sapiens* had an enhanced capability for language over that possessed by those species that went extinct – although without specifying what form that may have

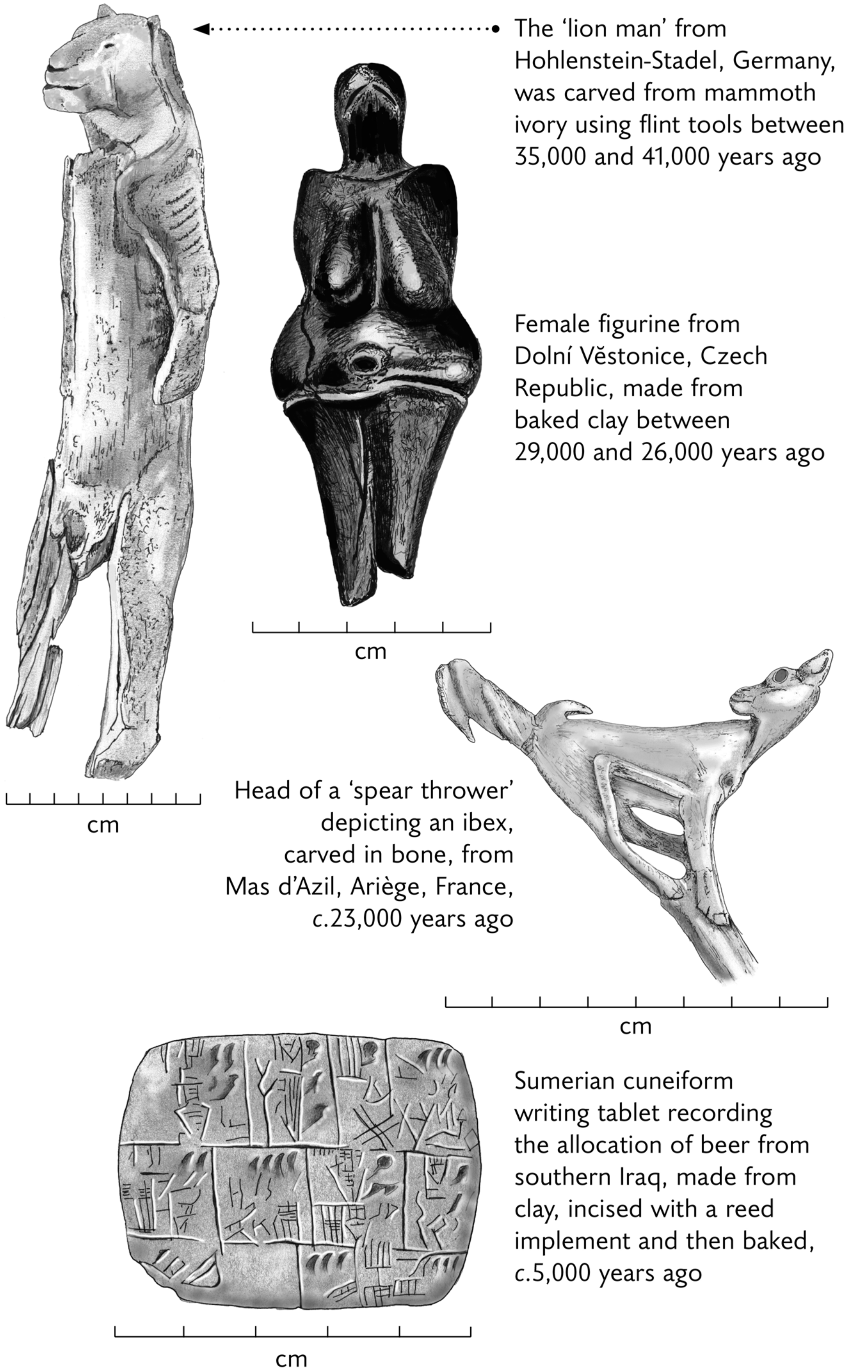

Figure 3 Early art and writing by modern humans

taken. At this stage, we can confidently agree that by 40,000 years ago *H. sapiens* had language of the type we possess today – which I will call the 'fully modern language' capability. It is simply inconceivable that they could have painted caves, built boats and colonised the world without fully modern language, the nature of which will be dissected in Chapter 3. We cannot, however, yet deny the same fully modern language to the Neanderthals, Denisovans and others, or attribute them with any other type of language, until a detailed consideration of their anatomy, behaviour and culture has been undertaken in the following chapters.

From the height of the last glaciation to the end of the Stone Age

By 40,000 years ago, the global climate was heading towards the height of the last glaciation, which arrived at 20,000 years ago. Ice sheets expanded across high latitudes, causing sea levels to fall and so expose extensive coastal shelves. Low latitudes suffered aridity, causing forest and woodland to retreat. Human communities responded by relocating, adapting their technology, adjusting their diets and social lives, and most likely suffering considerable demographic decline. The most striking response was in Europe. New technology and hunting methods enabled the mass slaughter of migrating reindeer herds while investment in ritual, evident from the painting of cave walls, enabled resilience to the harsh, glacial conditions by intensifying social bonds within and between communities. In central and eastern Europe large dwellings were constructed from mammoth bones and tusks; symbols that bound far-flung communities together into social networks took the form of female figurines, either carved in ivory or bone, or baked in clay (Figure 3).[30]

Similar innovations were happening throughout the world, creating a level of cultural diversity never witnessed before in the history of humankind. Equally, humans were having an unprecedented environmental impact: throughout Europe, Asia, Australia and the Americas, megafauna such as mammoth and giant sloths became extinct. Climate change was a major factor but human activity, either from the hunting of such animals or by influencing habitat change, likely tipped the balance from population decline into extinction. Megafauna has survived only in tropical Asia and more notably in Africa where we can still see elephants, hippopotamus, rhinoceros and giraffe.

Although the modern human response to the most severe ice age conditions at 20,000 years ago and their immediate aftermath displayed a new degree of innovation, this paled in comparison with the cultural revolution that was to come. Following a period of marked climatic fluctuations, dramatic global warming occurred at 11,650 years ago. Temperatures rose by around 4°C in a matter of decades while atmospheric carbon dioxide increased by 50 per cent. Ice sheets melted, sea level rose, and landscapes were transformed as woodland spread and animal communities changed to those of warmer-adapted species. The Holocene began, a period of warmer, wetter and more stable climate within which the modern humans would flourish.

Human communities recolonised landscapes that had been lost to ice and extended into new regions, now entering the High Arctic and travelling to Pacific islands. They did so through a constant stream of innovation and culture change. The manufacture of small blades and microlithic tools became prevalent in many regions, these providing the most efficient use of stone. New technology was devised to collect and process the newly abundant plant foods, ranging from pottery vessels in eastern Asia to flint sickles and stone mortars in the west. Marine and coastal foods became prominent in the diet with a new range of fishing technology and the accumulation of huge shell middens in coastal regions throughout the world.

The invention of farming was of most significance for human history. This first occurred in Southwest Asia where the intensive exploitation of wild cereals led to the evolution of domesticated strains that were as dependent on human harvesting as humans were on their regular supply of grain. Similarly, the hunting of wild goats was intensified, leading to the management of herds and the emergence of domesticated strains.

By 10,000 years ago, hunter-gatherers in Southwest Asia were living in permanent villages; they were soon reliant on domesticated plants and animals, becoming the first farmers. That lifestyle entailed a host of other innovations: new architecture made from stone, mud-brick and plaster; new technology; new social organisation for sedentary lifestyles; and new ideology, art and ritual. Populations began to grow and had to disperse into new lands, taking the farming lifestyle into Europe, North Africa and central Asia (Figure 4).

Much the same occurred in China, where rice and millet were domesticated by 10,000 years ago, leading to farming communities that spread throughout the east and into South Asia. Within a few thousand years domesticated plants and animals emerged in other regions of the world: beans, maize and peppers in Mesoamerica; taro and bananas in Highland New Guinea; quinoa, llamas and potatoes in South America. Hunting-and-gathering lifestyles soon became restricted to environments where farming could not be sustained, notably those of high aridity and within the thick forests of the Amazon, West Africa and Southeast Asia.

The earliest farming communities are designated as Neolithic – the New Stone Age. Other than pottery, they remained reliant on the same raw materials that humans had always used, notably stone and wood, even if they were now able to manipulate and transform these in entirely new ways. But the emergence of farming foreshadowed the inevitable end of the Stone Age. Villages soon became towns and then urban communities connected by networks of trade. The means to smelt

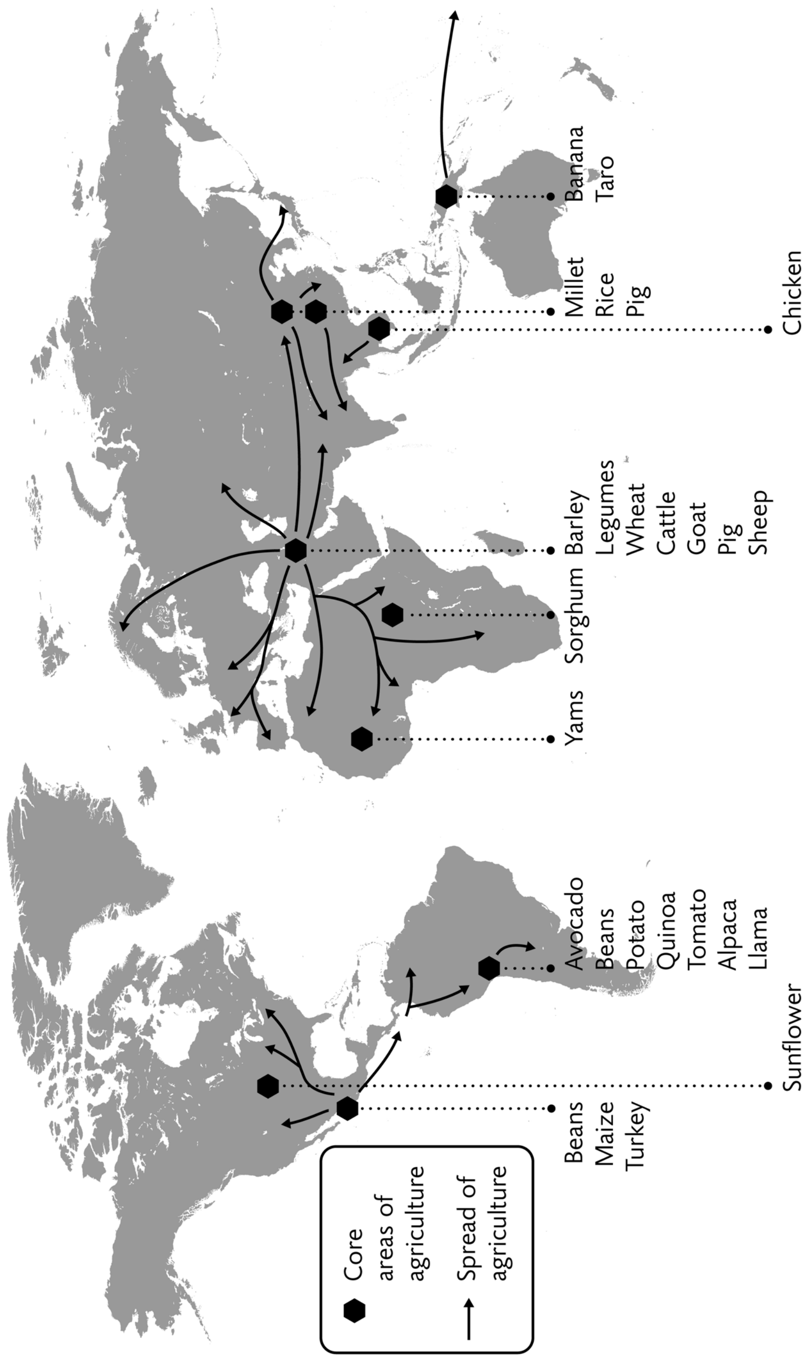

Figure 4 The origin of key domesticates and the spread of farming

copper was discovered, rapidly leading to bronze and then iron to provide the tools for work and warfare. Social hierarchies emerged with a constant thirst for prestige items and new forms of wealth, both supplied by ornaments of silver and gold. Population growth, technological innovation, economic change and social competition coalesced into the early civilisations of Mesopotamia, China and Mesoamerica. Within these a further step in the evolution of language occurred: the invention of writing.

The earliest writing took the form of marks imprinted onto clay tablets known as the cuneiform script of the Mesopotamian civilisation (Figure 3). The marks began at *c.*5,500 years ago as iconic signs known as phonograms and gradually became more abstract to represent the sounds of speech. That is the first definitive proof for the presence of a language capacity equivalent to that found in the modern world. Writing was independently invented in China and Mesoamerica, indicating the linguistic capacity was a feature of *Homo sapiens* throughout the world.

Six million years of language evolution

We have swiftly moved through 6 million years of human evolution, from the time when our ancestors used vocalisations comparable to those of a chimpanzee today to the use of fully modern language by 40,000 years ago, and potentially much earlier. Throughout those 6 million years there were changes in anatomy, brain size, life course, technology, diet, behaviour and geographical distribution. It would be perverse to think that vocal and cognitive capabilities did not also change and hence we should expect a gradual evolution of the present-day language capacity. Whether that was at a steady or intermittent pace of change, whether words and the rules evolved together or consecutively, and when we might wish to designate vocal communication as having crossed a threshold of complexity to become language, of a fully modern type or otherwise, cannot yet be specified.

To answer those questions, we need to find and assemble more fragments of the language puzzle. In this chapter we have noted the particular need to consider the linguistic implications of primate vocalisation, the evolution of the human vocal tract and brain size, stone tool technology, the control of fire, and the appearance of visual symbols (which will be covered in Chapters 4, 5, 7, 10, 11 and 15). Before assembling those fragments, we need to complete the jigsaw frame by defining and dissecting what we mean by 'fully modern language'.