Chapter 8: society – a community of brains

background reading

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notes

Constructive comments are welcome.

"**This enables an "empathic self"**", there's no single easy word for this. A better term might be "mentalising self", but we're more familiar with "empathy" than "mentalising". Gamble *et al*. view the two as related but different, since "*empathy might be regarded as a 'hot' form of cognition (we feel what the other person feels) whereas mentalizing is more like 'cold' cognition (we understand it)*" (Gamble 2014:51).

"***collectivism of thought***", Tudge 1996:260.

8.1 theory of mind

living in a mental environment

"***immersed in a constant process***" and "***very world we tread***", both from Landa 2013.

"***a mental world***" and "***mental states***", both from Wellman 2001.

"**This sentence may read oddly**", Frith 2006, Dunbar 2014a:45.

"***imagine a hypothetical being***", Wellman 1985:169, and quoted in Baron-Cohen 1997:59.

"**This is a brief description**", Baron-Cohen 1997:chapter 5.

"***can read people's actions***", Baron-Cohen 1997:59.

"**Someone who understands**", but why is it called "theory of mind"? A scientist uses a theory to explain the behaviour of entities that may not be directly perceptible, and thereby predict what they will do. We apply theory of mind to people's unobservable mental states, and thereby explain and predict their behaviour (Gleitman 2004:489, Baron-Cohen 1997:55).

"***make inferences***", Baron-Cohen 1985:39.

8.1.1 the Sally-Anne test for ToM

"**There are numerous tests**", Baron-Cohen 1997:70, Frith and Frith 1999, Dunbar 2004, Gleitman 2004:487 Kandel 2021:1526 and figure 62−2.

"**These children have understood**", we might think of theory of mind in a Western context, but it surely must be a universal human capability. For example, five-year-old Baka pygmy children in the rain forests of Cameroon were able to pass a version of the Sally-Anne test, so they could recognise a false belief and could predict how people would respond to it (Avis 1991, Whiten 2000:188).

Figure 8.1 is from Frith 2001:figure 1, and is reproduced here by kind permission from Axel Scheffler.

"**The false-belief test**", O'connell 2003, Frith 1999, Gleitman 2004:487.

"**The full mentalising ability**", Frith 1999. One group of subjects who typically cannot pass the Sally-Anne test are those individuals with autism spectrum disorder, ASD (Baron-Cohen 1997:chapter 5, Dunbar 2004:chapter 3, Frith 2001, Kandel 2021:1526). ASD is present in at least 1.5% of the population, and possibly as high as 2.6% (Kandel 2021:1526).

Many children with ASD learn to pass the Sally-Anne test, but on average with a 5-year delay. These children can have an excellent appreciation of physical causes and events. For example, "*a child who is incapable of falsely telling another that a box is locked is quite capable of locking the same box to prevent its contents from being stolen*" (Kandel 2021:1526).

It is found that more intelligent adults with ASD can pass the Sally-Anne test, but make errors in attributing intentions, for example, they confuse a lie with a joke and persuasion with misunderstanding (Fletcher 1995).

"***requires the representation***", Sommer 2007:5.

"**We perhaps take theory of mind for granted**", Simon Baron-Cohen gives an illuminating list of 8 important behaviours (Baron-Cohen 2000:262). See also note to section 8.6.2.

neuroimaging can distinguish between false and true belief reasoning

"**Neuroimaging studies**", Sommer 2007.

8.1.2 theory of mind and perspective-taking

"***other people have beliefs and desires***", Frith 1999.

"***beliefs about the world***", Dunbar 2005:59.

"***mental representations of the world***", Saxe 2006.

"***a subjective perspective***", Tomasello 2018:8491.

"**The child who passes**", the prepositions get a bit tricky here – whether to use "on" or "of". I'm using "perspective on" when it's about a person's frame of mind or their opinion, and "perspective of" when it's about what they can observe or perceive.

"**With theory of mind**", using theory of mind appears to be analogous to performing a Galilean transformation between different reference frames (see the section on Einstein's special theory of relativity in the notes to chapter 1). Robert Crease described a 'real' event as having "*the same physical description in different inertial frameworks, once you use the appropriate transformations to take the difference in speeds and directions into account*" (Crease 2009:160). In the cognitive analogue, two different people describe the same 'real', objective event in the same way, once they have used theory of mind to take their different personal perspectives into account.

"**The truth is that reality is bigger**", an individual can arrive at an "objective" perspective "*by collectivizing many – potentially an infinity – of perspectives and positing a kind of invariant objectivity that grounds them all*" (Tomasello 2019:77). It is this "objective" perspective that makes it possible that either or both the participants in a situation may be wrong (Tomasello 2019:75).

blue or green? – conflicting perspectives of the same object

"**A number of false-belief tests**", this test is in Moll 2013, and is also described in Tomasello 2018.

Figure 8.2 is based on Moll 2013:figure 3.

"***beginning to distinguish***", Tomasello 2018.

8.1.3 a scale of mentalising skills

"**Theory of mind is not a single cognitive ability**", Baron-Cohen 1997:chapter 4, Frith 2003, Wellman 2004 and 2011. Simon Baron-Cohen has proposed that the human capacity to mind-read comprises four components, comprising dyadic understanding between two people of (1) desires and goals, (2) perceptions, (3) shared triadic attention, and finally (4) the full theory of mind, which can understand mental states and relate them to actions. All four components are necessary for the full ToM capability. Baron-Cohen sees a core theory of mind as comprising a number of axioms, such as "*seeing leads to knowing*", "*appearance is not necessarily the same as reality*" and "*people think that things are where they last saw them*" (Baron-Cohen 1997:55).

"**A typical progression**", Wellman 2004 and 2011.

"**While the Sally-Anne test**", Frith 1999.

"***theory-of-mind understandings***", Wellman 2004:537.

8.1.4 do chimpanzees possess theory of mind?

"**Chimpanzees appear to possess**", these examples are from Tomasello 2013, and Hare 2011 and Whiten 2013 have written helpful reviews. Hare 2011 summarises experimental findings which show that in many situations chimpanzees are capable of psychological state attribution – that is, they understand what others can see and hear, what they do or don't know, and what their intentions are, and they are motivated to help. In many respects, chimpanzees are as capable as pre-verbal children.

"**We've seen an example of this**", this raises the question: does Yeroen's deception of Nikkie show that he has theory of mind? Yeroen put a lot of effort into deceiving Nikkie, perhaps in order to make Nikkie feel guilt and show sympathy (as Frans de Waal suggested), or to go easy on Yeroen, or maybe just to make Nikkie complacent. Yeroen acted in a certain way so as to put a false belief into Nikkie's mind, or at least sustain his belief that Yeroen was injured, in order to achieve a certain behavioral outcome. "*The purpose of a lie, after all, is to instill a false belief; thus it is difficult to see how lies could be either produced or understood without some realization that beliefs can be false*" (Miller 2009:760). Yeroen shows that he recognises the possibility of a conspecific holding a false belief, and that this influences their behaviour, and so his deception of Nikkie seems to come very close to demonstrating theory of mind.

"**Observations of spontaneous behaviour**", Kaminski 2008, Krachun 2010, Tomasello 2013.

"**In one of these experiments**", Krachun 2010.

"**The mentalising abilities of chimpanzees**", O'Connell 2003.

impression management

"**It is significant**", Engelmann 2012.

joint attention and shared perspectives

"**The collective evidence**", for example, see individual studies by Hare 2001, O'Connell 2003, Kaminski 2008, and Krachun 2010. The key experimental studies have been summarised and reviewed by Hare 2011, Whiten 2013, and Tomasello 2013 and 2018. The great majority of studies have been on chimpanzees, but recently bonobos have been receiving more attention (Hare 2011, Whiten 2013).

False-belief test have been done in a variety of ways, and some experimenters have included children from ages 3−6, and also individuals with autism, to provide context and comparison. Chimpanzees can usually out-perform 3-year-olds and autistic individuals (O'Connell 2003, Kaminsky 2008).

"***is not like understanding goals***", Tomasello 2013:86.

"***I must judge that your representation***", Tomasello 2018:8494.

"***a joint attentional interaction***", Tomasello 2013:84.

chimpanzees

"**The most complex coordinated behaviour**", see chapter 7, and Tomasello 2006:521. Tomasello noted that at the time of writing, there were no published accounts in which "*chimpanzees collaborate by playing different and complementary rôles in an activity*" (Tomasello 2006:521). I've made the case in chapter 7 that the Taï chimpanzees do play complementary rôles in their hunting expeditions, but this is in the context of one specialised activity, and is perhaps the nearest they get to theory of mind. I'm not considering any experimental studies of cooperation, because I'm looking for the natural precursors of human cooperation.

"***the notion of perspective***", Tomasello 2013:85.

"***do not understand different perspectives***", Tomasello 2018:8495.

children

"**Michael Tomasello**", Tomasello 2018.

"***both are attending to X***", Tomasello 2018:8494.

"***the coordination of three perspectives***", Tomasello 2018:8495.

"**These constructive interactions**", Tomasello 2018:8495. A number of studies have found that children with older siblings performed much better in false-belief tests, and this is ascribed to family life exposing them to different personal perspectives (McAlister 2007). Parents negotiating conflicts and reasoning with older siblings, fantasy play, cooperation, competition and disputes with siblings will all expose the pre-theory of mind child to differing and conflicting mental perspectives.

the importance of language

"**Nicaraguan Sign Language**", Pyers 2009.

"***language learning***", Pyers 2009:805.

the first human ancestors with theory of mind

"**How did they do this**", we'll see later in this chapter that our human ancestors probably passed the theory of mind threshold about 2½ million years ago. It appears that language evolved much later than this. Robin Dunbar concludes that "*the capacity for some form of language-like communication had to be in place by 500,000 years ago, but probably not a lot before*" (Dunbar 2009:27).

8.2 mentalising – a hierarchy of mind-states

8.2.1 theory of mind sets the threshold for level 8 of the hierarchy

"***I take my representation***", Tomasello 2018:8494.

"**Theory of mind is a hugely important step**", Thomas Suddendorf sees another consequence, for with theory of mind, the "*agent (the self) travels mentally in time*", so that she or he can hold mental representations of the past and the future and relate them to the present self. So, while " *we are changing dramatically in physical and mental make-up over time, all these stages are considered aspects of the same **me**. An extraordinary new structure appears to emerge: a sense of self that is not bound to time and body*" (both quotes from Suddendorf 2000:242).

"***The realization that beliefs***", Miller 2009:749.

"**The mentalising capability**", the transition from primates in Level 7 to humans in Level 8 is analogous to the transition from single-celled organisms in Level 5 to complex multi-celled organisms in Level 6. In both cases organisms that were highly capable as individuals came together in new communities to work towards a shared goal.

Simon Baron-Cohen lists 8 important social behaviours that depend on theory of mind (Baron-Cohen 2000:262). These are:

1) intentionally communicating with others
2) repairing failed communication with others
3) teaching others
4) intentionally persuading others
5) intentionally deceiving others
6) building shared plans and goals
7) intentionally sharing a focus or topic of attention
8) pretending

Without a theory of mind, none of these behaviours would be possible. For this reason, he sees the evolution of theory of mind in our human ancestors as important as the evolution of walking and language (Baron-Cohen 2000:261).

8.2.2 mind-states in the Sally-Anne test

"***Mentalising, or mindreading***", Dunbar 2020:55.

8.2.3 Intentionality and mentalising

"**Our look at the Sally-Anne test**", Dunbar 2004:chapter 3, Dennett 1989.

"***knowing, believing***", Dunbar 2004:45.

"***thinks, believes, wants***", Cheney 1990:142.

"**There are different levels**", psychologists regard theory of mind as a "*broad term, referring to the intentional stance … that characterizes human interaction*" (Astington 2003:15). For an explanation of the intentional stance see Dennett 1989. However, they don't work in orders of intentionality, but in understanding an individual's false-belief states. In this scheme, the Sally-Anne test is a 1st order false-belief task for the child subject, since the belief "*refers directly to some event in the world*" (Miller 2009:750). A 2nd order false-belief is "*a belief not about something in the world (as in the first-order case) but about someone else's belief about something in the world. Second-order reasoning of this form is thus recursive reasoning: A thinks that B thinks that …*" (Miller 2009:750). In the Sally-Anne test, the adult observer would be using 2nd order reasoning to assess the 1st order thinking of the child. So, the psychologist's 1st order false-belief reasoning corresponds to 2nd order intentionality, and their 2nd order reasoning corresponds to 3rd order intentionality.

While psychologists accepted that children's understanding of belief progressed beyond first-order reasoning, as of 2009, little research had been done on this (Miller 2009:749). Slaughter noted in 2003 that there was little work on children beyond the age of 7−8 or on adults, and there were "*few assessments that reveal significant and meaningful individual differences in mind reading*" (Slaughter 2003:5), and there was a "*lack of consensus on what constitutes a mature theory of mind*" (Slaughter 2003:6).

In this chapter, I've followed Robin Dunbar, Michael Tomasello, Dorothy Cheney and other primatologists and described the evolution of cognition in the human lineage in terms of levels of intentionality.

"***can be conceived***", Dunbar 2004:45.

"***has beliefs and desires***", Dennett 1989:345.

"**Someone with second order intentionality**", Dunbar 2004:45.

"**Thus, when Alice *believes* that Bob *wishes***", in this and future examples of mentalising, I use the standard alphabetic names for characters in cryptography protocols, see https://en.wikipedia.org/wiki/Alice_and_Bob.

8.2.4 higher mentalising states

levels of mentalising in children and adults

"**Children progress to higher levels**", Henzi 2007:figure 7, Dunbar 2009:35. Children typically pass 2nd order false-belief tasks (equivalent to 3rd level mentalising) around the ages of 7−8 years old (Slaughter 2003:4, Miller 2009:750).

"***children have typically mastered***", Dunbar 2009:35.

"**A group of normal healthy adults**", the mentalising profile is from Oesch 2017, and is consistent with Kinderman 1998, Dunbar 2004:figure 4, Stiller 2007 and Krems 2016. Oesch 2017 reports this approximate profile of normal healthy adults as capable of a particular mentalising level: level 3 – 100%, level 4 – 96%, level 5 – 78%, level 6 – 40%, and level 7 – 8% (figures derived from Oesch 2017:figure 1).

Kinderman's (1998) assessment of mentalising levels did not include the participant's mind-state, and so all the levels should be increased by one. This is corrected in later work, for example, Dunbar 2004:figure 4, which shows the majority of humans achieving level 5.

The small test group in Powell's study had the range 4−5.3, but with larger samples, Stiller found a range of levels from 2−8, and Oesch found a range of 3−7. Kinderman's data is for a sample of undergraduates, while Oesch's sample was predominantly undergraduates, postgraduates and working professionals, mainly from India and North America, so studies seem to have focussed mainly on adults with a high level of education.

"**There is some suggestion**", Stiller 2007 found that women achieved significantly higher levels than men, with the women's average score being about one level higher than the men's, and Oesch 2017 found the difference to be about half a level.

Oesch 2017 states that previous research showed that "*women tend to have higher performance than men in both language and mentalising abilities*", and references Hyde 1988, Powell 2010, and Stiller 2007.

However, Hyde assessed only verbal ability, and found a very small female superiority, leading their view that "*gender differences in verbal ability no longer exist*". Hyde also analysed tests requiring different cognitive processes involved in verbal ability, and found these "*yielded no evidence of substantial gender differences in any aspect of processing*".

Powell found average mentalising levels similar to those reported by Stiller 2007, but found "*no significant differences between mean scores for males and females on the intentionality task*", and found the same for the memory task (Powell 2010:3557).

Dunbar 2023 states that "*we have found in every one of half a dozen studies, men have lower mentalizing skills than women even in otherwise normal, neurotypical adults*", but gives no references (Dunbar 2023:121).

So, is there an overall gender difference in mentalising capability? It's a reasonable and significant question, and the limited evidence available gives no clear answer, although it suggests that women may be slightly ahead of men (Stiller 2007, Oesch 2017).

What does higher level mentalising look like?

"**Robin Dunbar gives an example**", Dunbar 2004:figure 3, also in Dunbar 2014a:figure 2.2.

"… **an example of 5th level mentalising** …", Dunbar 2004:chapter 3 and 2009:35.

how do we measure a person's mentalising ability?

"**The established way**", Kinderman 1998, Dunbar 2004a, Stiller 2007.

"**Here is one of the stories**", this is only one of the stories used by Stiller, and other stories went to higher levels. Each story was followed by a set of questions testing the subject's factual memory of events in the story, as well as mentalising questions, and only the mentalising questions are included here. An example of a story used in assessing mentalising in children is given by Henzi 2007.

The story "Emma's Dilemma" and selected questions are reprinted from "Social Networks", volume 29(1), James Stiller and R.I.M. Dunbar, "Perspective-taking and memory capacity predict social network size", pages 93−104, Copyright 2007, with permission from Elsevier.

the cognitive demand of high level mentalising

"**Test subjects typically could answer**", Lewis 2017:figure 2. This study also showed that mentalising tasks are cognitively more demanding than factual recall tasks, and that higher level mentalising draws on greater neural resources, especially those regions in the frontal and temporal lobes (Lewis 2017).

8.2.5 the breadth and depth of mentalising

breadth – multiple mentalising

depth – recursive mentalising

"**In dyadic mentalising**", see Dennett 1989 and Cheney 1990:chapter 5.

"**Now, the mentalising extends**", dyadic mentalising only involves two people, so I've called this polyadic, because it involves many people.

multiple and recursive mentalising make different cognitive demands

"**So, recursive mentalising**", Krems 2016 followed the established convention of counting levels of intentionality, and considered that "*a level of intentionality is "used" whenever one models the mind of another person and regardless of how one comes to know that mindstate*" (Krems 2016:note 2). The simple examples given here suggest that this is not the case.

8.3 mentalising in conversation

8.3.1 a "conversation" with no theory of mind

"***without theory of mind***", Dunbar 2009:30.

Simon Baron-Cohen sees autism as giving "*a clear illustration of what human life would be like if one lacked a theory of mind. The most devastating effect is on the ability to socialize, communicate, and use imagination*" (Baron-Cohen 2000:266).

8.3.2 the conversation "jigsaw"

"**For two people to have a meaningful conversation**", Frith 2006:533.

"***I ask you a question***", Front 2014:45.

The excerpt is from "Curious True Stories and Loose Connections", by Rebecca Front, © Rebecca Front 2014. Reproduced with permission of the Licensor through PLSClear.

"***has to monitor the hearer***", Dunbar 1998b:101.

"**The exchange of thoughts and feelings**", this seems to be analogous to the exchange processes that bind entities together in communities at every level in the hierarchy.

strangers need to keep it simple

8.3.3 the motivation to communicate

"***exploit another individual's view***", Dunbar 2004:44.

"**This simple example**", this is one of Simon Baron-Cohen's 8 behaviours that depend on theory of mind. Thus, to intentionally inform others, "*one needs a concept that others have minds that can be informed or uninformed*" (Baron-Cohen 2000:262).

8.3.4 the mentalising demands of speaking and listening

"***has to intend that the listener understands***", Dunbar 2014a:241, and this exposition is also in Dunbar 1998b:101 and in Dunbar 2016:131.

"**For her to communicate effectively**", a set of nested mind-states can also be represented as a mathematical expression. So, Alice's mind-state in figure 8.8, represented by the letter string **ABA**, can also be represented by the expression, $A^3(B^2(A^1(○)))$. Similarly, Bob's mind state can be represented as $B^2(A^1(○))$.

"**For there to be a meaningful conversation**", Robin Dunbar says that "*the speaker probably requires third order*" (Dunbar 2014a:241), but it looks more definite than that.

8.3.5 mutual assurance of theory of mind

"**If you and I want to cooperate**", the situation shown in figure 8.9 raises the thought that 4^{th} level dyadic mentalising might only be possible with a sophisticated language, even though it has been very difficult to put into words, and in fact, it was easier to draw the figure than to describe it. But it appears that our human ancestors started developing higher mentalising skills around 2 million years ago, which was almost certainly before the evolution of complex language, and this is covered in section 8.3.

"**We can see that with progressively higher levels**", Daniel Dennett says "*there seems to be no interesting difference between, say, a fourth-order and a fifth-order intentional system*" (Dennett 1989:244), and the situation shown in figure 8.9 agrees with this, because if 4th level mentalising assures both individuals that they are each working at the 2nd level, what extra benefit would 5th level mentalising bring?

But in figure 8.9 Alice and Bob are only considering an inanimate object – a can of beans. If they want to come to a shared understanding of another person, with her own mind-state, then they need 5th level mentalising, and this is shown in figure 8.19.

We'll also see that you need 4th level mentalising to follow a story like "Othello", but 5th level to write it (figure 8.18).

And Robin Dunbar sees 4th level intentionality as capable of sustaining a personal or a social religion, but that 5th level is needed to sustain a communal religion, because only then "*is it possible to formulate a proposition about God's intentional status that we can both sign up to. At this point, we are both committed to our belief in God's intentions, and so we can have a genuinely communal religion*" (Dunbar 2023:120).

See the note on the evolution of mentalising (section 8.9).

8.3.6 a conversation about Carol

Alice's mind-state in **figure 8.10**, represented by the letter string **ABAC**, can also be represented by the expression, $A^4(B^3(A^2(C^1(\triangle))))$.

In our everyday conversations, we routinely inform one person of something they don't know about another person. This is such a common experience that we don't take account of how cognitively complicated it is. Here's a familiar example.

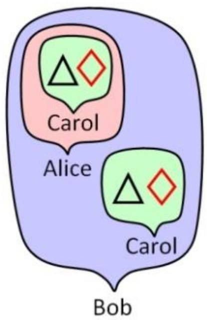
So, Alice *understands* (3^{rd}) that Bob *knows* (2^{nd}) only of Carol's *triangle belief* (1^{st}), and she wants Bob also to *know* (2^{nd}) Carol's *diamond belief* (1^{st}). The conversation might go like this.

Alice: "Bob, do you know that Carol also believes in diamonds?"

Bob: "Are you telling me that Carol believes in diamonds, as well as triangles?"

If Bob trusts Alice, he will accept this new information, and add it to what he already knows about Alice and Carol.

This involves 2 cognitive steps: (1) he adds a diamond (◊) to his *understanding* (3^{rd}) of Alice's *knowledge* (2^{nd}) of Carol's *beliefs* (1^{st}), shown as **BAC** in figure 8.10; and (2) he adds a ◊ to his own *knowledge* (2^{nd}) of Carol's *beliefs* (1^{st}), shown as **BC** in figure 8.10. This is shown in Bob's mind-state diagram on the right, with the new ◊ mind-states shown in red.



Alice needs to monitor Bob's mind-state to ensure he has accepted this new knowledge from her. So, Alice needs to *realise* (4^{th}) that Bob *understands* (3^{rd}) her *knowledge* (2^{nd}) of Carol's triangle and diamond *beliefs* (1^{st}), which is **ABAC** in figure 8.10. Thus, simply to transfer new knowledge about someone with their own mind-state requires 4^{th} level mentalising – a quite high level.

Figure 8.21 shows the new mind-states of Alice and Bob *after* the conversation.

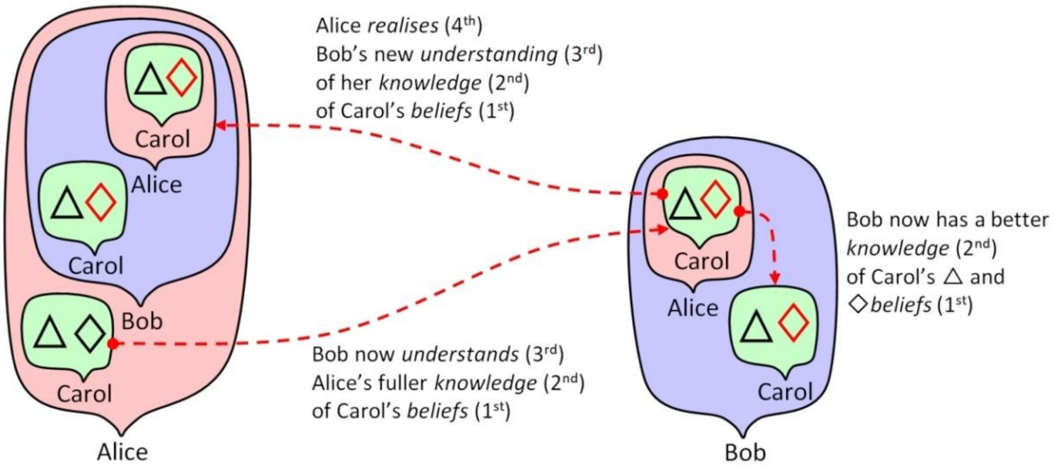


Figure 8.21. The mind-states of Alice and Bob, after Alice has told Bob about Carol's diamond belief. New mind-states are shown in red, and the dashed lines show the mind-state transfers.

8.3.7 the cognitive demands of conversation in groups

"**In this section, we will look at the level of mentalising**", Krems 2016 suggests that not all conversations require recursive mind-reading (Krems 2016:note 3), and this may be the case where one person does most of the talking. Here I'm considering a free and balanced conversation, where all are following what is being said, and participate more or less equally.

a clique of three talk about a can of beans

a clique of four talk about a can of beans

gossiping about Eve

8.3.8 the sizes of conversation cliques

"**Moreover, they must be able to do this**", Slaughter 2003:7.

"***social dysfunction may sometimes be characterized***", Slaughter 2003:7.

"**All these are found to be true**", Dunbar 1995, Krems 2016, Henzi 2007.

"**Cliques break up**", Dunbar 1995, Krems 2016.

"**In groups in which cliques form freely**", Dunbar 1995, Krems 2016.

"**All this supports the first inference**", there are a number of factors that make conversation more difficult for larger cliques. For example, the ambient noise level rises, participants are spatially more distant, there are problems taking turns to speak, and people may speak over each other. However, it seems that maximum clique sizes are set by the limits of mentalising.

"**More significantly**", Krems 2016.

"***modelling the mind***", Krems 2016.

"**Concerning the third inference**", Henzi 2007:figures 1 and 7.

8.3.9 permutations of recursion

8.4 the evolution of modern humans

8.4.1 a series of disillusionments

"***humans are unique***" and "***requires a special kind of explanation***", Lewin 1999:4.

"**Consequently, the development of our understanding**", many of these are discussed by Leakey 1994.

"***a long corridor***", Tooby 1987:203.

8.4.2 primates

"**Linnaeus considered humans**", Tudge 1996:165, and see also Lewin 1999:chapter 1.

"Primates evolved", Baggott 2015:313, Purves 1998:684.

"**A series of splits**", Purves 1998:684, Lewin 1999:chapter 10, Morowitz 2002:chapter 25, Campbell 2008:726, Boyd 2012:chapter 5, Dunbar 2014a:3, Tudge 2009:114 on prosimians.

"**All primates**", Morowitz 2002:140.

"**The major traits**", Purves 1998:684, Campbell 2008:723, Tudge 1996:168, Morowitz 2002:chapters 23 and 24, Boyd 2012:chapter 5.

"***the clinging of young***", Morowitz 2002:142.

"***extreme generalness***" and "***possess very few features***" and "***human beings***", Tudge 1996:165 and 167.

"**Evolution has no long-term goal**", evolution is clear in retrospect, for there is one path by which a past species has evolved into a present one, even if we can't see all the steps. But evolution is quite unpredictable in prospect, for we can't take a species and foresee how it will change, and what it will evolve to become.

"***we do see a wonderful chain***" and "***an ape that could***", Tudge 1996:176−177.

8.4.3 a series of splits

"**Around 10 million years ago**", Dunbar 2014a:5.

"**Genetic and fossil studies**", from DNA data: Lewin 1999:unit 15, Lieberman 2010, Stringer 2011b:chapter7, Leakey 1994:6; and from fossil evidence: Lewin 1999:unit 16, Kingdon 2003:chapter 4). Interestingly, DNA studies suggest that human and chimpanzee *Pediculus* lice diverged into separate species around 5.5 million years ago, in line with the time of the last common ancestor (Weiss 2009).

"**A split around 8 million years ago**", Dunbar 2014a:5. For the distinction between hominids and hominins, see Dunbar 2014a:8.

"**The members of the lineage**", it used to be thought that chimpanzees and gorillas were more closely related to each other than to humans, and in this arrangement, the great apes were called hominoids, and species that were more closely related to humans than to apes were called hominids. Molecular DNA studies have shown that the *Pan* species, chimpanzees and bonobos, are more closely related to humans than to gorillas, so species that are closer to humans than to *Pan* are now called hominins (Harcourt-Smith 2010).

In quotes that use the older term, "hominid", this has been replaced by "hominin".

chimpanzees and bonobos

"**In the 2 million years**", de Waal 1997 and 2006. There are significant differences between chimpanzees and bonobos (see de Waal 1997:chapters 2, 3 and 5), but I'm not concerned with those here, nor am I going to look at the diversity of primate social systems (see, for example, Dunbar 1988, Wilson 1975).

In some respects, adult bonobos behave like adolescent chimpanzees. For example, chimpanzees readily share food when young, but this decreases as they grow to adulthood. In contrast, adult bonobos share food as readily as juveniles (Lieberman 2013:30, Wobber 2010).

Barbara Smuts describes the contrasting natures and lifestyles of chimpanzees and bonobos (Smuts 2006:168).

In chimpanzee society, males dominate females, so that all adult males have a higher status than any adult female, and males frequently threaten and attack females, and males kill infants they are unlikely to have sired. Males are extremely status-oriented and form strong alliances with each other.

In bonobo society, females usually dominate males, so that they usually have priority of access to the best foods; male aggression against females is extremely rare, and life is more peaceful and less hierarchical. Adult females often rank above adult males, and in captive bonobo groups, it's common for the top-ranking adult to be female.

In male-dominated chimpanzee groups, "*males patrol the boundaries of their home ranges, invade neighbouring territories, seek vulnerable individuals, and attack or even kill them*" (Smuts2006:173). In contrast, bonobo territories have no defined boundaries, and overlap, and no serious aggression between neighbouring communities has been observed. When parties from adjacent communities do meet up, the males maintain their distance, but females mingle with their neighbours and engage in sexual encounters with both males and females from the other community.

Barbara Smuts observes: "*where chimps make war, bonobos make love, demonstrating just how much they have changes in the 2.5 million years since they split from a common ancestor*" (Smuts 2006:173). Smuts outlines a likely-looking explanation for why chimpanzees and bonobos, which physically similar, have such different social lifestyles (Smuts 2006:169).

"**For example, the bonobo**", de Waal 1997:24 and 26.

"***sensitive, lively, and nervous***", "***physical violence almost never occurs***", "***no quicker way to distinguish***", all from de Waal 1997:9.

"***drop straight out of the tree***", de Waal 1997:59 and 2006:15.

"***we should keep in mind***", de Waal 1997:143.

"**In genetic terms**", the DNA genomes of humans and chimpanzees differs by about 1.6%, and the difference between humans and bonobos is similar. The human/gorilla difference is about 2.3% (Morowitz 2002:143).

To compare the human and chimpanzee genomes in terms of a single percentage is highly simplistic. Boyd puts the difference at about 1.1%, and explains that this means that in 1.1% of all the nucleotides in the human genome, humans and chimpanzees differ (Boyd 2012:305). Each nucleotide carries a DNA base, adenine (A), cytosine (C), guanine (G) or thymine (T), and the human genome has about 3 billion bases, so a 1.1% difference means about 30 million bases are different between humans and chimpanzees. But, how are these base differences distributed across the genome? One study identified about 13,500 homologous genes that humans and chimpanzees have inherited from their common ancestor, when the two lineages diverged about 6 million years ago. Comparison of these homologous genes showed that the difference was far more than 1%, and that about 70% of them differed by 2 bases on average, and so produced different proteins. So, a small overall difference in DNA, concentrated in selected genes, can produce a very big phenotypic difference between closely related species.

"***human society is characterized***", de Waal 1997:136.

"**Humans and chimpanzees**", de Waal 1997:5.

"**Genetic variation**", Patterson 1999:82.

the last common ancestor

"**We don't know**", Dunbar 2014a:5. Both chimpanzees and bonobos are taken as models for the early hominins, for example in the development of upright walking (De Waal 2006:8). We have to be careful in making comparisons, for chimpanzees and bonobos have become distinct species, in both behaviour and anatomy, in the 2 million years that they have been separately evolving (de Waal 2006:7).

Daniel Lieberman sees the balance of evidence suggesting that the first of our hominin ancestors were not very different from today's chimps and gorillas (Lieberman 2013:30).

8.4.4 the changing climate

"**Over the last 4 million years**", Potts 1998:figures 1−3, deMenocal 2004:figure 11, and deMenocal 2011. Potts summarises the Earth's climate during hominin evolution, and reviews the different hypotheses linking climate changes to human evolution. Many hypotheses propose that humans evolved to survive in specific habitats. For example, the savannah hypothesis, which proposes that human evolution has been driven by the shift in habitat from forest to open grassland, was favoured until the mid-1990s (Potts 1998:110).

"**The overall pattern**", deMenocal 2004:8, Stringer 2011a:56. From about 4−3 mya the Earth's climate was influenced by the the tilt of its axis and the shape of its orbit round the sun. As the Earth slowly cooled, ice sheets built up at high latitudes near the poles, and around 2.8 mya these became sufficiently extensive that they imposed short-term climate variations with periodicities of about 40,000 years, from 3−1 mya, and then about 100,000 years, from 1 mya to the present (deMenocal 2004:figures 2 and 11).

"**For example, between 15,000 and 5,000 years ago**", deMenocal 2011, and there is a graphic illustration of the extreme variation in biological habitats in Boyd 2012:figure 12.20.

"**Underlying the wet/dry cycles**", deMenocal 2004:13, and 2011.

"**The more extensive grasslands**", deMenocal 2004:17, and 2011:panel F.

"**For example, one study**", deMenocal 2004:figure 10.

"***frigid highland to parched valley floor***", Leakey 1993:85.

"**Furthermore, this mosaic environment**", Potts 1998:130, Kingdon:chapters 3−5, Leakey 1994:16. The majority of Australopithecine habitats were situated above 1,000 m (Dunbar 2014a:114).

"**Instead of being habitat specialists**", Potts 1998:131, deMenocal 2004:18 and 2011:541.

Cat Bohannon captures the experience of rapid environmental changes, where the weather is "*swinging between wet and cool and hot and dry in just a few thousand years. There's a lake, then no lake. There's a forest, then a grassland, then a desert, and back again to a forest. As a rule, simple mutations aren't going to be fast enough to adapt to a world that changes wildly every thousand generations*" (Bohannon 2023:271). In such a constantly changing environment, "*it's the species that are **less** specifically adapted to an ecological niche who are the ones most likely to make it*" (Bohannon 2023:270).

8.4.5 the suite of human features

"**The human species can be characterised**", I wish I could claim this neat epigram as my own, but I can't. I found it in our local library, in a guide to walking holidays. I've been unable to locate the book since, so I can't acknowledge its author. But it sums things up very well – with each of us somewhere on an axis with locomotion at one end, and cognition at the other.

"***there is no one point***", Dunbar 2004:31.

8.4.6 one theme in human evolution

The account of human evolution given here is very brief, and becomes even more sketchy after our ancestors acquired theory of mind. Daniel Lieberman tells a much fuller story of human physical evolution up to the present day (Lieberman 2013).

Yuval Noah Harari surveys human history since the "cognitive revolution", about 70,000 years ago (Harari 2015). It was probably around this time that humans became capable of 5th level mentalising, and our cultural development since then has been based on a "*belief in shared myths*" (Harari 2015:41 and 117).

"***must be told***", Dunbar 2003a:163.

Simon Baron-Cohen considers that the evolution of a theory of mind in hominins was not only as important as the evolution of other capabilities, such as bipedalism and language, but in some respects was more important (Baron-Cohen 2000:261). However, we'll see that our human ancestors went way beyond theory of mind, or 2nd level mentalising.

"***the question of how we eventually came to be human***", Dunbar 2014:343.

"***we suspect that***", Cheney 2007:279.

"**Evolutionary pressures**", John Gowlett divided the 6 million years or so of human evolution into two halves. The first half involved "*adaptations of bipedalism and life in wooded environments*", and the second half involved adaptations which were "*committed to long ranging, open environments, meat eating and other new foods*", but he didn't include the enlargement of the brain (Gowlett 2016:2).

"**Locomotion and cognition**", Gowlett recognised that "*the evolutionary sequence is firmly anchored at both its ends – at one end among the* *great apes … and at the other end in modern humans*" (Gowlett 2012:694).

Figure 8.13 covers only the major hominin species that are considered to be ancestors of humans, and is based on a number of sources: Boyd 2012:figures 10.13 and 10.36 and chapters 10−12, Dunbar 2004:figure 2, 2009:figures 2.3 and 2.6 (which are based on de Miguel 2001), and 2014a:figures 1.2 and 1.3, Eccles 1991:figure 2.13, Foley 2009, Harcourt-Smith 2007:figure 5.1 and 2010, Lewin 1999:units 19, 21 and 24, McHenry 2000, de Miguel 2001:figure 2, Schoenemann 2006:figure 2, and Stringer 2011a:131.

These sources differ in the values they give for fossil brain sizes and dates, and in their allocation to a hominin species, and I've selected the values that are representative of the majority of sources. Estimates of fossil brain sizes can carry substantial errors, for example, estimates of the brain size of one *A. africanus* cranial fossil by various investigators ranged from 513−625 cc (de Miguel 2001:14).

Figure 8.13 is complementary with figure 1.9 in Gamble 2014:33, which shows a time-line of the main hominin species and their supposed ancestral links, but not their brain sizes.

Every hominin species can be represented as a scatter of points on the brain size/time plot (see for example, Dunbar 2004:figure 2, and Dunbar 2009:figure 2.6), and to keep the plot simple I've indicated the regions for the hominin species (as has been done in Eccles 1991:figure 2.13 and in Stringer 2011a:131). The fossil data suggests that the brain size for a species can increase during the time it exists, and this is shown for some of the species in the plot (Dunbar 2009:figure 2.3).

Brain volume is plotted up the left-hand axis in cubic centimetres (cc), where 1 cc = 1 millilitre (ml).

The mentalising level is plotted up the right-hand axis, and the scale has been made simply by putting chimpanzees a little below level 2 and humans at level 5, and assuming a linear relationship between mentalising level and brain volume, and hence spacing the intervening levels equally. The linear relationship is only an assumption, and so these intervening levels are put in brackets to reflect their uncertainty, and the grey bar shows the approximate range of normal adult mentalising levels. The tentative mentalising scale suggests that an increase in brain volume of about 300 cc raises the mentalising ability by one level.

Concerning brain sizes for current humans, two things are clear: (1) on average, males have significantly larger brains than females, and (2) there's a wide range in brain sizes for both sexes. Molina (2012, 2015) gives these figures: men, range 1,070−1,767 cc, average 1,407 cc; women, range 1,000−1,618 cc, average 1,233 cc, and these figures give a species average of 1,320 cc. Henneberg (1990:table 1) gives averages of 1,427 cc for males, and 1,272 cc for women, giving a species average of 1,349 cc, which is fairly consistent with Molina's values. DeSilva reviews a number of studies and arrives at a very similar species average value (DeSilva 2023).

The solid bars and circles on the right hand axis, give the ranges in brain sizes and the average values for current chimpanzees (Schoenemann 2006:figure 2), and for humans (Molina 2012 and 2015). The range in human brain size is remarkable. Ralph Holloway gives the range as 900−2,000 cc, with male brains being ~10% bigger than female brains (Holloway 2004:12 – weight in grams and volume in cc are numerically very close, since brain density is close to 1 g/cc).

The geological timescale is taken from Boyd 2012:figure 12.4 and Lewin 1999:27.

Homo habilis, or "handy-man", is so named because of the association with the first stone tools. *Homo ergaster* is named after the Greek work for workman, because of the extensive use of this new lithic technology. The species, *H. erectus*, are named for their tall and upright posture (Kingdon 2003:262).

De Miguel plotted hominin fossil brain sizes over the last 3.2 million years, without regard to species, and derived a long-term trend line, based on a double exponential equation, which accounts for 90% of the variance in brain size, and this is shown in de Miguel 2001:figure 2.

I've adapted this trend line in two ways. First, I've used the de Miguel equation to estimate hominin brain sizes from 3.2 mya back to 6 mya, and we can see that the extended line is consistent with the measured brain sizes of the *Orrorin* and *Ardipithecus* fossils. Second, the de Miguel equation gives a value of 1,480 cc for the average brain size of modern humans, which is at odds with the measured values of 1,320−1,350 cc given above. The trend line in figure 8.13 follows the de Miguel trend line from 3.2−1.0 mya, and then gradually diverges from it, while still maintaining the ever-steepening curve, and ends up at the correct current brain size of 1,320 cc. This modified trend line gives an increase in hominin brain size of roughly 900 cc in 3 million years.

How can one describe the accelerating trend in brain enlargement over the last three million years? We can look at the trend in terms of arithmetic growth, where the brain size increases in six steps, each of 150 cc, as follows …

brain volume/cc	440		590		740		890		1,040		1,190		1,340
time/mya	3.00		1.74		1.15		0.75		0.45		0.18		0
time lapse/My		1.26		0.59		0.40		0.30		0.27		0.18	

The arithmetic growth pattern shows that the time decreased for each successive step, so it took about 1.3 million years to add the first 150 cc of extra brain volume, but less than 0.2 million years to add the last 150 cc.

Has hominin brain size increased steadily with time, or have there been sudden increases at certain times? The sparsity of fossil evidence leaves us uncertain, and the plot of brain size with time can be seen either way (see Lewin 1999:192). However, there are apparent irregularities in the pattern, which suggest that there may have rapid increases in brain size at certain times. Robin Dunbar considers that there have been a number of jumps in brain size, one occurring about 2 mya, with the appearance of *H. erectus*, and a second at about 0.7 mya, with the appearance of archaic humans, and he links both events with major climatic instability (Dunbar 2009:24). He also sees a third a third jump occurring about 300,000 years ago, and has linked this to the control of fire, enabling cooking and an improvement in diet (Dunbar 2014a:190 and figure 6.2). Richard Wrangham has argued for discrete steps in brain expansion, fuelled by improvements in diet (Wrangham 2009:114).

Figure 8.13 presents human evolution in just two major stages, involving the development of locomotion and of cognition. Daniel Lieberman sees human bodies evolving in 5 transformations: (1) becoming upright bipeds; (2) adapting to forage for a wide range of foods; (3) becoming hunter-gatherers with slightly larger brains and nearly modern bodies; (4) developing larger brains; and (5) becoming modern humans, with language, culture and cooperation, and spreading across the Earth. To these he adds two further transformations, due to cultural evolution: (6) the agricultural revolution, when humans took up farming, and (7) the industrial revolution, when humans began to use fossil fuel energy and machines to replace human work. (Lieberman 2013:18−20).

From the graph one might think that there has been an unbroken trend of brain enlargement, but this is not the case, for the average human brain size has decreased slightly, but significantly, since the end of the last ice age, about 10−12 thousand years ago (Lieberman 2013:335, DeSilva 2023). "*Human brain volume has decreased by a standard deviation in the last 10,000 years … an overarching global reduction in human brain size*" (DeSilva 2023).

Neanderthals are sometimes described as having larger brains than modern humans (Lewin 1999:156, Lieberman 2013:104). Whilst this is correct, Neanderthals and humans had similar brain sizes when they co-existed about 100,000 years ago (DeSilva 2023:figure 1). Since that time, Neanderthals have died out and the average human brain size has decreased.

This has been ascribed to the agricultural revolution and the subsequent rise of complex societies (DeSilva 2023). Certainly, cognitive demands have changed hugely as humans have gone from being hunter-gatherers, to farmers, and then to specialists in an industrial society.

Hunter-gatherers "*did not forage only for food and materials. They foraged for knowledge as well. To survive, they needed a detailed mental map of their territory. To maximise the efficiency of their daily search for food, they required information about the growth patterns of each plant and the habits of each animal. They needed to know which foods were nourishing, which made you sick, and how to use others as cures. They needed to know the progress of the seasons and what warning signs preceded a thunderstorm or a dry spell.They studied every stream, every walnut tree, every bear cave, and every flint-stone deposit in their vicinity. Each individual had to understand how to make a stone knife, how to mend a torn cloak, how to lay a rabbit trap, and how to face avalanches, snakebites or hungry lions. Mastery of each of these many skills required years of apprenticeship and practice*" (Harari 2015:54). In contrast, people in agricultural and industrial societies "*could increasingly rely on the skills of others for survival … You could survive and pass on your unremarkable genes to the next generation by working as a water carrier or an assembly-line worker*" (Harari 2015:55).

A forager very probably had a more interesting lifestyle than a modern industrial worker. To take one example, "*a Chinese factory hand leaves home around seven in the morning, makes her way through polluted streets to a sweatshop, and there operates the same machine, in the same way, day in, day out, for ten long and mind-numbing hours, returning home about seven in the evening in order to wash dishes and do the laundry*" (Harari 2015:56).

"**Following the first approach**", Dunbar 2014a:9−17.

"**Nearly 1 million years ago**", Boyd 2012:chapter12, Dunbar 2014a:chapters 6 and 7.

"**If we follow the second approach**", the increase in brain size over the last three million years is "*best characterised as a gradual time trend*", since it appears to indicate a gradual and smooth increase in brain size with time, with little relation to the appearance of new hominin species (de Miguel 2001:figures 1 and 2, Schoenemann 2006:388 and 2013:155, and quote from de Miguel 2001:3).

"**We can be confident**", Robin Dunbar has derived regression equations to correlate intentionality (mentalising) level with brain volume (Dunbar 2009:table 2.3). He did this by deriving frontal lobe volume from total brain volume, and then plotting intentionality against frontal lobe volume for monkeys, chimpanzees, and humans, which appear to show a linear relationship between the two variables (Dunbar 2009:figure 2.5 and 2014a:figure 2.4, which show the same data but with different x-axis scales).

On this basis, Dunbar proposed a linear relationship between a brain's volume and the intentionality level it can attain, roughly as follows: ~400 cc can attain level 2; ~700 cc, level 3; ~1,000 cc, level 4; and ~1,350 cc, level 5. This correlation suggests that an extra ~300 cc in hominin brain volume raises the intentionality level by one.

These figures are based on a comparison of figures 2.3 and 2.6 in Dunbar 2009. Dunbar's various plots of intentionality levels for different hominin species show broadly the same picture, an accelerating rise from the 2nd to the 5th levels, but mean values and ranges for individual species can differ by half a level (Dunbar 2009:figure 2.6, 2014a:figure 7.4, and 2020:figure 4).

However, this correlation between intentionality and total brain volume is uncertain for three reasons: (1) human intentionality is put at level 5, but the range is 4−6 or greater, and adults also have a wide range of brain sizes; (2) it is based on intentionality levels only for chimpanzees (put at level 2) and humans (put at level 5); and then (3) it assumes a linear relationship between these extremes.

So, we can only have confidence in the ends of the mentalising scale, with chimpanzees close to level 2 and the majority of humans at about level 5, and we can only approximate the levels in between. The mentalising scale in figure 8.13 is constructed on this basis. The intervening levels are equally spaced, but put in brackets to reflect their uncertainty, and the grey bar shows the approximate range of normal adult mentalising levels. This rough scale is based on an assumption of a linear relationship between intentionality and brain volume, and so it is consistent with Dunbar 2009:figure 2.6, 2014a:figure 7.4, and 2020:figure 4.

Dunbar estimates that the australopithecines were capable of 2nd level mentalising, early *Homo* could achieve 3rd level, archaic humans could achieve 4th level, but 5th level was only achieved by anatomically modern humans about 200 kya (Dunbar 2009:34 and 2020:56).

"**Robin Dunbar has correlated**", Dunbar 2009:table 2.3 and figures 2.3, 2.5 and 2.6, Dunbar 2014a:figures 2.4 and 7.4, and Dunbar 2020:figure 4 (outlined above).

"**The trend towards larger brains**", Schoenemann 2006:388, Schoenemann 2013:155. *Orrorin* and *Ardipithecus*, earlier species in the hominin lineage, had brain sizes that were around 300 cc, which means that brain growth was only about 100−150 cc in 3 million years. So brain enlargement was negligible before about 3 mya, and only after that time did it become a significant trend. We'll see later in figure 8.14, how *A. africanus* was the first species to break out of the allometric brain-body correlation for the higher primates.

"**In mentalising terms**", I'm looking at broad trends, and so I'm not considering how recently our species became capable of level 5 mentalising.

8.4.7 towards a community of minds

"***so great that it cannot yet be measured***", Wilson 1975:548.

"**So, the inexorable and accelerating trend**", we know that the rate of brain enlargement accelerated, but since we can't directly relate brain volume to mentalising level, we can't say with any confidence if the rate of increase in mentalising level was accelerating – that is, if it took progressively less time to increase the mentalising level by one.

8.5 the evolution of locomotion

"**Human bipedality has developed**", this is based on Harcourt-Smith 2007:figure 5.2, and the times are approximate.

8.5.1 the first stage: about 6−4.5 mya, arboreal – occasional walkers

"**Modern chimpanzees and bonobos**", it's worthwhile thinking about the geometry of terrestrial and arboreal habitats. The terrestrial habitat is simply a horizontal two-dimensional surface. The arboreal habitat is one-dimensional, when the animal is climbing a tree trunk or moving along a branch. But where there are two branches, one above the other, the terrain becomes two-dimensional – but vertical, not horizontal. We remark on arboreal primates, such as chimpanzees, as having an "upright" stance, but they are only aligning their posture to their vertical 2-D terrain. Consequently, "*a somewhat bipedal arboreal lifestyle is probably the default mode for apes*" (Wilkinson 2016:53). This leads us to the counter-intuitive conclusion that life in the trees enabled our human ancestors to adapt to a bipedal lifestyle on the ground. They learned to stand and walk upright without having to steady themselves by holding on to an upper tree branch.

We perhaps think of chimpanzees as highly arboreal, and only moving on the ground when they have to, and then only for short distances. But male chimpanzees regularly travel long-distances on the ground, because this is how they go on patrols, to maintain their territorial boundary (Goodall 1986:chapter 17) and to go hunting (Mitani 1999:445). Patrols can last for several hours, and the chimpanzees move silently in single file on the ground, presumably to avoid the noise of travelling through the trees. The reports don't say whether the chimpanzees are walking upright (bipedal) or knuckle-walking (quadrupedal) – they may do both. But clearly, long-distance travel on the ground is an important part of the male chimpanzees' locomotion lifestyle, but this seems to be overlooked in discussions on chimpanzee locomotion.

John Gowlett points out that *Ardipithecus kadabba*, an early hominin living ~5.5 mya (see figure 8.13), lived in thick woodland, and that this "*supports the idea that bipedalism first arose as an adaptation to walking along tree boughs, perhaps while clasping the branches above*" (Gowlett 2024).

Matt Wilkinson has pointed out a major difference between the quadrupedal gaits of terrestrial mammals and arboreal primates (Wilkinson 2016:59). Most mammals walk with a lateral sequence gait, which gives them stability on two-dimensional flat ground. Primates use a diagonal sequence gait, which gives them better stability and security on a thin, one-dimensional tree branch. This primate gait shifts more of the body weight on to the hind limbs, which makes it easier to stand fully upright, and use the hands for picking leaves or fruit or for holding on to a higher branch.

"***arboreal or terrestrial specialists***", Harcourt-Smith 2007:1484. An arboreal lifestyle involves being upright to climb a tree trunk, and to reach up to swing on a branch or to reach fruit from above. The arboreal primates were elective uprights, and this naturally led to them being electively bipedal. The arboreal lifestyle also discriminates between the front and back limbs, so the front become hands, and the back become feet. The hands don't just support and cling, but start to become important in manipulating objects – the start of hand-eye coordination.

"**The early hominins inhabited**", Potts 1998:114 and 116, Lewin 1999:95, Harcourt-Smith 2010:335, Stringer 2011a:207. It's long been thought that our human ancestors became bipedal in order to move about on the hot open savannah, but it's now recognised that the earliest hominins lived in well-wooded environments, similar to current chimpanzees.

"**The climate was becoming drier**", Foley 2009. It's now generally accepted that from 6−4 mya the early hominins lived in a wide variety of habitats, and that there was a drying trend, and a shift from closed to open vegetation, and many arboreal species became more terrestrial (Foley 2009:3273, Stringer 2011a:207).

Between 10 and 5 million years ago, the Earth's climate steadily cooled, and the long-term effect was "*to cause the rain forests to shrink and woodland habitats to expand*" (Lieberman 2013:40). There would be little change for primates living in the heart of the rain forest, but big changes for primates living in the forest margins. The ripe fruits that were the major part of the diet became less abundant, more dispersed, and more seasonal. In Daniel Lieberman's view, the evidence most strongly supports the idea that "*regularly standing and walking upright was initially selected to help the first hominins forage and obtain food more effectively*" as close forest became open woodland.

"**The first stage in the development**", the fossils of *Ardipithecus* and tree-dwelling colobus monkeys are found together, providing good evidence that these hominins lived in forested habitats (Stringer 2011a:207).

Three species represent the earliest human ancestors: *Orrorin*, *Ardipithecus* (shown in figure 8.13), and *Sahelanthropus tchadensis* (sometimes called Toumaï), and their fossils have features suggesting they were adapted to walking upright (Lieberman 2013:33). These features include a femur with a large hip joint (*Orrorin*), a skull supported by a nearly vertical upper spine (*Sahelanthropus*), an S-shaped spine (*Sahelanthropus*), and a partly stiffened foot with flexible toes that can push on the ground (*Ardipithecus*). These species were not quadrupedal on the ground, but were occasional bipeds, walking with more efficiency and stability than chimpanzee, but not striding as well as modern humans. They were still adept climbers, but less agile than chimpanzees (Lieberman 2013:34−8).

"**The earliest hominins**", on *Orrorin*, see Harcourt-Smith 2007:1491, Boyd 2012:223, Dunbar 2014a:9.

"**For example, the foot of *Ardipithecus***", Harcourt-Smith 2010, Stringer 2011a:206, Lieberman 2012, Boyd 2012:224.

the energetics of locomotion

"**We quantify this energy**", the cost of transport is sometimes measured in terms of oxygen consumption per kilogram of mass – either the volume of oxygen consumed per kilogram of mass in a time of one second, or to move a distance of 1 metre. The metabolic combustion of 1 millilitre (ml) of O_2 yields about 20 J of energy, so 1 ml O_2/kg/m is equivalent to 20 J/kg/m (Rubenson 2007, Pontzer 2009:49).

quadrupedal vs. bipedal

"**A common image of the evolution**", Roberts 2015:299.

"**Modern chimpanzees and bonobos**", de Waal 1997:25, Lieberman 2010, Sockol 2007, Pontzer 2014. There's no settled view on how our early human ancestors moved around. There is anatomical evidence for our ancestors being adapted for knuckle-walking (Richmond 2001), while others take the view that "*our ancestors were tree-walkers who became ground-walkers*" (Roberts 2015:306, and also Kivell 2009).

"**These modern apes**", Lewin 1999:94 on upright posture, Richmond 2001:99 on upright feeding, and Harcourt-Smith 2007:1484 on locomotion styles.

"**Bonobos are good bipedal walkers**", de Waal 1997:26−27, Pontzer 2014.

"***the expansion of one particular mode***", Roberts 2015:305.

"**For the "average" chimpanzee**", Pontzer 2014, Dunbar 2014a:109, and also Wilkinson 2016:41. I've taken the figure of 6 J/kg/m from Pontzer 2014:figure 1F, which plots the average for five chimpanzees. But figures for costs of transport for chimpanzees vary quite widely. Rodman 1980 gives a figure of 8.5 J/kg/m for quadrupedal motion at 4.5 km/h, while Sockol 2007 gives 3.8 J/kg/m for quadrupedal motion, and 4.2 J/kg/m for bipedal walking at 3.6 km/h. While different researchers may disagree on absolute values for cost of transport, it's well established that there's little difference between the energy costs of quadrupedal and bipedal motion. Also, the large individual variations are real effects, because these appear when using the same experimental methods.

"**In studies of two separate groups**", Sockol 2007, Pontzer 2009 and 2014.

The anatomy of the spines of chimpanzees is surprisingly variable (Lieberman 2013:36 and 45, Pilbeam 2004). There are 4 types of vertebrae in the spines of humans and chimpanzees: from the neck down, they are cervical, thoracic, lumbar, and sacral. Chimpanzees are roughly evenly divided between having 3 and 4 lumbar vertebrae, with a very small number having 5. In contrast, the great majority of humans have 5 lumbar vertebrae, a few have 4, and none have 3 (Pilbeam 2004: tables 1 and 3).

With this amount of anatomical variation, it's not surprising that some chimpanzees walked more efficiently on two limbs than on four. It's reasonable to assume that there was a similar degree of anatomical variation in the earliest hominins, so, as with chimpanzees, there would have been some individuals who walked upright more easily than others.

"**This suggests that the early hominins**", Pontzer 2009.

Being bipedal brings drawbacks, as well as advantages: pregnancy is more difficult; there is a loss of speed, increasing the risk from four-footed predators; and there is reduced agility in trees (Lieberman 2013:46). However, we can infer that the advantages outweighed the drawbacks, for the first hominins "*must have had a slight reproductive advantage from being just partly better at standing or walking upright*" (Lieberman 2013:46).

8.5.2 the second stage: about 4.5−2.5 mya, arboreal and terrestrial – habitual walkers and elective climbers

"**From about 4.5−2.5 million years ago**", I'm lumping *afarensis* and *africanus* together, for they were anatomically very similar, with only minor differences in locomotion (Harcourt-Smith 2007:1500). I'm also lumping together the gracile and robust australopithecines (Lewin 1999:117, Stringer 2011a:126).

"**The australopithecines did not live**", Dunbar 2014a:98, 102 and 114, Harcourt-Smith2007:1508, and Reed 1997:289.

"**The climate continued**", Harcourt-Smith 2007:1508, Plummer 2004:123.

This cooling and drying caused the open woodland and savanna habitats to expand, in which there were fewer fruit trees that were more widely scattered (Lieberman 2013:53). This pushed the australopithecines to forage more widely for lower quality "*fallback foods*", such as leaves, stems and seeds, and also dig for underground foods, like tubers, bulbs and roots (Lieberman 2013:54). Consequently, australopithecines developed large teeth with thick enamel, and large chewing muscles that could be "*the size of small steaks*" (Lieberman 2013:56, and quote from p. 52).

Chimpanzees living in a well-fruited forest are "*surrounded by foods they mostly choose to ignore*", and typically travel 2−3 kilometres a day, mostly going from one fruiting tree to another (Lieberman 2013:60). The australopithecines had to forage over longer distances, and so adapted to become better long-distance walkers (Lieberman 2013:61).

"**Faced with a diversity of habitats**", Potts 1998:117 and 129.

"***there were several different "types" of bipedalism***", Harcourt-Smith 2007:1507.

The australopithecine anatomy

"***an ape-like skeletal design***", Dunbar 2014a:101.

"**The skeleton of *afarensis***", Harcourt-Smith:table 5.1, and also see Lewin 1999:chapter 17.

"***can best be considered***", Harcourt-Smith 2007:1498.

"***bipedality requires a combination***", Harcourt-Smith 2007:1488.

"**These include**", Lewin 1999:106, Lieberman 2004:figure 3, and 2010:figure 3, Stringer 2011a:118, Boyd 2012:221, Dunbar 2014a:101.

"**The Laetoli footprints**", Stringer 2011a:187 and 207, Harcourt-Smith 2007:1493.

"***less competent at complex bipedal behaviours***", Harcourt-Smith 2007:1500, and see also Lewin 1999:116.

"**Chimpanzees live mostly on a diet**", Plummer 2004:122, Lieberman 2010, Stringer 2011a:122.

"**This suite of adaptations**", Lewin 1999:114, Lieberman 2010, Lieberman 2013:51−61.

"***although afarensis was bipedal***" and "***could not achieve***", Lewin 1999:106, and see also Harcourt-Smith 2007:1495 and Stringer 2011a:121, although this conclusion about the restricted walking gait is disputed (Lieberman 2010).

"**These were apes**", Lieberman 2009 and 2010, Lewin 1999:units 19 and 20, Kingdon 2003:chapter 4. *A*. *afarensis* could well have spent the night in the trees to avoid predators (Harcourt-Smith 2007:1498). Also, the anatomy of *H*. *erectus* has lost adaptations for climbing, suggesting that facility in climbing was no longer essential (Wrangham 2009:100).

"**The australopithecine anatomy**", Harcourt-Smith 2007:1498.

Daniel Lieberman discusses the ways that the australopithecine anatomy was adapted to enable them for "*long-distance trekking through open habitats*" (Lieberman 2013:60−5, and quote from p. 64).

"**These hominins**", Daniel Lieberman sees the australopithecines as "*a key intermediate stage in human evolution … less arboreal, more habitually bipedal, and less dependent on fruit, setting the stage for subsequent evolution occasioned by yet more climate change*" (Lieberman 2013:66).

reducing the energy cost of walking

"**We've seen that the walking energy cost**", the experimental measurements aren't very consistent. An early study puts the human walking energy value at 3.4 J/kg/m (Rodman 1980), but the average of many studies gives values of 1.7 - 2.6 J/kg/m, with a mean of 2 J/kg/m (Rubenson 2007). But Sockol 2007 measured bipedal values of about 1 J/kg/m for modern humans and about 4 J/kg/m for chimpanzees, using the same experimental procedure. While different researchers come up with different energy values, there seems to be agreement that that the bipedal energy cost for humans is about 25−30% of the value for chimpanzees.

"**The low energy cost of human walking**", Carrier 1984, and Bramble 2004.

"***an inverted swinging pendulum***", Carrier 1984:485.

"**We can't measure**", Pontzer 2009:figure 4. Pontzer estimates the CoT figures (in J/kg/m) as: 4.6 for a bipedal chimpanzee, 3.6 for a quadrupedal chimpanzee, and 1.8 for a bipedal human, and the figure for *afarensis* at between 4 and 2 J/kg/m, depending on whereabouts the australopithecine anatomy lay between the chimpanzee and human extremes.

extended foraging and time budgets

"**All social apes have a time budget**", the general principles of time budgeting are in Dunbar 2014a:84−93, and time budgets for australopithecines are in Dunbar 2014a:102−126.

"**There must be time**", Dunbar 2014a:84 and figure 3.6.

"**The time budget model**", Dunbar 2014a:122.

"**It appears that the australopithecines**", Dunbar 2014a:116, Wrangham 2009:116, deMenocal 2004.

sweating, lice and body hair

"**A lifestyle that involves spending time**", an upright posture reduces the area of the body exposed to the tropical sun, and it's been argued that this was an important factor in the evolution of bipedalism (Dunbar 2014a:111). But the reduction in exposure is greatest when the sun is high in the sky, and this is the time when the hominins would have been resting. Hominins would have been travelling near the start and the end of the day, when the sun is lower in the sky, and an upright posture only slightly reduces the exposure at these times.

"**However, sweating**", Dunbar 2014a:112.

"**Gorillas, chimpanzees and humans**", Reed 2007, Weiss 2009.

sharing food – the start of inter-dependence?

"**With feeding being dependent**", de Waal 1997:135 considers this sort of situation. Individuals are more at risk from predators when on the ground than in the trees, and it would be females with dependent young who would be most at risk. So, one can imagine a scenario where males protect females and their young, and also go foraging and walk upright to bring food back. Frans de Waal considers that neither the female-centred bonobo social structure, nor the independent lifestyle of male chimpanzees would have coped with a lifestyle in which females and young were dependent on male assistance and protection. Our human ancestors are the only hominids who "*managed to abandon the safety of the trees altogether*" (de Waal 1997:136). It may be that this is the basis for the nuclear family, a feature unique to humans.

"***the males were probably less arboreal***", quote from Stern 1983, and also see Harcourt-Smith 2007:1508, and Stringer 2011a:121.

"**Next, the regular sharing of food**", Dunbar 2017c.

"**So, the experiences of early hominins**", Michael Tomasello has proposed that human cooperation started with early hominins, who had to become inter-dependent "collaborative foragers" to survive (Tomasello 2012). Individuals became "*inter-dependent with one another for subsistence, which led naturally to helping those on whom one was dependent. This required the development of cognitive skills for putting one's head together with others in acts of mutualistic collaboration and communication*" (Tomasello 2012:685).

8.5.3 the third stage: from about 2.5 mya, fully terrestrial – obligate walking and elective running

introducing the genus Homo

"**As the hominin body plan**", Bramble 2004, Lieberman 2009a and 2009b.

"**First came early *Homo***", for early *Homo* see Harcourt-Smith 2007:1503 and Lewin 1999:119. I've lumped together *H. habilis* and *H. rudolfensis*, which are very similar, with the latter appearing slightly more modern than the former (Lewin 1999:124). I'm also lumping together *H. ergaster* with the major species that followed it, *H. erectus*, (Lewin 1999:unit 24, Dunbar 2014a:10). While there are early skeletons of *erectus* in the Caucasus, dating from about 1.8 mya, it's generally accepted that *erectus* originated in Africa about 1.9 mya (Stringer 2011a:139).

"***H. erectus* is now regarded**", Dunbar 2014a:10 and 141.

"***H. ergaster* and *H. erectus* appeared**", Lewin 1999:chapter 24.

"**The new features include**", Lewin 1999:chapter 24, Leakey 1994:chapter3, McHenry 2000, Kingdon 2003:chapter8, Wrangham 2009:chapter 4, Bramble 2004, Lieberman 2009b.

"***H. erectus* stands**", The transformation of bodyplan from chimpanzee through *afarensis* and then *africanus* to *ergaster* to modern human is shown strikingly in Kingdon 2003:figure 8.4.

"***at a pivotal point***", Leakey 1993:46.

"**This body shape is optimal**", Stringer 2011a:139, Potts 1998:119.

"***Homo species appear the first***", Reed 1997:289.

"**If *erectus* hominins**", Daniel Lieberman sees *H. erectus* as "*the first ancestor we can characterize as significantly human*" (Lieberman 2013:72).

"***time-traveled to a modern city***", Wrangham 2009:5.

adaptations for running

"**In contrast, the running gait**", Lieberman 2007a:289.

"***somewhat like a controlled fall***", Lieberman 2009a:79.

"**The asymmetric leg movements**", Bramble 2004.

"**So, running requires specific adaptations**", Bramble 2004, Lieberman 2007a and 2013:85−8, and Wilson 1975:547 also gives a list of anatomical features.

"**All of these adaptations**", Bramble 2004, Plummer 2004:128.

"**This suggests that some time**", Harcourt-Smith 2007:1501.

"***H. erectus* could still climb trees**", Wrangham 2009:98.

the energy cost of running

"**The energy cost for human walking**", Cavagna 1977, Rubenson 2007.

"**However, if you switch to a running gait**", Pugh 1970, Cavagna 1977, Rubenson 2007, and Bramble 2004 all state that the energy cost for a running human is about 4 J/kg/m, and that it does not vary with running speed. However, Steudel-Numbers reports that the running energy cost varies with speed, with a minimum value of about 4 J/kg/m at a speed of around 12 km/h (Steudel-Numbers 2009, and the average energy cost is calculated from the graphs in figure 1).

sweating and endurance running

"**But humans can lose**", Carrier 1984.

"***specialised sweaters***", Lieberman 2007a.

"***This fits well with the genetic studies***", Reed 2007, Weiss 2009.

scavenging and persistence hunting

"**These increases required**", Dunbar 2014a:145−149. Brain tissue requires a lot of energy to function, so that in a modern human the brain takes about $1/5^{th}$ of the total nutrition intake. A 100% increase in brain size is equivalent to 100/5 = 20% increase in body mass, so the total increase in effective body mass of *H. erectus* is about 40+20 = 60%. The nutrition energy required to operate the body scales as body mass$^{0.75}$, which is the body mass raised to the power 0.75 (as 100 is 10 raised to the power 2). So, a 60% increase in body mass requires an increase in nutrition of about $60^{0.75}$ = 22%, most of which is needed for the increase in body size (Dunbar 2014a:146 and 387). This calculation is simplified, but still shows clearly that the *erectus* body and brain sizes can't be sustained by the australopithecine lifestyle.

"**Quadrupedal cursorial species**", the energy cost for running quadrupeds varies with species, but it follows a general trend of decreasing with increasing body mass: for a hunting dog it's about 6 J/kg/m, for a 50 kg elk calf it's about 4 J/kg/m, and for a pony or a horse it's about 2 J/kg/m (figures for ponies from Bramble 2004, and for other quadrupeds from Rubenson 2007).

"**These species can travel**", a cheetah can out-sprint all other prey species, but its body temperature rises rapidly as a result of the heat generated, and it rarely runs more than 1 km. It appears that the duration of the cheetah's sprint is limited not by fatigue, but by over-heating (Carrier 1984).

“**In long-distance travel**”, Lieberman 2007a.

“**The major limiting factors**”, Carrier 1984, Bramble 2004.

“***can outrun almost all other mammals***”, Bramble 2004, Lieberman 2007a.

“**Grassland is a poorer source**”, Leonard 1997:277, Plummer 2004:124. Grassland is about half as productive as forest for primary plant nutrition, but about three times as productive in secondary herbivore meat. For a standard amount of 100 g, leaves provide about 40−80 kJ, fruits provide about 200−400 kJ and meat provides about 400−800 kJ (Leonard 1997:277).

“**They could practise persistence hunting**”, Lieberman 2007a, 2009a:84 and 2010, Liebenberg 2006.

“**If hunting was not possible**”, Lewin 1999:chapter 26, Lieberman 2007a, 2007b, 2009a.

“**By about 2½ million years ago**”, Lieberman 2007a.

8.6 the evolution of cognition

Figure 8.14 is based on Lewin 1999:191, and Bonner 2006:figure 16, using McHenry 2000:137 for hominid data, Grabowski 2015 for hominin body masses, and Dunbar 2014a:figure 1.3 for hominin brain volumes. Representative values for body masses and brain sizes for hominins, current *Homo* and primates all vary considerably. Ranges for current primates are: bonobos, 275−380 cc, chimpanzees, 280−450 cc, and for gorillas, 350−750 cc (Schoenemann 2013:154). I’ve used Molina’s figure of 1,320 cc for current humans (Molina 2012, 2015). I’ve used body mass values from a recent study, which found that many hominins were smaller than previous investigators had thought (Grabowski 2015). The plot in figure 8.14 is very similar to Lewin’s plot (Lewin 1999:191), just shifted to lower body masses. Grabowski shows that all hominin species show a wide range of body masses, just as de Miguel 2001 shows a wide range in fossil brain sizes. Grabowski’s values should be self-consistent, and they clearly show the hominin species breaking out dramatically from the allometric pattern of the great apes.

Robin Dunbar considers that there is a linear relation between mentalising level and brain size (Dunbar 2014a:figure 2.4), but I’m being cautious about this.

“***what features of the environment***”, and “***once started***”, Wilson 1975:566.

8.6.1 bones and stones – indicators of a carnivorous lifestyle

“**Around 2½ million years ago**”, Potts 1991, Lewin 1999:unit 23, de Heinzelin 1999, Schick 1995 and 2006, de la Torre 2004, Delagnes 2005, Semaw 2000 and 2006, Roche 2009, Toth 2018. It seems to be generally accepted that the first use of stone tools for butchering animal carcasses dates from around 2.6 mya, but these tools are fairly sophisticated. This implies that these hominins had already accumulated experience in making stone tools (Thompson 2019:7). Stone knapping requires considerable skill, which would have taken some time to develop, and so there must have been some shaping of stone before 2.6 mya, but the artefacts are so crude that they are hard to find. However, cut-marks from stone tools have been found on bones dating from about 3.4 mya, and attributed to *A. afarensis* (McPherron 2010, Toth 2018:5). No stone artefacts were found with the bones, so we don’t know how the tools were made.

Jessica Thompson has proposed that hominins first used stones as simple hammers, to break scavenged animal bones to access the marrow (Thompson 2019:10). The fossil record shows that before ~2 mya, stone tools were being used in the butchery of animal carcasses, for example in skinning, tongue removal, and de-fleshing (Pobiner 2020). While this evidence seems fairly clear, it’s comparatively rare, suggesting that tool use was not yet well established. However, the fossil record shows regular, organised use of stone tools after ~2 mya (Thompson 2019:7, Pobiner 2020:73).

“**The earliest stone tools**”, de la Torre 2004.

“**These tools are known as Oldowan**”, de la Torre 2004, Semaw 2006:43, and see Potts 1991:164. Oldowan tools are named after the Olduvai gorge, also called the Oldoway gorge, where they were first discovered.

“**It’s uncertain whether**”, Lewin 1999:134, Schick 1995:102 and 2006:18, Plummer 2004:125, Semaw 2006:69. Plummer 2004 is a thorough and comprehensive review of Oldowan hominins.

“**Whoever were the first tool makers**”, Lewin 1999:chapters 25 and 30.

“**Oldowan tools are simple**”, Potts 1991, Lewin 1999:unit 23, Schick 1995:chapter 3 and 2006, Toth 2018.

“**It appears that it was the flakes**”, Delagnes 2005, Schick 2006:18 and 26, Toth 2018:17.

“**Reconstructions have shown**”, Potts 1991:163, Delagnes 2005.

“**Even the simple Oldowan tools**”, Schick 1995:57 and 135, and 2006:24, Toth 2006, and 2018:12.

“**Chimpanzees in the wild**”, Toth 2007:1947.

“**The East African environment**”, Plummer 2004:122.

“**The majority of Oldowan sites**”, Plummer 2004:124, Schick 2006:10, Toth 2018:8.

“**Tools were made**”, Schick 1995:122 and 2006:9 and 29, de la Torre 2004.

“**Experiments with stones**”, Braun 2009:1610.

“**Hominins selected rock**”, Braun 2009:1611.

“***the great majority***”, Schick 2006:25.

“**They were selective**”, de Heinzelin 1999, Semaw 2000 and 2003, de la Torre 2004, Schick 2006, Toth 2018:14.

“***four meat or butchering knives***”, Keeley in Schick 2006:19.

“**Several studies**”, Lemorini 2014, Plummer 2016:35, Boyd 2012:figure 11.12.

“**This suggests that the Oldowan hominins**”, Boyd 2012:250.

“**When hunting, chimpanzees limit themselves**”, chimpanzees hunt woodland species, mainly colobus monkeys, and they are very reluctant to scavenge from carcasses killed by other carnivores (Plummer 2004:141).

“**In marked contrast**”, de Heinzelin 1999, Semaw 2003, Plummer 2004:130 and 147, Schick 2006:10, 19 and 34.

“***unequivocally that the earliest artifacts***”, Semaw 2006:43.

“**It’s worth bearing in mind**”, Pickering 2006:123.

“**Some archaeologists**”, Schick 1995:chapter 5.

“***were amazed***”, Schick 1995:168.

“***with a simple flake***”, Schick 1995:169.

hominins have their own tapeworm species

"**Additional evidence**", Hoberg 2001 and 2006, Boyd 2012:276. There is further evidence of hominins' diet shifting to take in more meat from grazing savannah herbivores from the chemical analysis of the balance of carbon isotopes in their teeth (Dunbar 2014a:117).

"**Modern humans**", Hoberg 2001:781 and 785, and Hoberg 2006:S26 and figure 1.

scavenging or hunting?

"**In passive scavenging**", Plummer 2004:142, Parkinson 2018:45.

"**In active scavenging**", also called confrontational or power scavenging.

"**It's difficult to distinguish**", Plummer 2004:144, Roche 2009:141.

"**Sites in the Olduvai Gorge**", Plummer 2004:141, Pickering 2006, Roche 2009, Parkinson 2018.

"**These Olduvai sites**", Plummer 2004:141−143, and tables 5 and 6 and also Roche 2009:140. These are from Olduvai Bed I, which dates from about 1.8 mya (Plummer 2004:121). One 2 million-year-old site in Kanjera South, a little way from Olduvai, has yielded complete skeletons of small immature antelopes, bearing damage from stone tools, and this suggests that hominins acquired these by hunting rather than scavenging. Bones of larger grazing animals appeared to be scavenged, either by passive or active scavenging (Plummer 2016).

"**Carcasses of mammals of this size**", Plummer 2004:152.

"**Most, possibly all, of the animal bones**", Plummer 2004:144.

"**The remains of small, immature carnivores**", Plummer 2004:140 and 144.

"**A number of lines of evidence**", Parkinson 2018:47.

"**First, carnivores tend**", Parkinson 2018:47.

"**Second, the bones**", Parkinson 2018:46.

"**Finally, the patterns**", Parkinson 2018:45.

"**Many sites yield bones**", Plummer 2004:145.

"**The patterns of cut-marks**", Plummer 2004:145, Pickering 2006:122.

"**The larger mammals**", Parkinson 2018:47.

"***often had access***", Plummer 2004:146.

"**In this the hominins are like**", Lewin 1999:152, Leakey 1994:72, Boyd 2012:263.

"***not an occupation***", Boyd 2012:262.

"**To ask whether the Oldowan hominins**", Lewin 1999:152. There has been a lot of effort put in to answering this question, and it possibly stems from the view that it is unflattering to think of our ancestors as scavengers, and that a scavenger lifestyle is "*far from the Man the Noble Hunter image of traditional theory*" (Leakey 1994:72). Roche sees the dichotomy of the hunting vs. scavenging debate as an "*oversimplification that does justice neither to the evidence, nor to the behavioral variability*" of hominins (Roche 2009:137).

8.6.2 the cognitive abilities of the Oldowan hominins

2nd level mentalising enables imagining complex, shared tasks

a behavioural test for theory of mind

joining the carnivore guild

"**The early Oldowan hominins**", Roche 2009:136.

"***to be a carnivore***", Lieberman 2007a:290.

"**So, around 2½ million years ago**", Lieberman 2009a:83, Roche 2009:136.

"***hominins possessed the capability***", Pickering 2006:122.

"***cooperation and cunning***", Stringer 2011:109.

"**For example, a large pack of hyenas**", Plummer 2004:139 on hyenas, and Cheney 2007:47 on baboons.

"**Following this pattern**", Roach 2013 has analysed the modern anatomy of the human shoulder, and how this enables us to throw objects with high speed and accuracy. Some of these anatomical features appear in the fossils of late *Australopithecus* and early *Homo*, and probably contributed to their success in competing against other carnivores in scavenging and hunting.

"***a unified, sophisticated predatory 'organism'***", Whiten 2012:2122.

the manual and mental skills involved in tool-making

"**The early Oldowan tools**", Schick 1995:118 and 122, Delagnes 2005.

"***efficient flaking of stone***", Schick 1995:133.

"***turned the core***", Schick 1995:96.

"**The early Oldowan tool-makers**", Delagnes 2005.

"***carry an air***", Lewin 1999:131.

"***overlap and continuum of form***", Potts 1991:161.

right-handed hominins

"**But making a stone tool**", Schick 1995:140.

"**Experiments in recreating Oldowan tools**", Schick 1995:142, Boyd 2012, figure 11.3.

extended childhood and learning

"**Modern human infants**", Leakey 1994:46, Lewin 1999:143.

Christopher Wills sums it up in this way: "*The human brain does most of its developing outside the womb, but the chimpanzee brain develops primarily within it*". Consequently, most of the development of a human brain comes from being "*bombarded with stimuli from the outside world, stimuli that are largely denied to the developing brain of a chimpanzee*" (both quotes from Wills 1994:6). As our hominin ancestors evolved, the balance of their brain development shifted from inside the womb to the outside world, and this opened up more opportunities for further brain evolution.

"**Experiments in stone knapping**", Schick 1995:chapter 4, Stout 2006, Toth 2018.

"***suggests the presence***", Stout 2006.

"***strong selection pressure***", Roche 2009:142.

the logistics of supply of stone tools

"**Chimpanzees use stones**", Goodall 1986:544, Schick 1995:57.

"**The Oldowan hominins**", stone tools and processed bones are found together in many Oldowan sites, and many investigators have tried to infer hominin lifestyles from the fossil evidence at these sites. Many hypotheses have been put forward, and there appears to be no consensus on how the sites were used (Lewin 1999:chapter 26, Plummer 2004:133, and Schick 2006:20 outline different models). I'm concerned with the factors that caused hominin brains to get bigger, and I don't think that considering these different lifestyle hypotheses will help.

One of the hypotheses proposed that stones in both raw and partly processed states were cached at certain sites (sometimes called manuports) ready for future use (Potts 1991, Plummer 2004:134). Further investigation proposed that many caches were the result of natural processes, but accepted that some had been accumulated intentionally, and were genuine manuports (de la Torre 2005).

"***two spatially separate resources***", Potts 1991:170.

"***Oldowan sites***" and "***tool-makers***", Potts 1991:163.

"**In the early Oldowan**", Schick 1995:128, Plummer 2004:132 and 2016:34, Roche 2009, Toth 2018:15. Hominins were transporting stone from the earliest Oldowan times, around 2.6 mya (de Heinzelin 1999, Semaw 2000 and 2003).

"**The logistics**", Potts 1991:161, Schick 1995:128, Plummer 2004:132 and 2016:34, Toth 2018:15.

"**Cobbles were often partly flaked**", why did the Oldowan hominins do things this way? The accounts given by Potts 1991:161, Schick 1995:128, and Plummer 2004:132 and 2016:34 suggest some simple inferences. The most difficult step in stone-knapping is the production of the first flakes, and these are sometimes produced by pounding one cobble with another to produce an acute edge from which flakes can be detached in a more controlled way. Breaking open a cobble would give some indication of its internal quality, and whether it would produce a series of good flakes. These two observations indicate that the initial flaking of cobbles at their source would be a useful practice (Schick 2006:27, Toth 2006:215). Thereafter the partly flaked core could be carried as one unit to the butchery site, and flakes produced from it as they were needed (Schick 1995:169). Partly flaked cores would then be taken from one site to another, if they could still provide further flakes.

"***it was the spatial pattern***", Potts 1991:153.

"***were moved around***", Plummer 2016:30.

division of labour in the Oldowan social economy

"**So, we can infer**", Wrangham 2009:chapter 6, Lieberman 2009b:11, Plummer 2004:152.

"***hunting and extractive foraging***", Boyd 2012:252.

"**This division of labour**", Boyd 2012:253.

"**Both extractive foraging and hunting**", Boyd 2012:figure 11.10.

"**The hominin group depended**", Plummer 2004:152, Lieberman 2009a:87.

In Daniel Lieberman's view, "*the first hunter-gatherers would have benefited so strongly from sharing food that it is hard to imagine how they could have survived without both females and males provisioning each other and cooperating in other ways*" Lieberman 2013:75).

He sees the division of labour coinciding with the development of a lifestyle of hunting and meat-eating (Lieberman 2013:74). But mutual dependence is the basis for the division of labour, and this must have started earlier (see section 8.5.2: sharing food – the start of mutual dependence).

Oldowan hominins had passed the theory of mind threshold

"**In these activities**", Dinah Davison has noted the disparate natures of the activities that sustain the "*Oldowan carnivory institution*". Thus, activities such as "*obtaining raw material, tool production, and carcass processing are either pointless or impossible considered separately since they are adapted to be parts of an emergent system*" that produces something useful for the hominin community as a whole (Davison 2021:218).

"**Thus they pass the behavioural test**", and we can go further and use the list of social behaviours that Simon Baron-Cohen regards as depending on theory of mind (Baron-Cohen 2000:262). These are:

1) intentionally communicating with others – to change the knowledge state of the listener
2) repairing failed communication with others – such as, checking that the listener has understood
3) teaching others – to change the knowledge state of the listener
4) intentionally persuading others – to change someone's belief about the value of something
5) intentionally deceiving others – to place false information, or a false belief, in the mind of another
6) building shared plans and goals – to combine individual actions to achieve a goal that is not possible alone
7) intentionally sharing a focus or topic of attention – so that each is aware of the other's attention to the same object
8) pretending – to treat one object as if it's something else, with a different "pretend" identity

Three important features of the Oldowan lifestyle are: membership of the carnivore guild, the logistics of tool production and distribution, and making individual stone tools. The first two features depend on social behaviours 1, 2, 4, 6 and 7, and the third depends on behaviours 1−3. So, it seems clear that the Oldowan hominins had cleared the theory of mind threshold, and were operating at the 2nd mentalising level in a number of respects. See also the earlier note to section 8.2.1.

"***biological adaptation was overtaken***", Kingdon 2003:276. The Oldowan hominins are sometimes described as inhabiting a "*socio-cognitive niche*", where "*many more resources become available by the ability to perform appropriate learned or invented manipulations*" (Tooby 1987:209, Whiten 2012). An organism's habitat is its "address", but its niche is its "profession" – how it supports itself in the ecosystem (Campbell 2008:1199). Niches are competitively exclusive, and two species can't coexist permanently if their niches are identical, which makes a niche look like the biological equivalent of a set of quantum numbers (such as the quantum numbers that define electron orbitals in atoms – see the notes to sections 3.6.2 and 5.7.5).

"**Robin Dunbar has correlated**", Dunbar 2014a:figure 7.4 and 2020:figure 4, and see the notes following figure 8.13.

"**Clive Gamble regards features**", Gamble 2011.

Daniel Lieberman sees a hunter-gatherer lifestyle as being dependent on "*intense cooperation*", which requires "*complex cognitive skills beyond* *those of apes. To cooperate effectively one needs a good theory of mind (to intuit what another person is thinking)*". So, it is "*not coincidental that major increases in brain size occurred after the origins of hunting and gathering*" (all quotes from Lieberman 2013:92).

crossing the theory of mind threshold

8.6.3 going beyond theory of mind to higher levels of mentalising

"**If theory of mind**", one view of this is that a positive feedback loop came into play, which drove brain enlargement (Lieberman 2013:121).

The basic idea is that once an individual has taken care of their own body's basic needs, any surplus energy can be "spent" in four different ways: (1) to grow further, if they are young; (2) to store as fat; (3) to be more physically active; or (4) to raise more offspring. The Oldowan hominins would benefit by investing their surplus energy in "*fewer, better-quality offspring by extending their development so they can grow larger brains*" (Lieberman 2013:121). These bigger-brained offspring would be capable of learning more complex cognitive and social behaviours, and so become better hunter-gatherers, who will generate even bigger surpluses of energy and resources.

This section outlines some plausible selection pressures that would favour the evolution of hominins' cognitive abilities beyond basic theory of mind.

the cognitive demands of hunting

"***an intensely social activity***", Sterelny 2007:725.

"**Thus, there is an evolutionary selection pressure**", considering modern hunter/gatherer societies, Andrew Whiten suggests that hunting success rests on "*each hunter utilizing a model of his co-hunters' psychology, including states of mind*", such as "*desires, intentions, ignorance, knowledge and belief. This suggests that selection pressures were active with respect to mind-reading*" (Whiten 2000:188). However, we'll see that the cognitive demands of group hunting would drive mentalising beyond theory of mind, or 2nd level mentalising.

"***competent others***" and "***mutual expectations***", Gruneisen 2015:288.

Alice and Bob go hunting

Figure 8.15 gives a comprehensive view of the gazelle hunt, and includes both Alice and Bob, and depicts their mentalising processes in three ways: visually, verbally and as strings of initial letters, to cater for different styles of thinking.

Alice's thoughts about Bob

the selection pressure for higher levels of mentalising – the cull of the dull

"**We can't be sure**", in modern hunting/foraging groups, men take responsibility for hunting and women take responsibility for foraging (Boyd 2012:252).

"***hunting is always dangerous***", Tudge 1996:200.

mentalising and mediation

"**Frans de Waal has estimated**", de Waal (2007:178) gives the following figures: male-male conflict every 5 hours (meaning about 5/day); male-female conflict every 13 hours (about 2/day); and female-female conflict every 100 hours (about one every four days). He suggests that the reason females have far fewer fights than males is "*probably because they work hard to avoid them*" (de Waal 2006:150). While males have many more disputes, about half of them end in a reconciliation, whereas for females the figure is about one in five (de Waal 2006:150). For bonobos, females reconcile far more readily, and males much less so.

"**It's only females**", de Waal 2006:157−159.

"***allows male rivals***", de Waal 2006:158.

"***no male would ignore her***", de Waal 2006:158.

"***All the females obeyed her***", de Waal 2006:79.

"***the entire community***", de Waal 1989:26.

fire and cooking

"***biologically committed***", Wrangham 2012.

"***adapted to eating***", Wrangham 2009:14.

"**Very few humans**", Wrangham 2009:chapter 1, and 2012.

"**There is direct evidence**", Wrangham 2009:85−88, Wrangham 2012, Gowlett 2016.

There is unambiguous evidence, in the form of burned bones and plants, of the use of fire in caves in South Africa around 1 million years ago (Berna 2012).

"**The evidence implies**", Rowlett 2000:198, Schick 2006:23, Gowlett 2013:23, Toth 2018:26.

"**Natural fires, caused by lightning**", Gowlett 2016.

"**Modern savannah chimpanzees**", Pruetz 2010.

"**Natural fires enable fire foraging**", Gowlett 2012:705 and 2016.

"**These casual fires**", Gowlett 2016.

"**The physical evidence**", Wrangham 2009:88, Gowlett 2012:704.

"**Cooked food**", Wrangham 2009:chapter 3, and 2012.

"**They would need less time**", this is the "expensive tissue hypothesis" (Wrangham 2009:112, Schick 2006:23). Neurons need a lot of energy in the form of glucose in order to operate. Nerve tissue requires about 10 times the energy input as normal body tissue, so the average human brain requires about 20% of the body's total food energy intake, even though it is only about 2 % of the total body weight, so that overall, "*every fifth meal is eaten solely to power the brain*" (Wrangham 2009:109). But the gut also requires a lot of energy to function, because it is "*churning, making stomach acid, synthesizing digestive enzymes, or actively transporting digested molecules across the gut wall and into the blood*" (Wrangham 2009:112). An improvement in diet, which reduced the burden on the gut, would make an energy saving that could be used to sustain a larger brain. Wrangham 2009:chapter 5 explains how the enlarging hominin brain can be enabled by an improving diet.

"**The transition**", Wrangham 2009:96.

For non-human primates, the time spent feeding loosely correlates with body mass and tooth size (Organ 2011). If humans fed themselves like these primates, then we would spend about 50% of the day feeding. But we spend only about 5% of the day feeding, and this shows us to be clear evolutionary outliers in terms of feeding time. Trends in body mass and molar size in human ancestors and non-human primates have been taken as supporting the idea that hominins started cooking food around the time that *H. erectus* appeared, which was about 1.9 million years ago (Organ 2011, and see back to figure 8.13).

"**The adaptations for running**", Wrangham 2009:99.

"**It might be that our human ancestors**", Wrangham 2009:102 and 2012:190.

"**Meat is more nutritious**", Lieberman 2009b:12.

"**For example, a chimpanzee can take an hour**", Wrangham 2009:118.

"**Chimpanzees need to spend**", Wrangham 2009:142−144, Lieberman 2009b:11, and Lieberman 2013:48.

So, to get enough nutrition from a wholly fruit diet, a chimpanzee will consume about 1 kilogram of fruit in an hour, then wait for about 2 hours for this to be digested, so that its stomach becomes empty, and it can feed again (Lieberman 2013:48).

"**This disparity is wholly down to cooking**", Wrangham 2009:139−142. In experiments in which chimpanzees and other apes were offered the choice of raw or cooked food, no apes preferred any food raw, and preferred their carrots, potatoes and meat to be cooked. Even chimpanzees of the Tchimpounga population, who had no experience of eating meat, strongly preferred cooked meat over raw meat (Wrangham 2009:90).

"**Cooking would solve this problem**", Wrangham 2009:138 and 142.

"**Furthermore, the fire that was used**", Wrangham 2009:146.

fire and socialising

"**It brings an increased demand**", Gowlett 2012:705.

"**Fire provides protection**", Dunbar 2014a:228, 2014b.

"**This would open up possibilities for social interactions**", Wiessner 2014.

"**… once the subsistence needs …**", Dunbar 2014b, Wiessner 2014.

"**This would ease the constraints**", Dunbar 2014a:228.

"***time structures interactions***", Wiessner 2014:14027.

"**Communal eating**",Dunbar 2014a:195, and 2017c.

"**Evenings around a fire**",Dunbar 2014a:208 and 227, 2014b.

"***charismatic storytellers***", Dunbar 2014b:14014.

mentalising and storytelling – a shared imagined world

"***the capacity to understand***", Dunbar 2020:55.

"***decoupling of mental representation and reality***", Sommer 2007:5.

"***to step back far enough***", Gamble 2011:117.

"**With theory of mind**", with theory of mind we comprehend we each have a limited perspective on reality, and so there may be a greater reality, that is bigger than any of us can perceive. From this it's only a modest step to imagining an all-seeing creator, who lives in another world, and who understands all perspectives.

See the note on the evolution of mentalising (section 8.9).

"***the composition of a modern novel***", Dunbar 1998b:102, the levels of mentalising have been added in square brackets.

"***the eternal triangle of relationships***", Dunbar 1998b:102.

"**As an example of this**", Dunbar 2004:120 and 162.

"**Robin Dunbar makes the point**", Dunbar 2004:162.

Figure 8.18 is based on Dunbar 2004:120 and 162.

8.6.4 a review of the scale of mentalising

8.7 a community of minds

is 5th level mentalising the end of the line?

"**As we ascend the levels in figure 8.19**", figure 8.15 maps the mentalising processes of Alice and Bob about hunting. I attempted to extend this to their dyadic mentalising about Carol, but the full diagram became too complicated. Since Alice's and Bob's mentalising processes are complementary, we can understand the whole just by following Alice, and figure 8.19 does this.

the "cognitive zip" binding Alice and Bob together

But it's worthwhile looking at the pattern of interlocking mental states in Alice and Bob, and this is shown in figure 8.22. To construct this mentalising diagram, we first imagine a series of mentalising levels, rising from 1st to 5th, so each level subsumes the ones below. Then we consider the "cognitive dialogue" between Alice and Bob, as each of them strives to comprehend what the other thinks about Carol. This dialogue takes the form of a recursive series of mind-states that starts at the lowest mentalising level, and ascends to ever-higher levels. The figure shows a highly schematic representation of each person's nested mind-states, and focusses on the sequence of mind-state transfers that end up in Alice at the 5th level, which are highlighted in red.

We're interested in how Alice and Bob become bound together through their shared knowledge of Carol's triangle belief. Alice and Bob each *know* (2nd) Carol's triangle *belief* (1st). However, what's important is their *understanding* (3rd) of each other's *knowledge* (2nd) of Carol's triangle *belief* (1st), because this is the basis for their cognitive harmony.

With 3rd level mentalising, Alice *understands* (3rd) Bob's *knowledge* (2nd) of Carol's triangle *belief* (1st), but doesn't comprehend if this is reciprocated.

With 4th level mentalising Bob can *realise* (4th) Alice's *understanding* (3rd) of him.

Then, with 5th level mentalising Alice can be *aware* (5th) of Bob's *realisation* (4th).

So, 3rd level mentalising is the basis of the cognitive accord between Alice and Bob. Ascending one further level enables one-way comprehension, and to achieve two-way, reciprocal comprehension requires ascending two levels. So, when Alice and Bob ascend two levels beyond the 3rd level, they achieve a mutually assured, reciprocal awareness of their understanding of each other's knowledge of Carol's belief. They need go no further than this.

The figure shows the dynamic nature of the cognitive accord between Alice and Bob. Starting at the bottom of the diagram, we can see representations of Carol's triangle belief shuttling between Alice and Bob at successive mentalising levels. The outcome is that the two sequences of mind-states in Alice and Bob become interlocked like the two parts of a "cognitive zip", binding the two individuals together.

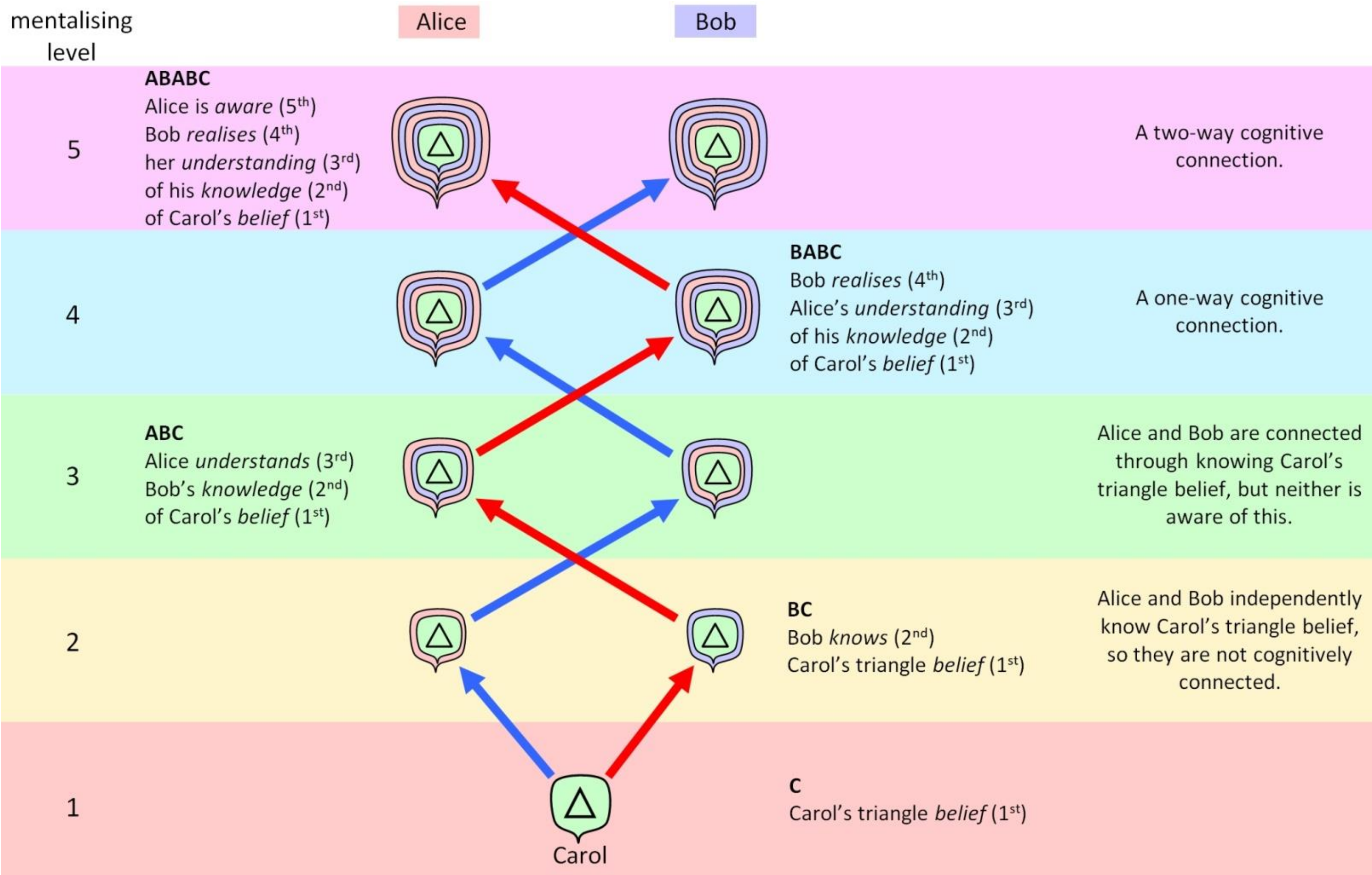


Figure 8.22. The "cognitive zip" that binds Alice and Bob in their shared knowledge of Carol's triangle belief. The mentalising levels are distinguished by the shading, but the colours aren't significant. Alice and Bob's nested mind-states are indicated by colour-coded balloons and by letter strings; Carol's mind-state balloons are coloured green. The arrows mark where one person's mind-state is taken in by another.

an optimal level of mentalising

"***an optimal level of intelligence***", Barrow 2008:chapter 87.

"***evolutionary 'ratchet'***", "***general intellectual standing***" and "***intelligence itself becomes a burden***", Humphrey 1984:22.

"**Every event**", we've seen that over our 6 million years evolution, our ancestors have become adapted for a number of things – to walk upright, to be endurance athletes and hunters, to cook food, and to develop higher mentalising skills.

But Daniel Lieberman points out that the special adaptation of modern humans is, "*our ability to be adaptable because of our extraordinary capacity to communicate, cooperate, think, and invent*" – that is, we have become adapted for culture. "*The pace and scope of cultural evolution now vastly exceeds the pace and scope of biological evolution*" (Lieberman 2013:149 and 150).

This chapter has described how our ancestors attained theory of mind, and has outlined the drivers for their further cognitive development. For an account of humanity's physical evolution to the present day, see Lieberman 2013, and for an account of our cultural evolution, based on shared belief in imagined social orders, otherwise known as history, see Harari 2015.

"**The connections are mediated**", Crystal 2010.

"***reliably cause precise new combinations of ideas***", Pinker 1995:1.

"***collectivism of thought***", Tudge 1996:260.

8.8 review of level 8

"***the local embodiment of a Cosmos***", Sagan 1981:345.

8.9 the evolution of mentalising

This section was written during the summer of 2025, around the time the book was published, so it has been added to the notes on chapter 8.

Its aim is to place the development of mentalising within the context of human evolution.

In section 8.1.2, we saw that someone with theory of mind (ToM) can understand another person's perspective, so they are able to "read" that person's mind, and know what that person is thinking (Dunbar 2004:43). Theory of mind is the ability to hold two mind-states simultaneously, your own and someone else's, and so it is also known as 2nd level mentalising (Dunbar 2004:45). Most children are capable of 2nd level mentalising by the age of 5, and they go on to attain 5th level mentalising in their early teenage years (page 360). Thus, most adults are capable of recursive mentalising, where they can hold the mind-states of other people, nested one within the next, like Russian dolls (figure 8.4).

In the polyadic case, one person holds the mind-states of a number of different people. In this section, we are interested in the dyadic case, where two people hold each other's mind-states, ascending through a series of mentalising levels. The two sequences of mind-states complement each other, like left and right hands.

8.9.1 mentalising is an established human capability

Humans and chimpanzees are descended from a common ancestor who lived around 6 million years ago, and whose cognitive abilities were no better than modern chimpanzees. It is an established fact that chimpanzees are on the threshold of 2nd level mentalising, also known as theory of mind, while the majority of adult humans are capable of 5th level mentalising (page 360). The mentalising abilities of successive hominin species must therefore have increased from 2nd level to 5th level mentalising, as shown in figure 8.13.

An account of the evolution of humans must include theory of mind and the development of higher levels of mentalising, otherwise it's incomplete. But this raises the question – can this cognitive development be seen in the archaeological record?

It's difficult to connect the enduring, inanimate objects found in an archaeological dig to the fleeting thoughts in the "squishy" brains of the people that made them. And so one might conclude that the "*one thing archaeologists know they are* ***never*** *going to find are fossilized examples of friendship, kinship or fifth order intentionality … There simply isn't a stone tool that unequivocally states 'She was my friend', or a burnt animal bone that allows us to reconstruct some precise social reasoning such as 'His intention in cooking a steak was to make her believe he loved her for her mind.'*" (Gamble 2014:61). Put like this, the idea of seeking evidence for mentalising in the archaeological record would seem to be quite unrealistic, even fatuous. However, the essence of mentalising is reading someone else's mind, so it is the basis of shared thinking, leading to shared actions that can have consequences in the material world.

In this section, we will see that as our ancestors attained ever-higher mentalising levels, they became capable of increasingly sophisticated shared thinking, and this enabled new cooperative behaviours that left enduring material remains.

8.9.2 culture, cognitive communities, and theory of mind

Mark Pagel outlines the parallels between biology and culture: "*just as genetical evolution brings together the sets of genes that produce a successful biological species or vehicle for a particular environment, cultural evolution brings together the sets of ideas, technologies, dispositions, beliefs, and skills that over the millennia have produced successful societies, good at competing with others like them, and well adapted culturally to their particular locale. These are our cultural survival vehicles, and it is important to see them as not different in principle from biological vehicles, it is just that the information on which they are based takes a different form: it resides in our minds rather than in our genes. … social learning is to ideas what natural selection is to genes*" (Pagel 2013:47 and 46).

Definitions of human culture commonly focus on information, and teaching and learning, as shown by these three examples: (1) "*information acquired by individuals through imitation, teaching, and other forms of social learning*" (Boyd 2012:378), (2) "*the full complement of characteristics passed between generations, mainly by active teaching*" (Moffett 2019:82), and (3) "*the large body of practices, techniques, heuristics, tools, motivations, values, and beliefs that we all acquire while growing up, mostly by learning from other people*" (Henrich 2016:3).

Michael Tomasello emphasises the cooperative human behaviour that underlies this, so "*Human culture is the form of social organization that arose in the human lineage in response to specific adaptive challenges. Its most distinctive characteristic is its high degree (and new forms) of cooperation. … The outcome is that virtually all of humans' most remarkable achievements … are based on the ways in which individuals are able to coordinate with one another cooperatively, both in the moment and over cultural-historical time*" (Tomasello 2019:3 and 4). So, human culture comprises "*the skills and motivations of collective intentionality*" (Tomasello 2019:10).

We can see that human culture is created and sustained by minds that function cooperatively, that is, by shared cognition, and this, in turn, is based on theory of mind (section 8.1.1). So, to try to understand human culture and sociality without including theory of mind and higher levels of mentalising would seem to be like trying to understand the solar system without mentioning gravity.

8.10 the mentalising basis of a cognitive community

Sections 8.1 and 8.2 briefly describe the hierarchy of mentalising levels, and sections 8.6.2 and 8.6.3 outline the development of successively higher mentalising levels by our hominin ancestors. In this section, I'll sketch out how successive levels of mentalising can enable and sustain a cognitive community that is bound by shared beliefs, and this will give us some idea of what sort of material evidence to look for in the archaeological record.

In section 8.11, I'll outline the archaeological evidence that suggests when our human ancestors attained new mentalising levels.

8.10.1 2nd level mentalising – passing the theory of mind threshold

(a) mentalising level thresholds are fuzzy

It's tempting to see the boundary between mentalising levels as sharp and precise, so you "jump" suddenly from one level to the next. For example, in figure 8.7, we imagine we can "turn on" theory of mind, like switching on a light bulb. But it's been found that theory of mind is not a single cognitive skill, but a suite of distinct skills that children acquire as they grow (section 8.1.3). Typically, a child first understands *diverse desires*, then *diverse beliefs*, then *knowledge/ignorance*, next *false beliefs*, and finally they can discriminate *real and apparent emotions*. It takes around 2 years (from about 3 to 5 years old) for an individual child to acquire all of these cognitive skills (Wellman 2011:figure 1 and table 4, which shows a large sample of pre-school children steadily gaining more skills as they grow). Consequently, the 2nd mentalising threshold is intrinsically "fuzzy".

Imagine gathering together a group of young children, all the same age, but with a spread of cognitive abilities, and monitoring their mentalising as they grow. At the age of 3, few children have even the first skill in the theory of mind suite; at the age of 4, a few gifted individuals have most of the skills; and by the age of 5, most of the children have all of them. Then they go on to acquire higher mentalising skills, reaching the 5th level when they are teenagers (section 8.2.4).

If we think of this group of teenagers as a wave, breaking on a sloping cognitive "beach", then we see the wave surge past the 2nd mentalising mark, gradually slow down as it rises up the beach, then finally come to rest, leaving a tide-mark at the 5th mentalising level. If we go back one generation, to the children's parents, we find their cognitive waves also leave a tide-mark at the 5th level, and the same for the children's grandparents also.

But if we go back further, to ever more distant generations, then we find that our ancestors' tide-marks recede down the cognitive beach. More than 3 million years ago, the tide-mark had not reached the 2nd level mentalising level. Then a few cognitively gifted individuals, a tiny fraction of the population, dimly comprehended *diverse desires*, the first of the theory of mind skills. This would be the high point of their cognitive development, so they would reach this state only as mature adults, after a lifetime's experience. Very slowly, over many generations, the fraction of the population that understood *diverse desires* increased, as the cognitive leaders advanced to understand *diverse beliefs*, the second of the theory of mind skills. And so it went on.

As time passed, the mentalising tide-mark advanced up the beach, until, around 2−2½ million years ago, a sufficient fraction of the population had acquired all the theory of mind skills, so they could sustain the complex, mutually dependent Oldowan lifestyle (section 8.6.2). It may be impossible to estimate how long it took hominins to pass the 2nd mentalising threshold, but, on a time-scale measured in millions of years, we probably have to think in terms of tens, or even hundreds of thousands of years, and maybe millions of individual waves breaking on life's cognitive beach (see "*the cull of the dull*" in section 8.6.3).

It seems reasonable to assume that the higher levels of mentalising are also not single cognitive skills, so their thresholds are also "fuzzy", like the theory of mind threshold. We should therefore expect that hominins took some considerable time to pass each of these higher thresholds.

(b) theory of mind and a bigger reality

Someone with theory of mind can distinguish between "*a subjective perspective (appearance, opinion, belief) and an objective perspective (reality, fact, truth)*" (section 8.1.2, and quote from Tomasello 2018:8491). So, they can recognise that while Sally the doll in the Sally-Anne test (figure 8.1) is acting irrationally within the greater objective perspective, she is acting rationally within her own limited, subjective perspective.

Without theory of mind "*the notion of perspective does not arise at all*" (Tomasello 2013:85), and this means that "*there is no possibility of perspective problems, no possibility of a mismatch between a subjective perspective and the objective situation, and no coordinating of different perspectives into new understandings*" (Tomasello 2018:8495).

Possessing ToM enables someone to see that there is a single objective reality, and that each of us has only an incomplete perspective of it. Only someone with ToM can recognise that other people's disparate – even conflicting – subjective points of view can be parts of a greater objective whole, which can be bigger than anyone alone can perceive (Tomasello 2019:75 and 77). With ToM, we can imagine the better outcome arising from cooperation, so we're ready to trade a small individual loss for a bigger shared gain. If one person cheats then they risk losing all the riches gained by cooperation.

(c) theory of mind and attributing agency

In the formal Sally-Anne test, we know that Sally was not present when Anne moved the ball to the box (figure 8.1). With theory of mind, we comprehend Sally's false belief that the ball is still in the basket, and so we know that's where she will look. Consequently, we understand Sally's surprise when she doesn't find her ball there.

But the Sally-Anne test is an artificial situation, in which we see everything that happens, and so we know what Sally's mind-state is. In real social interactions, we don't see everything that has gone before, so there are things we don't know – something is "missing". In these situations, we must use a person's behaviour to imagine what their mind-state might be. With this in mind, let's imagine two variations of the Sally-Anne test in which there's a part of the story that we don't see, so our knowledge is incomplete.

In the 1st variation, we don't see the third part of the story, so we're not aware that Sally has gone away. We assume she has seen Anne moving her ball, and we're surprised when Sally goes to the basket to look for it. There's now a disparity between what we expect and what actually happens, and we realise that we're missing part of the picture. With theory of mind, we know that Sally went to the basket because she believed her ball was there, and so we have to infer that she did not know the ball had been moved.

In the 2nd variation, we don't see the fourth part of the story, so we don't know that Anne has moved the ball. Now, Sally looks in the basket for her ball, as we expect, but we're as surprised as she is when it's not there. Again, we realise we're missing something. We look at Anne, and we wonder why she's giggling behind her hand. Now, we infer that naughty Anne has secretly moved the ball. This explains why Sally looked in the basket, and why Anne is giggling.

In the "normal" Sally-Anne test, we know the whole situation, so we know what Anne has done, and we know Sally has a false belief. From this, we can predict what Sally will do, and there are no surprises. In the 1st and 2nd variations, our information is incomplete, and we're faced with odd or unexpected behaviour from Sally or Anne. Now it's possible that **we** hold a false belief. We have to use the behaviour of Sally and Anne to infer their mind-states, and then work out which bits of the story we've missed.

(d) resolving everyday cognitive differences

Every day, we encounter individuals with experiences and beliefs that are different from our own, so they have different perspectives on things we think we know well. These interactions are like variations on the Sally-Anne test; there are "bits" missing, so things don't "fit" together, and people do things that we don't expect or understand.

Why did *A* do this? Why did *B* say that? In some cases, it may be that the other person has a false or mistaken belief, but we don't know why, and we have to infer a possible cause. In other cases, we may have to accept that we have a false belief, and we have to work out what we have missed that has led us to this state. Dorothy Cheney and Robert Seyfarth have characterised humans as "*intentional systems almost to a fault*" (Cheney 1990:143). Consequently, we're always motivated to look for the pattern of causal connections that can harmonise disparate individual perspectives.

(e) Galilean transformations

This appears to be a cognitive analogue of a Galilean transformation (see the note to section 8.1.2). A Galilean transformation brings disparate observations in different physical reference frames into alignment. In the cognitive analogue, individuals can use theory of mind to bring their different personal perspectives into alignment, so they can come to an objective view of a real event.

(f) attributing agency

With theory of mind, we understand the direct connection between a person's internal beliefs and intentions and their external actions and behaviour. Every action is driven by an intention, so there can be no action without a prior intention.

When someone's behaviour is unexpected or anomalous, then we can think up a "hidden" intention to explain it. So, "*we routinely attribute agency to other people besides ourselves. We understand that other people have intentions like ourselves, and that individuals vary. Hence we devote much of our daily brain activity to understanding other individual people and to monitoring signs from them … in order to predict what some particular individual may do next, and to figure out how we can influence her to behave in a way that we want*" (Diamond 2012:337).

(g) animism – the creation of an imaginary spirit-world

When our ancestors developed theory of mind, they became capable of creating a whole world of imagined beliefs and intentions. They could explain the actions of their fellow hominins by inferring imagined belief states and intentions, as in the Sally-Anne test. But why stop there? Their natural world was full of inexplicable things and events: trees that grew, rivers that flowed, the sun that passed daily across the sky, the moon that swelled and shrank, the storm clouds that produced bolts of lightning and claps of thunder, and illness and death. Every event must have its cause, so what are the causes of these events?

We now have detailed scientific explanations of all these natural events. We understand the biology of plant growth, the gravity-driven dynamics of water flow, the astronomy of our solar system, with its central sun, planets, and moons, the physics of storm clouds, and the medical knowledge of health and mortality. So, it is very hard – perhaps impossible – for us to recreate the state of mind of someone who experiences these things, and has no physical explanations for them at all. Today, we see a fundamental separation between "rational" science and "supernatural" religion, but religion, in its earliest form, "*might have been something closer to the received causal understanding of the* *world rather than "religion" in the carefully articulated and restricted modern sense*" (Pagel 2013:147).

Once our ancestors achieved theory of mind, they found that their intentional approach made sense of the behaviour of their fellow beings, and so they extended it to the natural world around them, and imagined non-physical "spirit-beings" that were "hiding" behind all external events, making things happen.

Thus, a "spirit-world" was brought into existence, which existed only in the minds of the hominins who imagined it. The intentions and actions of the imagined spirit-entities explained the events in the real world. This is discussed in section 8.10.4. This general belief is widespread in the world today, and is known as animism, after the Latin word *anima* meaning "life, soul" (Dunbar 2023:1, Harari 2015:60).

(h) seeing 2nd level mentalising in the archaeological record

In sections 8.1.2 and 8.2.1, we saw that a person with theory of mind, capable of 2nd level mentalising, can comprehend differing and even conflicting individual perspectives and see them as part of a greater whole. Two people with theory of mind can integrate their different individual perspectives to perceive a greater reality. They can then integrate their different actions, each of which may be meaningless on its own, to carry out a complex task, which is beyond their individual capabilities. In section 8.6.2, we were able to use this as a behavioural test for 2nd level mentalising, and conclude that the Oldowan hominins had passed the theory of mind threshold around 2−2½ mya.

8.10.2 3rd level mentalising

With theory of mind, I know what you're thinking about an object like a can of beans (figure 8.7), or an activity like hunting (figure 8.15). But with 3rd level mentalising (section 8.6.4), I can go further and *understand* (3rd) what you *know* (2nd) about my own *beliefs* and *intentions* (1st), or about someone else's beliefs and intentions. I can then mediate in a dispute between you and another person, as shown in figure 8.17. If you and I are both capable of 3rd level mentalising, we can resolve differing perspectives on an inanimate object (figure 8.8). A community with 3rd level mentalising can appreciate stories about simple characters and their beliefs and intentions (although this would require a story-teller working at the 4th level).

This is an important cognitive advance, but I cannot see how it might show up in the archaeological record.

8.10.3 4th level mentalising

To see how 4th level mentalising can show up in the archaeological record, let us first look at how it enables a shared understanding of a symbolic object.

(a) mutual assurance of a shared understanding of a symbol

In section 8.6.3, we saw that when Alice and Bob are capable of 4th level mentalising – two levels higher than theory of mind – they can be mutually assured that their own theory of mind is recognised by the other person. This two-way mental connection enables them to think and act as one cognitive unit when hunting. This is shown visually in figures 8.15 and 8.16.

So, mentalising at the 4th level brings an assurance of mutual understanding between individuals, regarding something that doesn't have its own mind-state. This can be an activity, like hunting, or it can be an object that has a shared meaning or significance.

We're familiar with objects that act as symbols, carrying meanings that are socially significant. For example, a circle of a precious metal, worn on a particular finger, can indicate your marital status, and a strip of fabric tied around the neck can indicate your educational achievement. In common with contemporary traditional societies, we use body decoration and objects as symbols to "*tell well-informed viewers about the wearer's place in kinship networks, their marital status, group affiliations and so forth*", and also to "*express "insider information" that helps unite people or coordinate actions*" (Kuhn 2014:157). Gamble *et al*. characterise an ornament as "*a tool for projecting information about its wearer*" (Gamble 2014:104).

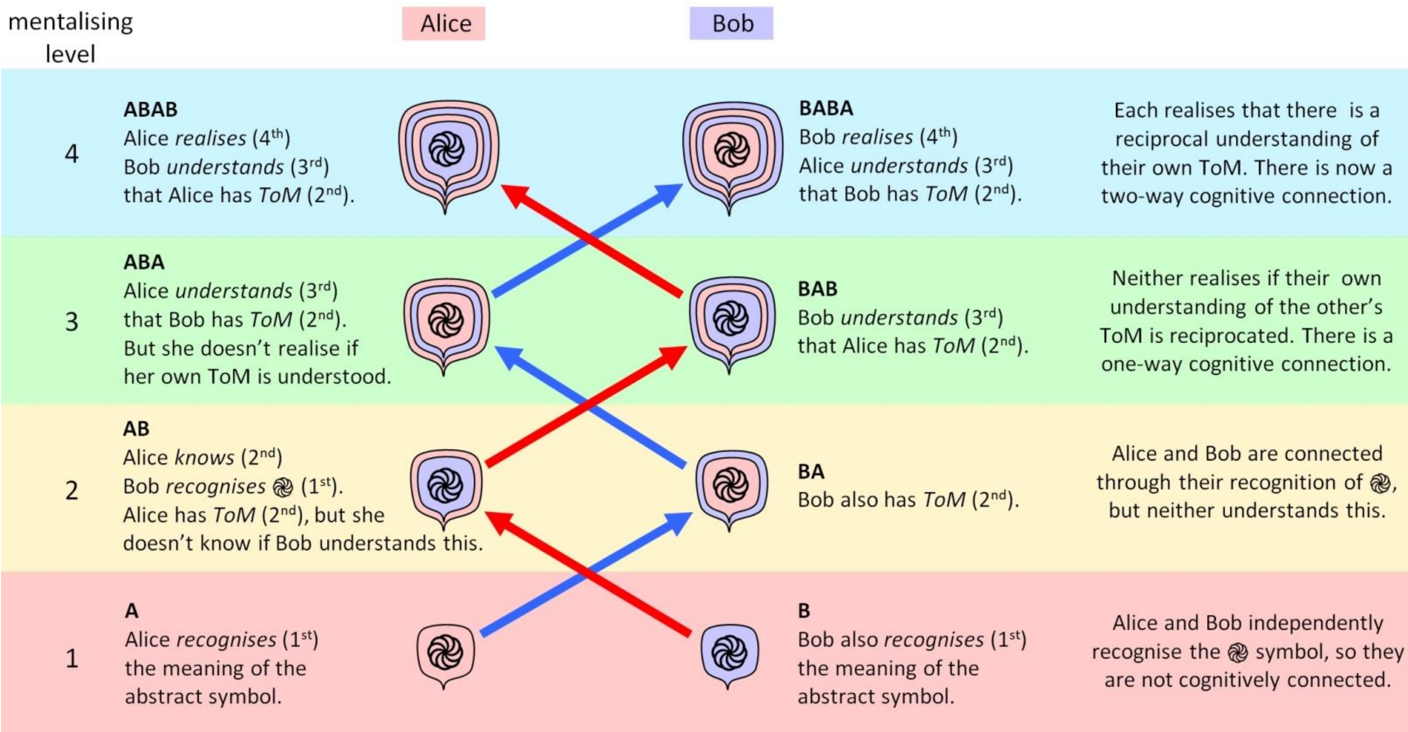


Figure 8.23. The "cognitive zip" that binds Alice and Bob together in their shared understanding of a symbolic object, which carries socially significant information. The mentalising levels are given different colours but there's no significance in the colours. Alice and Bob's nested mind-states are indicated by colour-coded balloons and by letter strings. The arrows mark where each person's mind-state is taken in by the other.

To see how 4th level mentalising enables two people to have a cognitive connection, we construct a recursive, cognitive "dialogue" between them, ascending through successive levels of mentalising. Figure 8.23 shows such a dialogue between Alice and Bob about a symbolic object, shown here as ֍, which carries social information, and which may influence how they respond to a particular situation.

At the 1st level, Alice and Bob separately recognise the meaning of the symbolic object, but neither knows of the other's recognition, so there is no cognitive connection.

At the 2nd level, each knows that the other recognises the object, so each of them has ToM, but neither of them understands this.

At the 3rd level, each of them understands that the other has ToM, but does not realise if this understanding is reciprocated, so there is a one-way cognitive connection.

Finally, at the 4th level, there is the realisation of a reciprocated understanding of each other's ToM, and a two-way cognitive connection. Alice and Bob have had to go two mentalising levels up from 2nd level ToM, but now they are mutually assured of a shared understanding of the symbolic object ֍. They can now use it as a shared social signal, confident that the other fully comprehends its meaning and will respond appropriately.

We can see the recognition of the symbolic meaning of ֍ shuttling between Alice and Bob at successive mentalising levels. This recursive, dyadic interaction binds them together like a "cognitive zip". Alice and Bob can now think and act as one, brought together by their shared understanding of the abstract meaning of a symbolic object.

(b) seeing 4th level mentalising in the archaeological record

How might 4th level mentalising show up in the archaeological record? The particular feature of 4th level mentalising is that it's the first level that brings mutual, reciprocal assurance of shared cognition. This suggests that we don't look at objects, such as stone tools, which show a continuum of use and incremental improvement, and which can be created by a single maker (Mithen 1998, Schick 1995). Instead, we should look for the appearance of a novel artefact, appearing for the first time in the archaeological record, which can only be understood in terms of shared thinking. Also, we're now dealing with higher-level thinking, so this artefact is not so utilitarian, not part of the business of daily material subsistence, such as a stone tool, but is more linked to the interactive cultural life of the group. Robin Dunbar considered a parallel problem, how to recognise the signature of religious belief in the archaeological record, and he came to a similar solution, which is "*to look for phenomena that do not have any obvious functional use*" (Dunbar 2004:187).

8.10.4 5th level mentalising

To see how 5th level mentalising can show up in the archaeological record, we first look at how it enables a shared belief in an imaginary "spirit-world".

(a) mutual assurance of a shared understanding of another person

We've seen that two individuals, who are thinking at the 4th mentalising level, can be assured of a mutual understanding of something that doesn't have its own mind-state, such as an object or a shared activity.

However, when Alice and Bob together consider a third person, Carol, with her own 1st level beliefs, their mentalising must move up one level, and this is shown in figures 8.19 (in the original book) and 8.22 (in these notes). At the 3rd mentalising level, Alice and Bob each understand the other's perspective on Carol, but neither of them realises this. However, by moving up 2 levels to the 5th level, Alice and Bob have a shared, common understanding of Carol, with her own mind-state.

At the 5th mentalising level, these two individuals can be assured of a mutual understanding of another entity, with his or her own beliefs and intentions. This might be a real member of the social group, or it might be an imaginary character in a story, such as Desdemona in Shakespeare's play, "Othello" (figure 8.18), or it might be a being in an imagined spirit-world, as introduced in section 8.10.1(g) in these notes.

(b) mutual assurance of a shared belief in an imagined "spirit-world"

We've seen that with 2nd level mentalising, a person naturally attributes agency to their natural world, and imagines a spirit-world of beings with their own intentions and actions. In this section, we'll see how 5th level mentalising enables two people to be mutually assured that they believe in the same imaginary spirit-world.

We start by imagining two people, Alice and Bob, trying to come to an agreement over the cause of lightning in a storm. To follow their thinking in a mentalising diagram, we first construct a series of mentalising levels, rising from 1st to 5th, so each level subsumes the ones below. Then we consider the "cognitive dialogue" between Alice and Bob, as each of them strives to comprehend what the other is thinking about the lightning. This dialogue takes the form of a recursive series of mind-states that starts at the lowest mentalising level and ascends to ever-higher levels. The spirit-beings exist only in the imaginations of Alice and Bob, so they first appear at the 2nd level, as beliefs in intentional beings.

This process is similar to Alice and Bob coming to a mutually agreed understanding of Carol and her beliefs, which is shown in figures 8.19 and 8.22. However, in that situation, Carol already exists, and Alice and Bob are in fundamental agreement about Carol's triangle belief. Now, Alice and Bob have to imagine the spirit-beings around them, along with their intentions. Because they are working from different perspectives, they imagine different versions of these spirit-beings, so they are in disagreement from the outset, although they don't initially realise this.

First, figure 8.24 describes how Alice and Bob come to understand that they hold different views. Then, figure 8.25 describes how they resolve their differences, and become bound together by a shared view of an imagined god-like being in the storm cloud.

In figure 8.24, Alice and Bob see the thunderstorm, and each has a 1st level response of dread and *fear*.

With 2nd level mentalising, each *imagines* (2nd) a spirit-being inside the storm cloud, who *intends* (1st) to create lightning. However, they imagine different beings. Alice imagines a spear-god (G_S), who hurls lightning, like a spear, down to Earth, while Bob imagines a fire-god (G_F). Alice might wonder what, if anything, Bob imagines to be the cause of lightning, but at this level, she can have no idea. Alice and Bob both have an animistic view of their physical world, but their beliefs are private, and they are not connected by them.

With 3rd level mentalising, Alice can *understand* (3rd) Bob's *imagined* (2nd) view, and she perceives that their views differ. She might wonder if Bob also understands that they hold different views, but at this level, she can't tell. Alice and Bob now understand that they share an animistic view of the world, but their gods are different, and at this level they can't resolve the difference.

To understand why this should be so, consider Alice's position. Alice believes that the spear-god is the one true god of storm clouds, hurling heavenly thunderbolts down to Earth. She is concerned that Bob has got the wrong god for the storm cloud. But at this level, Alice is unable to realise if Bob understands that she believes in a spear-god. At the 3rd level, Alice and Bob are unable to resolve their differing beliefs, because neither of them is able to realise what the other understands about their own belief.

However, with 4th level mentalising, Alice can *realise* (4th) that Bob *understands* (3rd) her *belief* (2nd) in a spear-god in the cloud, and Bob comes to the reciprocal realisation. They realise they are not in accord, but they can now try to reconcile their different beliefs.

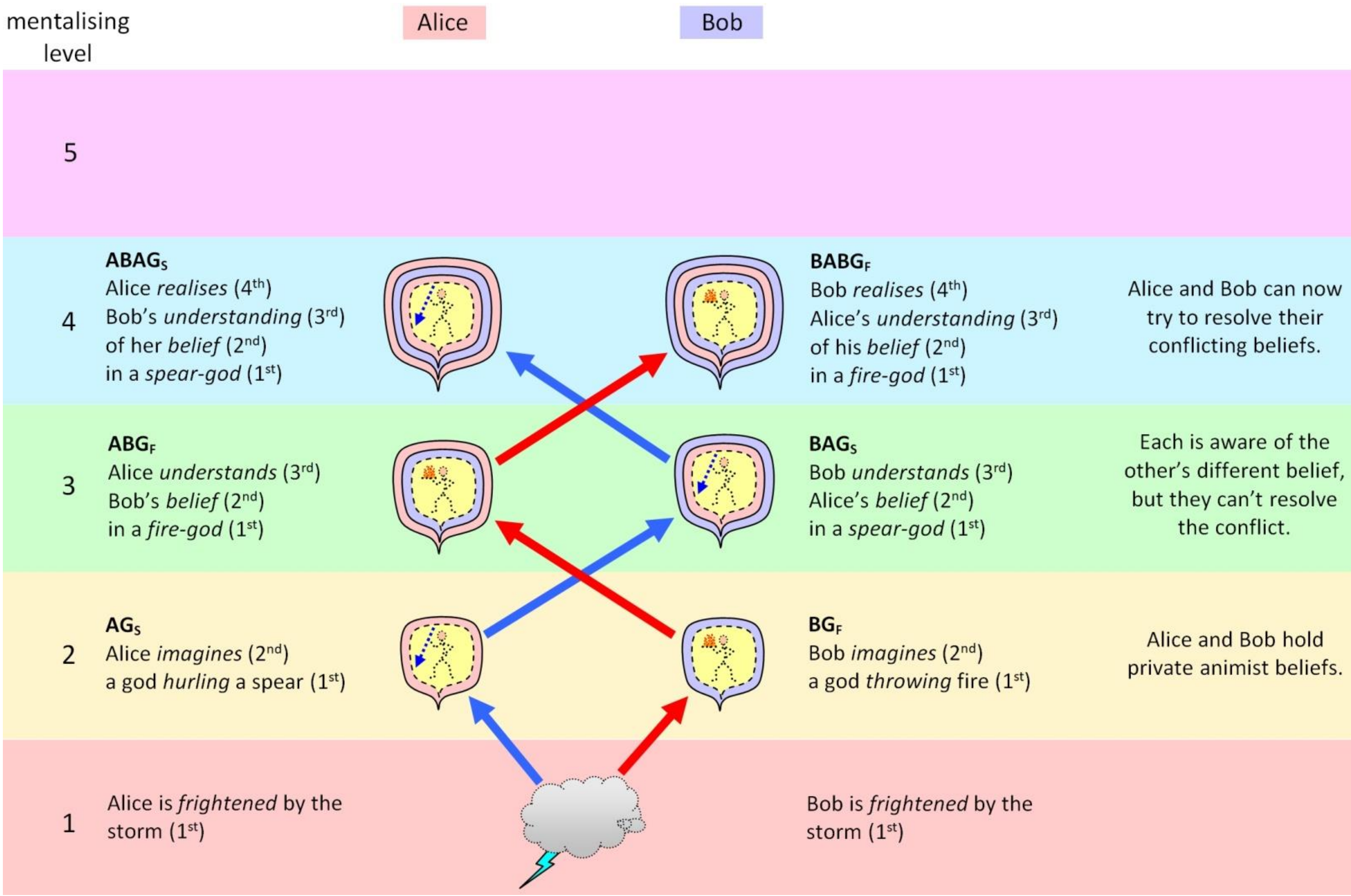


Figure 8.24. Alice and Bob hold conflicting views of the nature of the storm god. The mentalising levels are given different colours but there's no significance in the colours. Alice and Bob's nested mind-states are indicated by colour-coded balloons and by letter strings. The arrows mark where each person's mind-state is taken in by the other. The storm gods are shown as dotted figures within mind-states, which are marked by dashed lines because they are imagined by Alice and Bob. The spear-god is indicated as G_S, and the fire-god is indicated G_F.

It seems obvious to Alice that the fire-god is the god of the volcano – after all, both fire and volcanoes are hot, and make red sparks and smoke. Bob might not accept this argument, and he might maintain his belief in the fire-god in the storm cloud. Alice and Bob could then be driven apart by their different beliefs. They could form rival sects, which could possibly be drawn into physical conflict.

It's possible that Alice and Bob could come into conflict over their differing views earlier, at the 3rd level. Alice might say, "I believe in the one true spear-god, but you believe in a false fire-god. We can't have this", and Bob might reciprocate. However, at the 4th level, the difference becomes sharper, for Alice can now say to Bob, "I realise that you understand that I believe in the one true spear-god, yet you insist on believing in the false fire-god". Either way, we have a situation where two people can come to physical violence over a difference in their beliefs in entities that exist only in their imagination.

However, let us imagine that Bob sees sense in Alice's argument, so he renounces the fire-god, and converts to the belief in the spear-god as the true god of the storm cloud. Both Alice and Bob now believe in the same spear-god (G_S), and so we have a new sequence of mind-states, which are shown in figure 8.25.

Bob has been persuaded by Alice's argument, so at the 2nd mentalising level, they both *believe* (2nd) in the same *spear-hurling* god (1st) of the storm cloud (G_S). Their shared belief exists independent of any particular physical storm, so we can dispense with level 1.

At the 3rd mentalising level, Alice *understands* (3rd) that Bob now *believes* (2nd) in the same spear-god as she does.

At the 4th level, Bob *realises* (4th) that Alice *understands* (3rd) his new *belief* (2nd), and there is a one-way cognitive connection.

Finally, at the 5th level, Alice is *aware* (5th) of Bob's *realisation* (4th), and now there is a two-way connection.

At the 3rd level, each understands the other's belief in the same spear-god. By going 2 levels higher than this, Alice and Bob achieve a mutually assured, reciprocal awareness of their understanding of each other's belief in the same imaginary storm god. We can see the representations of this shared belief shuttling between them at successive mentalising levels. As with their shared understanding of Carol in figure 8.22, their shared belief in the same imagined storm god acts as a "cognitive zip" that binds them together. Whereas their differing beliefs could separate them, and even drive them into conflict, their shared belief brings them together and can sustain them in cooperative ventures that are beyond their individual capabilities.

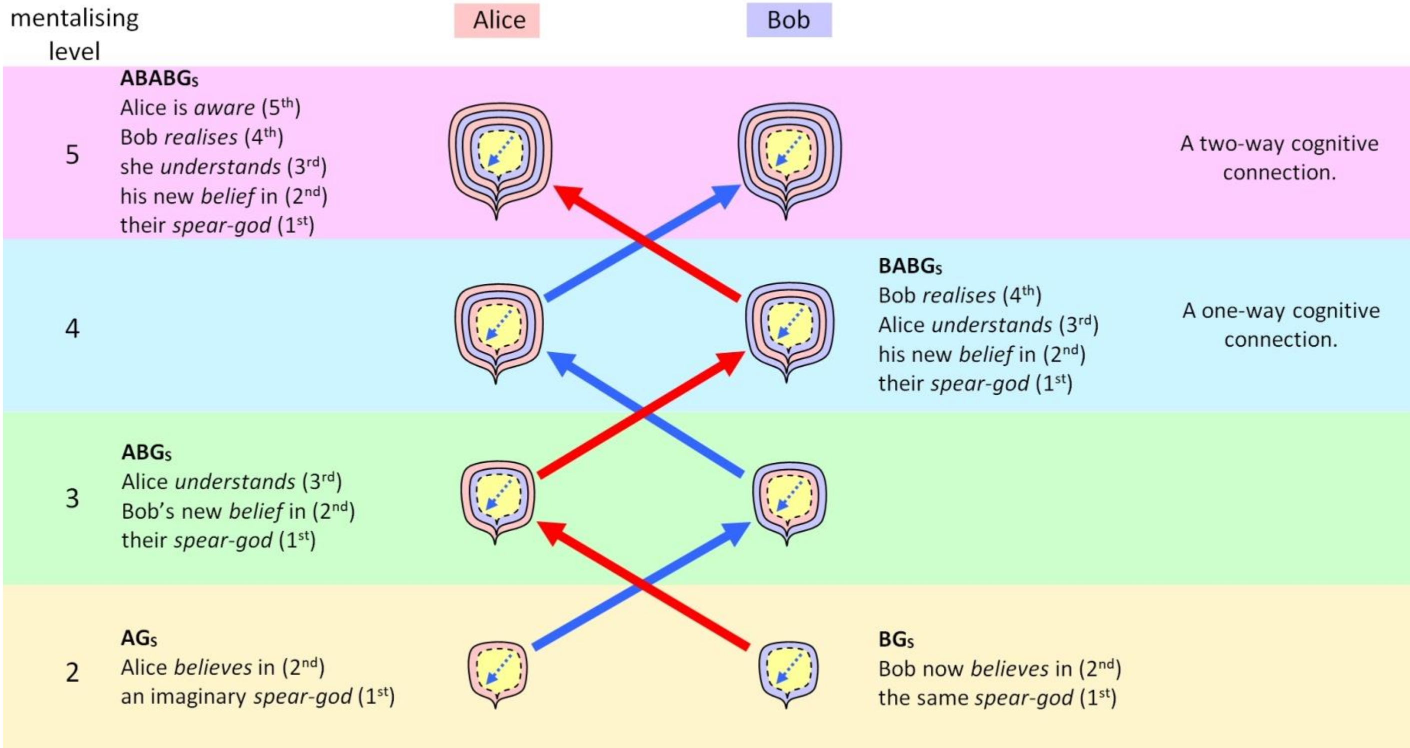


Figure 8.25. Alice and Bob become bound together by their shared belief in the same imaginary storm god (G_S), represented by the dotted spear within the dashed mind-state.

(c) the mentalising basis of religion

Religion "*depends on being able to imagine that there is another spirit world that exists in parallel to the everyday world of experience*". This requires "*formal theory of mind*" and, in addition, "*to make it a religion, you have to be able to talk to others about it*" (all quotes from Gamble 2014:162).

The recursive mentalising sequence in figure 8.25 is the basis of the formal religions that we know today. We can see that 2nd level mentalising is only the start. At the 3rd level, each person understands the other's belief in the spear-god. Then at the 5th level, they are mutually assured of this reciprocal understanding. This is only a dyadic connection between two individuals, Alice and Bob, but each member of the community can form similar dyadic connections with all the other members. This network of dyadic relationships enables the whole community to sustain a shared religion.

Figure 8.25 can be compared with mentalising sequences given by Robin Dunbar, for two people coming to a shared belief in a moralising, interventionist god (Dunbar 2004:185; 2014a:285, table 8.1; 2020:table 1; and 2023:119, table 1). Dunbar's four mentalising sequences, spanning about 20 years, are different from each other, and from figure 8.25. However, he also concludes that 5th level mentalising is necessary for a communal religion based on shared beliefs. Only at this level, "*is it possible to formulate a proposition about God's intentional status that we can both sign up to. At this point, we are both committed to our belief in God's intentions, and so we can have a genuinely communal religion*" (Dunbar 2023:120).

Figure 8.25 only shows the the mentalising level needed for two people to be assured of a shared belief in a supernatural being, who may or may not be a moralising, interventionist agent. This is a long way from organised, formal, doctrinal religions (Diamond 2012:chapter 9, Bellah 2017, Dunbar 2023, Turchin 2023).

(d) seeing 5th level mentalising in the archaeological record

How can beliefs in an imagined spirit-world show up in the material archaeological record? It would seem to be fundamentally impossible. But consider that Alice and Bob are members of a social group who all share a belief in the same imaginary storm god. United by this belief, they are motivated to undertake large-scale and long-term projects. They could, for example, make depictions of their storm god, and they might construct a tall edifice that brings them nearer to the storm god's realm. If they passed their beliefs on to their children, then these projects could be sustained over more than one generation.

And so we can look for two new features appearing in the archaeological record that mark the threshold of 5th level mentalising. First, we look for signs of shared belief in an imagined world. This might be the shared depictions of living things, as they are perceived in an individual's imagination. It might also be a belief in some kind of life after death, where the deceased person now lives in a spirit-world. Second, we look for evidence of a communal engagement in some venture that is not directly related to everyday subsistence, and is large-scale (involving the commitment of all in the social group) and long-term (spanning many generations).

(e) the 2-level rule of mutual understanding

In figure 8.7, both Alice and Bob have theory of mind, so each individual *knows* (2nd level) what the other *thinks* (1st level) about the can of beans. However, for each to be assured that their own theory of mind is understood by the other, they have to go 2 levels up, to 4th level mentalising, as shown in figure 8.9.

Similarly, in figure 8.23, Alice and Bob can each use 2nd level mentalising to know that the other recognises the symbol ֍. But again, they need 4th level mentalising to be mutually assured that they have a shared understanding of the symbol.

When the shared understanding is of a person, then everything must move up a level to accommodate this person's own thoughts and intentions. This is covered in figures 8.8 and 8.10. So, in figure 8.25, Alice and Bob can each use 3rd level mentalising to understand the other's belief in the spear-god. But now they need 5th level mentalising to be mutually assured that they have a shared belief in this imaginary being.

In each case, for mutually assured shared thinking, Alice and Bob have to go up 2 levels from the level at which each reads the other's mind. In general, for two individuals to be mutually assured that each of them is thinking at a particular mentalising level, they both have to move up two levels. This seems to be a fundamental principle; it could be called the 2-level rule of mutual understanding.

Theory of mind and mentalising are not for thinking individually, but are for thinking together. The higher levels can bring individuals the assurance of cognitive alignment, and bind a community together so they think as one. Until a community is capable of a particular mentalising level, there will be types of social interactions, which we may take for granted, that are unimaginable to them.

8.11 *archaeological evidence for the evolution of mentalising*

It's a fact that our hominin ancestors achieved progressively higher levels of mentalising to reach the current level. We've considered how this progress might be revealed in the archaeological record, and in this section, we'll see what this record tells us. I'll follow the approach taken by Steven Mithen, in which we focus less on what happens, but more on "*why things happen – the mental states of the actors. … our interest is not so much with what our Stone Age ancestors did or did not do, as with what their actions tell us about their mentality*" (Mithen 1998:15).

My purpose here is to try to correlate the development of human mentalising with the archaeological record.

This section is summarised in figure 8.42, which gives a timeline for the evolution of human mentalising.

8.11.1 mentalising in the literature

It appears that relatively little attention has been paid to theory of mind and mentalising in the context of human evolution, with Robin Dunbar giving it the most consideration (Dunbar 2004:43, 45, 120, 185, Dunbar 2014a:45, 49 (figure 2.4), Dunbar 2023:112, Mithen 1998:53, 92, 120, Pagel 2013:41, 248, Pettitt 2011, Stringer 2011b:112, 212).

However, some authors (Mithen 1998:120, Pagel 2013:248, Pettitt 2011) seem to have used a different system, favoured by psychologists (see the note to section 8.2.3), which assigns mentalising levels one level below the current system, so the highest level achieved by adult humans is 4 (Dunbar 2003:figure 4).

Robin Dunbar has used brain size data to estimate the mentalising levels of the different hominin species, and from these has suggested rough dates when our ancestors attained the higher mentalising levels (Dunbar 2004:75, 191-figure 6; Dunbar 2014a:242-figure 7.4; Dunbar 2023:168-figure 9). This is considered in the next section, 8.11.2.

The appearance of personal decorative symbols and burial practices in the archaeological record have been taken as indicators of higher levels of mentalising (Pettit 2011, Gamble 2014:chapter 6). Symbols are covered in section 8.11.5, and burials are covered in section 8.11.6(a).

The remains left by the Neolithic communities of south-west Asia have been taken as evidence that they were the first communities that were behaviourally modern (Watkins 2012:38). This is covered in section 8.11.6(d).

Dunbar has also considered how higher levels of mentalising enable formal, communal religion (Dunbar 2004:chapter 7, Dunbar 2014a:chapter 8, Dunbar 2023:chapters 5 and 7).

8.11.2 using brain size to estimate rough dates for attaining higher levels of mentalising

Figure 8.13 shows that over the 2−2½ million years since our human ancestors passed the theory of mind threshold (section 8.6.2), the average brain size has increased from ~500 to ~1,350 cc, and the average mentalising capability has risen from the 2nd to the 5th level. Moreover, the curve becomes steeper, showing that the process of brain enlargement has accelerated with time.

Robin Dunbar has estimated when hominins passed the higher mentalising thresholds, based on a correlation between mentalising level and brain size (Dunbar 2014a:242, figure 7.4, 2020:56, and Dunbar 2023:168, figure 9, and also see the notes on figure 8.13 in section 8.4.6). He proposed that early *Homo*, living ~2 mya, would have been capable of 3rd level mentalising, but 4th level mentalising would not have been achieved before the arrival of archaic humans, living ~500 kya, and that the 5th level was only attained by anatomically modern humans, who appeared ~200 kya.

It's known that chimpanzees, not quite capable of 2nd level mentalising, show "*much individual variation in their degree of insight*" (Gamble 2014:147). Up at the other end of the mentalising scale, modern adult humans range from about the 4th to the 6th levels, that is, level 5±1, with ~80% being capable of 5th level mentalising (see section 8.2.4). We can infer that earlier hominin species also varied in their mentalising abilities. So, "*It is not possible to say that a widespread species such as Homo erectus was capable of third order* [mentalising] *and only ever operated at that level*" (Gamble 2014:147).

It seems reasonable to suppose that hominins living ~500 kya had a distribution similar to modern humans, but 1 level lower, that is, level 4±1. However, if the majority were at the 4th level, then we can say that the hominins of that time had effectively attained 4th level mentalising. We can imagine the proportion of hominins capable of 5th level mentalising would increase over time to become a majority, and this would have happened in the second half of the 500,000 year time period. The ever-steepening curve of brain enlargement suggests a quickening of cognitive evolution, and this implies that hominins passed the 5th level mentalising threshold quite recently – maybe as recently as 100,000 years ago.

So, we cautiously infer that our hominin ancestors had attained 3rd level mentalising sometime between 1 and 2 mya, and by ~500 kya, they had effectively achieved 4th level mentalising, and maybe by ~100 kya they had reached the 5th level.

8.11.3 2nd level mentalising – passing the ToM threshold

Joseph Henrich considers that around 2 mya, our ancestors crossed an "*Evolutionary Rubicon*", and entered "*a regime of cumulative cultural evolution, which has driven human genetic evolution ever since. … The products of cumulative cultural evolution are sufficiently complex that single individuals cannot figure them out in their lifetime*" (Henrich 2016:57, 280 and 288). Once cultural evolution became cumulative, "*both this accumulating body of information and its cultural products, like fire and food-sharing norms, developed as the central driving forces in human genetic evol*ution" (Henrich 2016:317).

We've seen that the archaeological evidence suggests that the Oldowan hominins had attained theory of mind (ToM) 2−2.5 mya (section 8.6.2). This would explain Henrich's Evolutionary Rubicon. With theory of mind, hominins can put their individual perspectives together to make a bigger perspective. They are motivated to share information and expertise, and add to what they already know and can do. This leads to a cumulative cultural evolution.

Figure 8.42(a) shows the theory of mind transition as the first of a series of mentalising transitions that occurred over the following 2 million years or so.

8.11.4 3rd level mentalising

Figure 8.13 suggests that hominins passed the 3rd level mentalising threshold sometime around 1 million years ago (section 8.9.3). However, Steven Mithen summarises hominin evolution between 1.8 mya and 100 kya as "*utter tedium*", in which "*there seem to be hardly any changes in* *material culture*", and the archaeological record "*seems to revolve around an almost limitless number of minor variations on a small set of technical and economic themes*" (Mithen 1998:18 and 131).

Our ancestors must have attained 3rd level mentalising during this time period, but this seems to have left no material traces. Hominins had acquired bigger brains, but "*apparently – superficially – there was very little to foreshadow the huge cultural changes that came with anatomically modern humans within the last 100,000 years*" (Gamble 2014:184).

Figure 8.42(a) shows hominins making the 3rd mentalising level transition, sometime around 1.5 mya.

8.11.5 4th level mentalising

Around 200 kya, a more gracile (slender) and larger-brained form of hominin emerged in Africa, known as Anatomically Modern Humans, or *Homo sapiens* (Dunbar 2014a:217). By ~100 kya, these had replaced the existing archaic humans that had lived there. These were a new human species that "*looked like us and even had our genes but who did not behave like us*", because they had no art, burials, ornaments or musical instruments (Gamble 2014:28 and 15).

In this section, I will follow Steven Mithen, and give our ancestors generic names, according to the time they lived. Before ~100 kya, they were Early Humans; between ~100 kya and very roughly 60 kya, they were Early Modern Humans; and after this time they became Modern Humans (Mithen 1998:130, 171, 207, 222). This is shown in the timeline in figure 8.42(b).

Around 250 kya, Early Humans in Africa started using "*durable material substances and objects as media for signaling*" (Kuhn 2014:156). In this section, we'll look at the evidence of symbolic artefacts being used to convey social messages. This will tell us when our ancestors crossed the threshold to 4th level mentalising.

(a) ochre and pigments

Our planet is rich in the metal iron, which is present in the Earth's crust and becomes oxidised, mostly to haematite (Fe_2O_3), which may be mixed with other minerals. Ochre is the generic term for a mixture of clay and iron oxides and hydroxides, with colours ranging from pale brown to deep red (Henshilwood 2011a, Watts 2002:1). The presence of other minerals can alter the appearance; for example, the mineral specularite is a mixture of iron oxide and mica, which has a dark red or purple colour, and sparkles because of the tiny mica crystals (Barham 2002:183 and 188, Watts 2016:294).

From about 250 kya onwards, ochre starts to appear in human dwelling sites across Africa and the Near East (Barham 2002:181, d'Errico 2008, Henshilwood 2011a, Knight 1995:86, Roebroeks 2012, Stringer 2011b:48, 126, 127). The early occurrences were rare, but around 110 kya, there was an "*explosion in the use of red ochre*", and after this time, "*copious amounts of ochre are ubiquitous in cave rockshelter sites*" (both quotes from Knight 1995:87).

Iron oxide has some utilitarian uses (d'Errico 2011:56), such as in making adhesives to fix stone points to wooden spears (Wadley 2009). One proposal that has received quite a lot of attention is that ochre was used to treat and preserve animal hides, rather than as a coloured pigment (Knight 1995:88). However, this has been dismissed by Ian Watts (Watts 2002:3 and 2009:72), who considers that this was proposed because of scepticism that the hominins of that time were capable of any symbolic behaviour (Watts 2002:10).

The archaeological evidence shows that it was the red-coloured ochres that were preferred (Marean 2007:906, Stringer 2011b:126, Watts 1999:127, 2002:9, and 2009:86). For example, it's typically found that the darkest "blood-red" ochres were more intensively used than paler shades of red (Watts 2009:86). Sparkly specularite, with no known utilitarian value, was also a popular choice, when it was available (Watts 1999:126, 2002:8, and 2016:289). It seems clear that the major uses of ochre were as a pigment, to make patterns of colour (d'Errico 2011:56, Knight 1995:89, Stringer 2011b:126, Watts 1999:128). We can be confident that humans were using ochre to apply colour to something, but whether "*it was their bodies, caves, or some other objects isn't known*" (Pagel 2013:32).

In most cases, the ochre was ground to a powder, usually on some kind of grindstone, as shown in figure 8.26(a) (Watts 2002:8). But a small proportion of ochre pieces are shaped as crayons, with "*small working surfaces, edges, and points, rather than maximising the worked surface area, indicating that some pieces were directly applied to demarcate clearly areas or designs of colour*", as shown in figure 8.26(b) (quote from Knight 1995:87, and also see d'Errico 2008:169).

Figure 8.26. (a) hematite pieces and a grindstone, from experimental simulations (Wadley 2005:figure 1a); (b) a hematite "crayon", about 34 mm long (Watts 2009:plate 4.2).

In one South African cave-site, dated at ~100 kya, the ochre had been ground to a powder and then mixed with other materials, such as charcoal and animal fat, using a seashell as a "palette", as shown in figure 8.27 (Henshilwood 2011a).

Large amounts of ochre could be collected (>60 kg being estimated at one site – Barham 2002:186, and 12 kg of specularite at another – Watts 2002:8), from places that were often far away from the human group's dwelling-site (Barham 2002:187, d'Errico 2008:169, Henshilwood 2011a:222, Rossano 2016:12, Stringer 2011b:126, Watts 1999:119). Grinding the ochre to powder was hard work, and simulation experiments found that it took an hour's vigorous grinding to produce 10 ml – about 2 teaspoons – of usable powder (Wadley 2005:5).

Chris Stringer considers that the occasional use of ochre by the Early Humans, living before ~100 kya, shows "*a low level of symbolic intent, in terms of personal decoration and simple display*" (Stringer 2011b:211). After that, pigment use was an important feature in the lifestyle of the Early Modern Humans, who put significant effort into acquiring and processing the right type of ochre.

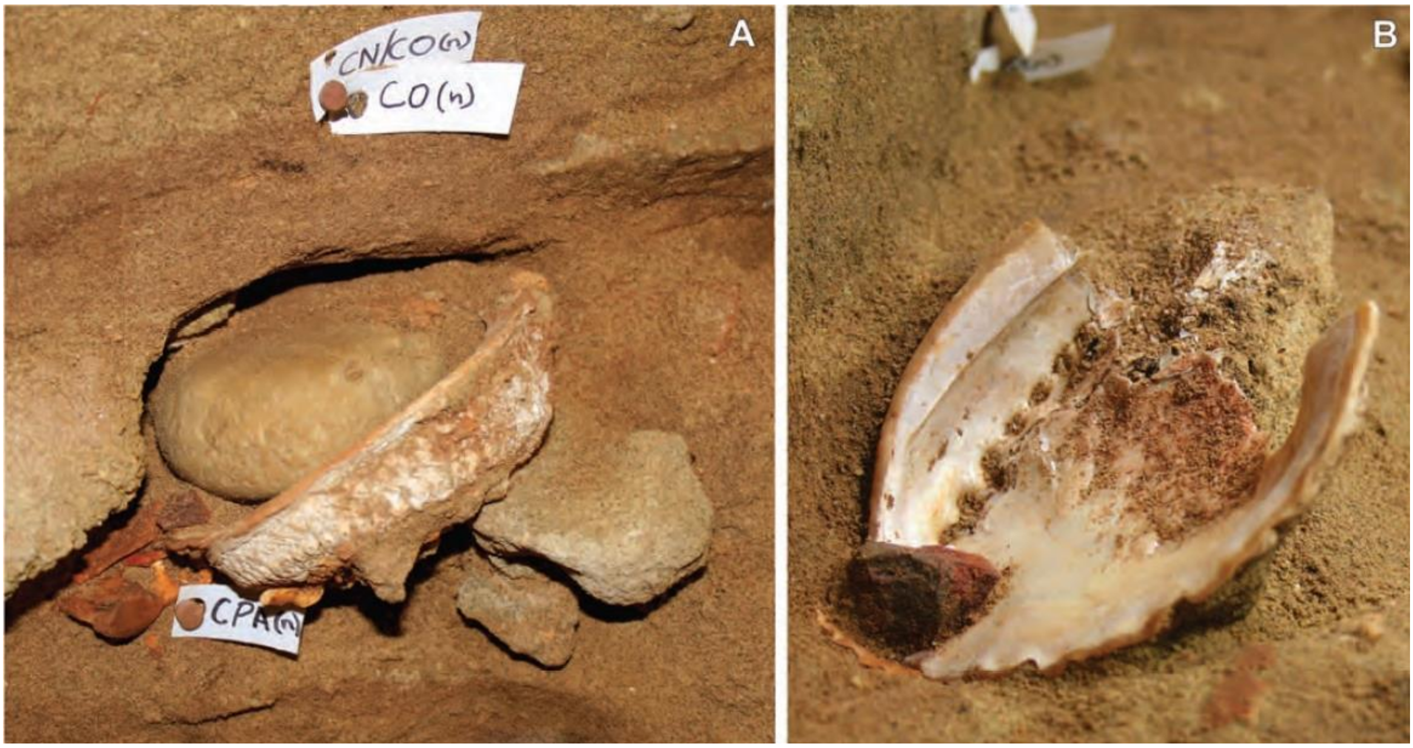


Figure 8.27. Two toolkits for processing ochre, found in Blombos cave, South Africa, last used ~100 kya. (A) shows an abalone shell palette, with a grindstone and pieces of red ochre; (B) shows a second abalone shell, bearing traces of ochre (Henshilwood 2011a-figure 1).

(b) marine shell beads

Around 100 kya, at the time when ochre use was widespread, perforated marine shells started appearing in human dwelling places around the Mediterranean, and also in South Africa – see figure 8.28 (Bar-Yosef Mayer 2015, Henshilwood 2004, Kuhn 2014:158). These shells seem to appear independently in various sites across Africa, the Near East, and Eurasia (Stiner 2014:159).

The most commonly found shells are from the genus *Nassarius*, commonly known as tick shells (Stringer 2011b:128). It's agreed that these tick shells were used as decorative beads: they are consistently perforated in the same way, and some bear marks of wear, compatible with being threaded on some kind of string or thong, and worn as body decoration (Bar-Yosef Mayer 2015:81, Henshilwood 2004, Stringer 2011b:128). They are generally known as shell beads, following the broad definition of a bead as "*any small artifact that is perforated and suitable to be used as adornment*" (Bar-Yosef Mayer 2015:79).

Where ochre might have some material uses, in addition to use as a pigment, we can readily interpret shell beads solely in terms of their "*symbolic, non-practical significance*" (Stringer 2011b:128). They cost nothing to collect, and holes could be simply punched with a stone tool (Stringer 2011b:129).

Figure 8.28. Perforated Nassarius shells (tick shells) used as beads for body adornment, and last worn ~75 kya. The scale bar = 5 mm (Henshilwood 2004:figure 1).

Mediterranean *Nassarius* shells have been found about 200 km from the coast, and this suggests the existence of an extensive social network of exchange or trade, in which shell beads "*had a role in reinforcing social networks as items of exchange within groups, perhaps in gift-giving ceremonies* (Stringer 2011b:129). This, in turn, supports the idea that shell beads played a part in establishing the social identities of individuals and groups (Kuhn 2014:161).

Shell beads differ from pigments in a number of ways. The colour of an ochre pigment is an intrinsic property, and it will transfer its colour to anything it comes in contact with – your fingers, your skin, or your hair. In contrast, an empty marine shell has no particular intrinsic property, and it must be mentally re-purposed to become a symbolic decoration that can serve as a "*personal ornament*" (Kuhn 2014:158). Whereas pigments only make temporary markings on one person, shell beads are permanent objects that transcend a single person, and can be transferred or exchanged between individuals (Kuhn 2014:161).

(c) pigments and shell beads as social signals

It's tempting to dismiss "dressing up" as a rather frivolous aspect of human behaviour, with little significance to the important things in life. But in dressing up, people are saying something about themselves, because their personal decorations are "*conscious or unconscious symbols of group identity, marital status and their roles in society. Equally, the use of such symbols implies that the meaning … would be recognized within their communities*" (Stringer 2011b:95).

Based on the way that traditional societies use personal decorations, we assume that the Early Modern Humans, living after 100 kya, used them to carry "*social information, messages about an individual's identity, affiliations, social roles, and social standing*" (Kuhn 2014:157). So, we need to set aside any artistic or aesthetic considerations, and see that they used pigments and shell beads primarily – maybe wholly – to send social signals, which helped to bind their own community together, and differentiate it from other communities.

sender and receiver

A signal is meaningless if it's not understood by the receiver, and so, when we think about social signals, we must include both the sender/writer and receiver/reader (Godfrey-Smith 2014 and 2017). Consequently, symbols "*only function as such when both a writer and a reader are in accord*" (Pettitt 2011:145). Seen this way, the "*point of marking is not to carry information, but to induce behavioral coordination of some kind*" (Godfrey-Smith 2014:15).

Using a symbolic object to send a social signal only works when it has a mutually agreed meaning for the sender and receiver. The cognitive "dialogue" between Alice and Bob in figure 8.23 shows that this requires 4th level mentalising. At that level, two individuals can exchange meaningful signals, where the sender *realises* (4th) that the receiver *understands* (3rd) that the sender *knows* (2nd) the receiver *recognises* (1st) the signal. This is in accord with Paul Pettitt, who sees a clear link between the use of symbolic decoration and levels of intentionality, so that "*the evolution of the symbolic capacity (although not always accompanied by symbolic expression of that capacity) should have paralleled cognitive evolution*" (Pettitt 2011:154).

Christopher Henshilwood has proposed that a "*symbolically mediated culture is one in which individuals understand that artifacts are imbued with meaning and that these meanings are construed and depend on collectively shared beliefs*" (Henshilwood 2011b:76 and 2011c:368). So, when we see Early Humans start to use symbolic objects, even in a simple way, we can infer that they were taking the first steps in 4th level mentalising. Conversely, the absence of symbolic objects from the archaeological record tells us that humans were not yet capable of 4th level mentalising.

(d) a defining trait

Mark Pagel sees the use of symbols as "*a revolutionary development in our minds because now one object could stand for another or even for a set of ideas, and a symbol's presence acted to communicate those ideas to other people*" (Pagel 2013:32). It seems to be accepted that "*'symbolic capacity' or 'symbolically-mediated behaviour' is a defining – perhaps the defining trait of Homo sapiens*" (Pettitt 2011:142), and so "*the presence or absence of personal ornamentation has become one of the key measures of modernity in the culture-evolutionary record*" (White 2007:287). Sally McBrearty and Alison Brooks consider symbolic behaviour, along with ecology, technology, economy, and social organization, as archaeological signatures of modern humans (McBrearty 2000:492).

(e) a fuzzy threshold

We've seen that the 2nd level mentalising (ToM) threshold is fuzzy (section 8.10.1(a)), and there's no reason to think that the 4th mentalising threshold is any different. Paul Pettitt gives a set of examples that show a progression from simple non-symbolic decoration to "*concept-mediated symbolism*" (Pettitt 2011:148).

The first step is **Decoration**, and is simply for visual effect – "*I wear red because I like red*". In the second step, the decoration is **Enhanced** to bring out a simple message – "*I wear red as I know you will read it as a sign of my strength or be impressed by it*". In the third step, the sender uses **Accessorization** to make a more specific statement – "*I wear red as I know you will recognise it as the regalia of our clan and infer from it that were* [sic] *are culturally the same*". The fourth step uses **Full symbolism** to make a complex message – "*I wear red as, like you, I am a successful hunter and have killed an adult eland; it is my right to wear this colour and I therefore command respect from all*". Finally, a fifth step uses **Time/space-factored symbolism** – "*I wear red only at a specific time, marking the time of year when the ancestors created this land, in honour of the creation myths and to mark out that I am the bearer of this knowledge*" (all quotes from Pettitt 2011:148).

We can be confident that a hominin population approaching the 4th mentalising level would have a spread of mentalising levels, so there would be a minority of "gifted" individuals who were capable of 4th level mentalising. As time went on, this proportion would increase until there was a working majority capable of 4th level mentalising. However, we cannot assume that progress was inevitable, and there must have been relapses in various places and at various times, leading to intermittent developments (McBrearty 2000:458, Pettitt 2011:144). So, we must be prepared for hominins to take some time to pass the threshold to full 4th level mentalising.

A symbol's meaning would only have been apparent to the local people of that time. For example, we can handle the shell beads that were made by the Early Modern Humans, but we have no idea what they meant. Paul Pettitt points out that the only guide to "*the efficiency of a symbol's agency in the past might therefore be an abundance of that symbol, not only on one site, but among several sites of the same broad period*" (Pettitt 2011:145).

The sporadic appearance of ochre pigments before ~100 kya suggests that a minority of Early Humans were capable of basic 4th level mentalising. The common use of pigments after that time is evidence that this had become a "working majority" in Early Modern Humans. The extensive use of shell beads and their long-distance exchange, shows that these hominins had re-purposed these objects as symbols, and were using them to convey more complex social signals.

(f) the origin of "clothing"

Modern humans can carry two species of louse, the head louse that lives in our hair, and the body louse that lives in clothing (Dunbar 2014a:254, Stringer 2011b:161). Body lice can only survive when there is clothing available; this suggests that they evolved as a separate species after humans began wearing clothing regularly. Comparison of the mitochondrial DNA of the two species shows that body lice evolved from head lice, and that the two species have a common ancestor that lived around 100 kya.

We wear clothing for practical reasons, for modesty, and to keep warm, and we choose a style to send social signals that say something about ourselves. But humans living 100 kya in Africa didn't have to keep themselves warm, and we can assume there was no sudden sense of modesty. This was a time when pigment use was well-established, and people were starting to wear shells as body decoration. So, it's reasonable to suppose that they were wearing other materials, such as animal skins, simply to send social signals. This was not "clothing" as we understand it, but another means of enabling social interactions that benefitted communities who were capable of 4th level mentalising.

(g) in conclusion

We can cautiously infer that around 100 kya, Early Humans crossed the 4th level mentalising threshold and became Early Modern Humans.

This date is significantly later than Robin Dunbar's estimate of ~500 kya, based on brain size data (section 8.9.3 and figure 8.13). But it is consistent with Paul Pettitt's proposed 3-step timeline for the emergence of symbolism in Africa (Pettitt 2011:149). In the 1st step, the occasional appearance of pigments before 100 kya represents simple decoration or enhancement. Next, the widespread use of pigments and shell beads after 100 kya suggests Early Modern Humans were using accessorization and full symbolism. Finally, Pettit sees true Time/space-factored symbolism emerging in Africa after ~40 kya.

Steven Mithen points out a major discontinuity in the archaeological record of human evolution. Modern humans, from hunter-gatherers to urban dwellers, all "*use material culture to transmit social information*. … *Yet we have no evidence that Early Humans were doing this: no beads, pendants, or necklaces, or paintings on cave walls. … And a few pieces of red ochre found in Early Human sites in South Africa may imply body* *painting. Yet if they do, then the absence of any actual artefact for body decoration in more than 1.5 million years of prehistory becomes even more bizarre.*" (Mithen 1998:153).

But if we view the evolution of our ancestors in terms of their cognitive development, then we see them ascending from one mentalising level to the next, and becoming capable of behaviours that previously were not just impossible but unimaginable. With only 3rd level mentalising, ochre is just a coloured rock, and tick shells are just litter on the sea shore. It's only when a community attains 4th level mentalising that these objects can be seen in a new light, as symbols with a mutually understood social meaning. Seen from this viewpoint, the absence of body decoration is not bizarre at all, and the appearance of a few pieces of red ochre becomes a momentous event.

The timeline in figure 8.42(b) shows the emergence of Anatomically Modern Humans and the passing of the 4th mentalising level transition, at around 100 kya.

8.11.6 5th level mentalising

With 4th level mentalising, there can be mutual assurance of a shared understanding of an inanimate symbolic object (figure 8.23). With 5th level mentalising, there can be mutual assurance of a shared understanding of an imaginary spirit-world, populated by beings with their own mind-states and intentions, such as the storm god in figure 8.25.

The following sections present archaeological evidence that shows our ancestors' shared imaginary spirit-world becoming increasingly real and concrete. This, I believe, is due to their gradually attaining 5th level mentalising. This evidence comprises: (a) the burial of the dead, (b) cave decorations, and (c) monumental buildings.

In these sections, we'll see the cognitive foundations of what we know as "art" and "religion". However, I will try to avoid these particular words because they have powerful modern meanings for us, which shape and constrain the way we think about these human activities. Instead, we'll see that art and religion have their roots in shared thinking that helped bind social communities together.

(a) the burial of the dead

Since the spirit-world is already the home of the imaginary gods of the real world, it is a small step to see it also as the place where the living go after their deaths. Thus, we can replace the imaginary storm god in figure 8.25 with the imaginary spirit of someone who has died – maybe a parent or a child. Death is no longer the end of an existence, but the transition to another world that exists in the shared imagination of the individuals in the community. The deceased will naturally need material items from their former life to sustain them and to confirm their social status in their new life. So, one of the signs of 5th level mentalising in our ancestors' archaeological record is their mortuary practices – how they treated their dead and how they provided for their new existence.

The remains of dead bodies are a major feature of the archaeological record, but it's only bodies that have been deliberately buried with grave goods that are taken as evidence of a belief in an after-life (Dunbar 2014a:282, 2023:150). Grave goods are objects that can support the deceased's continued life, and can include clothing, tools, weapons, and indicators of social status, and some of these items can be very valuable (Dunbar 2004:187, 2014a:283). The deliberate disposal of items that are valuable to those living in the here-and-now, so as to support the imagined life of a spirit-being, is hard to explain without assuming a belief in a non-material after-life (Dunbar 2014a:282).

a social interaction between the living and the dead

Paul Pettit sees burial practices as revealing the nature of the "*social interaction of the living with the dead*" (Pettitt 2011:150) and suggests four types of burial practices that show increasing levels of engagement (Pettitt 2011:152). The 1st type is just simple **observation** – "*It is dead, I am confused*". In the 2nd type, there is **emotive interaction** – "*It is dead, I am mourning; hide the corpse away from activity*". In the 3rd, there is an **associative (symbolic) interaction** – "*He is dead; he must be disposed of at a recognized place*". Finally, the 4th type is a **time/space-factored associative interaction**, in which the agency of the dead is recognized and mortuary activity is organized in time and space according to social rules – "*He is dead; he was an elder in life and has earned the right to be buried at the place of the elders*".

There are only a few burials dated to before ~40 kya that can be inferred as deliberate, due to the positioning of the body and the presence of items such as red ochre. These burials are simple and rarely associated with grave goods (Dunbar 2023:151, Mithen 1998:153). Here are three examples of very early burials. Skhul cave in Israel has one of the oldest known symbolic burials, dated to 100−115 kya, where an adult male was interred, holding the massive jaw of a wild boar, and accompanied by shell beads and ochre pigments. (Dunbar 2023:152, Stringer 2011b:126). Qafzeh Cave, also in Israel, held a number of bodies, of which at least 4 are seen as deliberately buried between 90−120 kya. One of these burials was a child whose body was covered by huge deer antlers (McBrearty 2000:519, Stringer 2011b:126). Border Cave in South Africa has the possibly deliberate burial of an infant, around 100 kya, who was interred with a pierced seashell that had come from more than 80 km away (Mithen 1998:208, McBrearty 2000:520).

After ~40 kya, burials accompanied by grave goods become increasingly common and elaborate (Dunbar 2014a:283, 2023:xii and 150, Pettitt 2011:157), and the graves found at Sunghir are a well-known example.

Sunghir

At Sunghir, ~200 km East of Moscow, there is a burial complex dated to ~34 kya, in which one grave contains the skeletons of two children, aligned head-to-head, and another grave holds the skeleton of an adult man, which is shown in figure 8.29 (Dunbar 2023:xii, White 1993:288, Mithen 1998:199, Stringer 2011b:101 and 134, Trinkaus 2018).

The bodies were buried with many valuable items of personal decoration, notably beads made from mammoth ivory. The adult had been buried with ~3,000 beads, but the children had been buried with ~5,000 beads each. It takes well over an hour to make a single ivory bead, less than a centimetre across, using contemporary stone tools (White 1993:282), so the beads alone had taken many thousands of hours of skilled and painstaking work to produce (Dunbar 2014a:253). This huge investment in valuable objects tells us that the social community was stratified, with some individuals having higher status than others. Furthermore, the fact that the adult was buried with fewer beads than the pre-teenage children tells us that "*social position was ascribed rather than achieved*" (White 1993:296).

The four burials mentioned above fit Pettitt's 3rd and 4th types of burial practice, and are evidence of a "*concept of death as a transition to a non-physical form*" (Mithen 1998:200). The three cave burials could have been carried out by a few people, or even a single individual. However, the massive commitment of material wealth in the Sunghir burials strongly implies the approval of the whole community. The Sunghir burials tell us that there was a strong and widely-shared belief in an imagined after-life. This suggests that by ~34 kya, 5th level mentalising was becoming fairly well established.

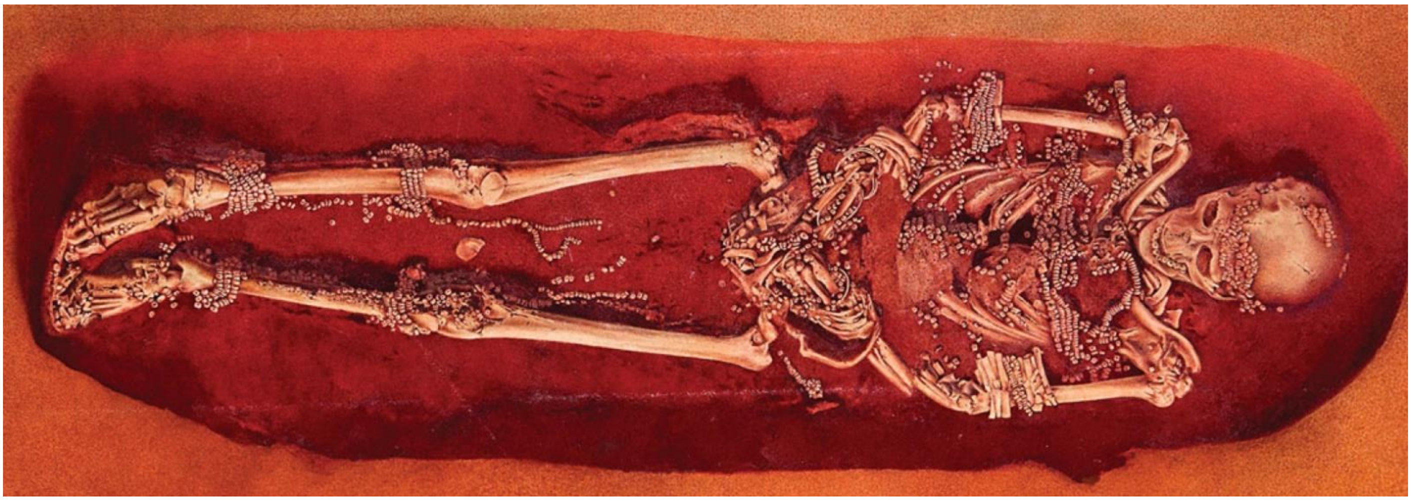


Figure 8.29. The single adult male in Sunghir grave 1. The skeleton is covered in red ochre and bears ~3,000 ivory beads, pierced fox teeth, and ivory arm bands. The arrangement of the beads in multiple strands suggests they were sewn on to fur clothing, which is now perished (Trinkaus 2018, figure 1).

(b) cave decorations – cave "art"

There are about 400 known decorated caves in Europe, dating between about 40−14 kya, most of which are in France and Spain (Assaf 2025:1). This is a small portion of the global record of palaeoart, which goes back further than the earliest European cave art (Bednarik 2008:173).

In this section, I will look at European cave decoration, from the point of view of what it tells us about the emergence of 5th level mentalising in Palaeolithic humans. I'll avoid using the word "art" because of its powerful modern associations, and this will let us see cave decorations as the visual record of a shared, communal activity. So, it's not about whether Palaeolithic humans discovered "art" in the depths of their caves, but how they thought together in the process of making it.

When we think of cave "art", we probably think of the remarkable figurative representations of animals, but the caves also feature very many non-figurative markings, such as patterns of dots, abstract shapes, finger flutings, and images of hands. I'll start by looking at the non-figurative decorations, because these tell us something about the social interactions going on in the caves. In the traditional view, cave decorations were made by a small group of adult male artists, working in seclusion (Rabazo-Rodríguez 2017:375). But the non-figurative markings give us a quite different picture.

footprints

Before we look at the deliberate marks that humans made with their hands, we can consider the marks they made with their feet (Bednarik 2008:177, Assaf 2025:table 1). For example, Chauvet cave has hundreds of human footprints, with one set of tracks extending for nearly 50 metres (Bednarik 2008:177). A study of 11 caves found that relatively few tracks were made by adults, and that the great majority were made by teenagers and young children, some as young as 3 years old (Bednarik 2008:177). Footprints of toddlers, and even babies, have been found in the deepest parts of some caves (Assaf 2025:4).

estimating age and sex from hand marks

We know that hands grow through childhood and adolescence, so we can use this to discriminate between children and adults, but not so readily between males and females. However, the relative dimensions of male and female hands vary significantly and consistently, and this difference is known as sexual dimorphism (Peters 2002, Fernández-Navarro 2025:32).

If you place your hands flat on a table-top, you can readily see the relative lengths of the different fingers on the left and right hands. On each hand, the middle finger (known as F3) is very probably the longest, and it is flanked by the index finger (F2) and the ring finger (F4). The sexual dimorphism is revealed in the relative positions of the tips of these three fingers.

In males, the ring fingertip is consistently ahead of the index fingertip, in both hands. If the fingertips were having a race, then the result for each hand would be: middle, ring, index. However, in females, the index fingertip is generally slightly ahead of the ring fingertip, although there is variation between studies, and between left and right hands. The fingertip race result for females would generally be: middle, index, ring. So, males and females differ in the length of their index fingers, relative to the middle finger, with the index finger being shorter in males than in females (Peters 2002).

There is a slight sexual dimorphism in the measured finger lengths, which is calculated as the ratio of the index finger length to the ring finger length, F2/F4, also known as the Manning index (Manning 2008:xi and 4). In males, the F2/F4 ratio is typically slightly less than 1, while in females it's close to 1. John Manning shows typical male and female hands (Manning 2008: figures 1.1 and 1.2). For the male hands, the F2/F4 ratios are both 0.92, while it is 1.00 for the female right hand and 0.94 for the left hand. The sexual dimorphism is also clearly visible, without measurement, in the very different profiles of the hands.

finger flutings

Finger flutings are lines drawn in the soft clay surface of a cave wall or ceiling, using one or more fingertips, so no pigments are involved (van Gelder 2009, 2010a and b). For some time these markings were ignored, and even omitted from re-drawings of the figurative images (Nowell 2020:585). Flutings are now included in the study of cave art, partly due to a broadening of the definition of "art" in a Paleolithic context, and also because they tell us something about the social interactions of the people of that time (Nowell 2020:585, Assaf 2025).

It's possible to use the widths and proportions of fluting patterns to estimate the ages and sex of the fluters. But this must be done with caution because young children can produce flutings with a range of widths (Sharpe 2006:943, Assaf 2025:6). So, narrow flutings could only have been made by children, but wide flutings could have been made by people of a range of ages. The use of finger flutings to decide age and sex has recently been challenged (Walshe 2024).

Rouffignac Cave, in South-West France, is well known for its depictions of mammoths and has an estimated 500 m^2 of flutings on the walls and ceilings of its many chambers (van Gelder 2009, 2010a). The cave decorations are dated to around 13 kya, based on their style, although they could be older than this (van Gelder 2009:324).

Flutings made by adults and children, both male and female, have been found in every chamber of the cave, even in the furthest extremities, which are a 45 minute walk from the entrance, as shown in figure 8.30 (Williams 2018:223). There seems to be no part of the cave from which the children were excluded, and there are many children's flutings on high ceilings (Cooney 2011).

Leslie van Gelder and Kevin Sharpe examined the widths and proportions of the flutings in the ceiling of chamber A1 of Rouffignac Cave, which can be located in the figure (Sharpe 2006, van Gelder 2009, 2010a, 2010b). They concluded they were made by 32 different individuals, none of whom were adults. Instead, the fluters were teenagers or young children, some estimated to be less than 5 years old. There were small-fingered flutings in places that could only be reached by an adult, suggesting that the small children had been held up high so they could reach the ceiling.

To discover a fluter's sex is more demanding, because you need a fluting with at least 4 fingers, to know if it's a left or right hand, and to determine the relative finger lengths. Further work in the same cave found 7 flutings that were considered to be good enough for this, and it was tentatively concluded that 2 were male and 5 were female (van Gelder 2009).

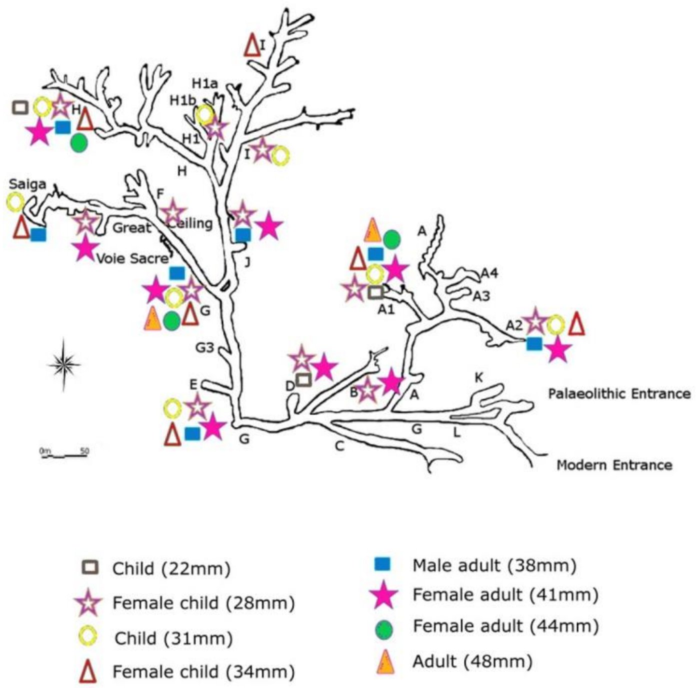


Figure 8.30. A schematic view of Rouffignac Cave in France, showing how flutings by adults and children, both male and female, are found throughout the cave. There is no part of the cave that has only adult flutings (Williams 2018:figure 3a).

In most cases, the flutings are sets of parallel lines, depending on how many fingers were used, following no recognisable pattern, as shown in figure 8.31(a). But in some cases, the fluter has created a recognisable depiction, such as the mammoth shown in figure 8.31(b).

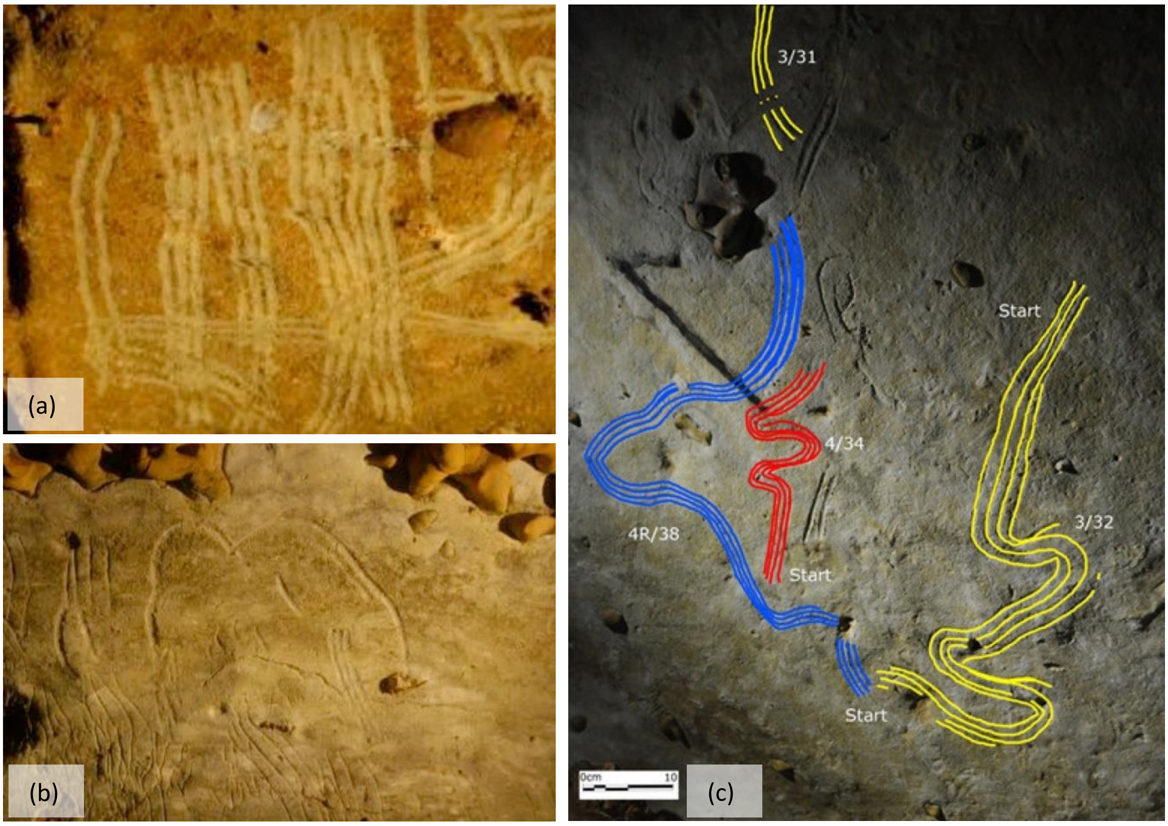


Figure 8.31. Three images of fluting patterns in Rouffignac Cave: (a) a cluster of 3-finger flutings made by a child (Gelder 2010a, figure 6); (b) a finger-fluted image of a mammoth (Gelder 2010b, figure 3); (c) a fluting pattern made by two children (highlighted yellow and red) and an adult (highlighted blue) (Willliams 2018:figure 7). This fluting pattern is also shown in Nowell 2020:figure 2.

The fluting pattern in figure 8.31(c) appears to have been made by three people, who are identified by the widths and patterns of their markings (Williams 2018:227 and figure 7). Two of them have been identified as children, with fluting widths of 31–34 mm, and the third is an adult, with a fluting width of 38 mm. Some researchers have considered this to be a composite image, with the blue and red flutings representing a saiga antelope, a species that was widespread across the Eurasian steppe (https://en.wikipedia.org/wiki/Saiga_antelope). The location of this image is marked by "Saiga" in figure 8.30.

hand stencils

A hand image can be a positive hand print, made by pressing a pigment-coated hand on to a cave wall. Alternatively, it can be a hand stencil, which is made by placing the hand against the cave wall and blowing pigment at it, to create a negative image (Snow 2006:390, García-Diez 2015:3, Rabazo-Rodríguez 2017:375). Nearly 60 European caves, mostly in southern France and northern Spain, have nearly 800 hand motifs, with the great majority being negative stencil images (Fernández-Navarro 2022:3 and 2025:7, Assaf 2025:4).

Figure 8.32 shows a drawing of the "Panel of the Hands" in El Castillo Cave in northern Spain, which bears many hand stencils, some dots, and the partial outlines of bison. The great majority of the stencils are of the left hand, probably because the dominant right hand was holding the pigment (Fernández-Navarro 2025:6). The outlined part of this panel is shown in figure 8.33(a).

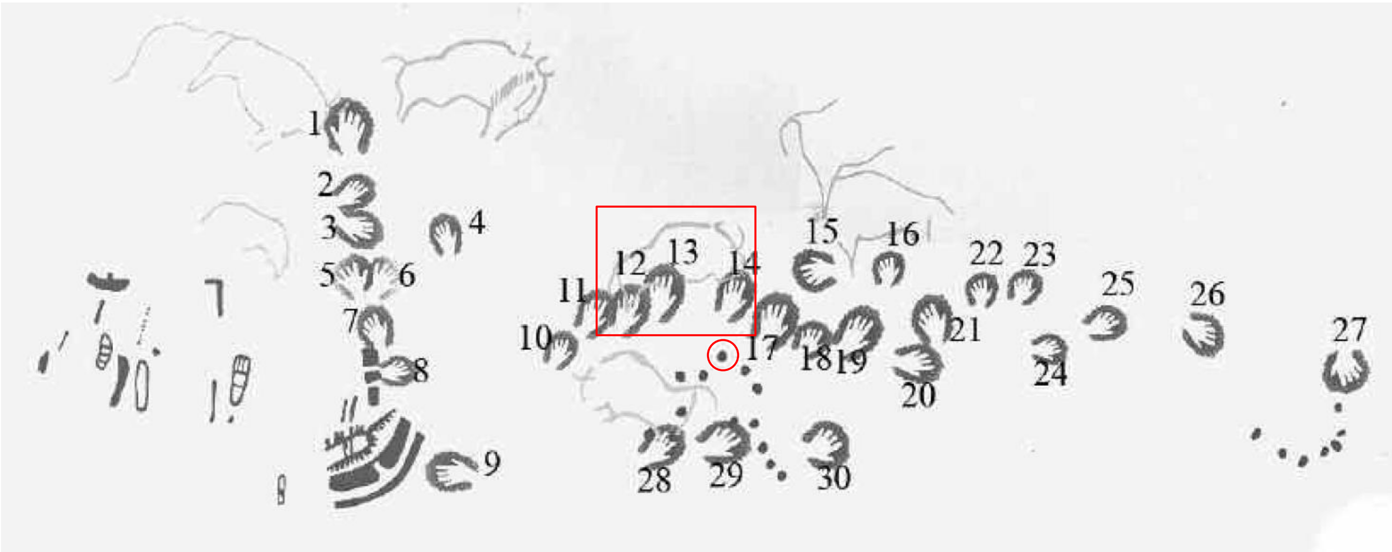


Figure 8.32. A drawing of the "Panel of the Hands" in El Castillo Cave in northern Spain, showing dots, hand stencils, and outlines of bison (Snow 2013: figure 4). The red rectangle and circle have been added. Hand stencil 12 was made more than 37,000 years ago, and the other stencils are probably of a similar age; the dot circled in red is at least ~41,000 years old (Pike 2012:figure 5 and table 1). The part of the panel in the red rectangle is also shown in figure 8.33(a). Pike 2012:figure 5 shows a drawing of the same panel, in which Hand 12 = Hand O-82, and the circled dot = O-83.

hand stencils can indicate age and sex

The dimensions of a hand stencil can tell us something about the age and sex of its owner (Snow 2013, Rabazo-Rodríguez 2017, Fernández-Navarro 2022 and 2025). Figure 8.33(b) shows the stencil of a Palaeolithic left hand, and how the lengths of the hand and index and ring fingers are measured. Only some hand stencils are good enough for accurate measurements (Fernández-Navarro 2022:table 1 and 2025:table 2), and even with these, there is some uncertainty in the interpretation.

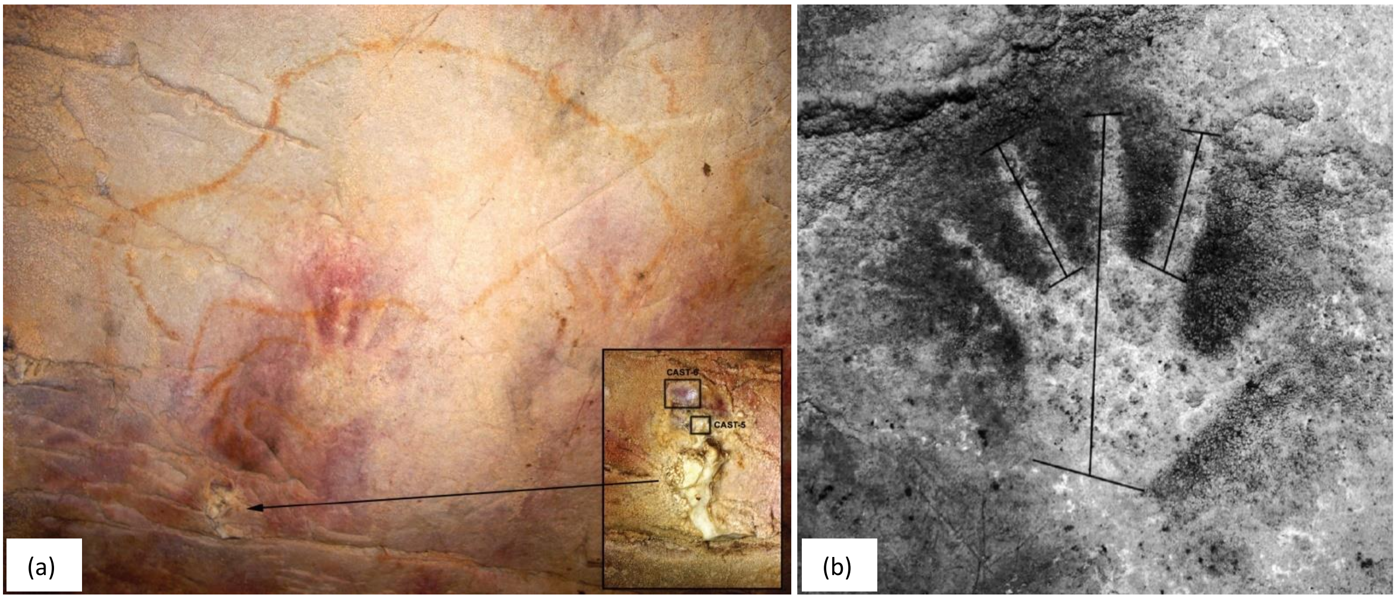


Figure 8.33. (a) a photograph of part of the "Panel of the Hands" in El Castillo Cave (García-Diez 2015: figure 3A), which shows hands 12 and 13 and the bison outline that can be seen in figure 8.32. Hand 13 can be seen fairly clearly, but Hand 12 is very faint. The minimum age of Hand 12 has been determined from the flowstone growth, which is shown in the inset box; (b) an image of a hand stencil of a Palaeolithic left hand, showing how measurements are made of the lengths of the hand and the index and ring fingers (Rabazo-Rodríguez 2017:figure 3).

demographics

Studies of hand stencils in French and Spanish caves indicate that they were made by both males and females, with ages ranging from very young children to adults (Snow 2013, Rabazo-Rodríguez 2017, Fernández-Navarro 2022 and 2025). The male:female ratio varies between studies, from about 1:3 (Snow 2013), through about 1:1 (Rabazo-Rodríguez 2017), to about 2:1 (Fernández-Navarro 2025). Overall, it would seem that males and females are fairly equally represented in their hand stencils.

Studies of eight Spanish caves found the male:female ratio and age distribution varied between caves (Fernández-Navarro 2022 and 2025). Males were generally, but not always, in the majority. The great majority of stencils (~85%) were made by mature individuals (taken as >12 years old) of both sexes, but the hands of children, and even of infants, appeared in most caves. A greater presence of female hands in a cave seems to be associated with a greater presence of children under 12 years old (Fernández-Navarro 2025:figure 5).

dates of hand stencils

Hand stencils are non-figurative, anatomical images, so these, along with the dots and circles, can't be dated by stylistic analysis (García-Diez 2015:11). Hand stencils are usually made either with black carbon or red iron oxide. The ages of black carbon stencils can be estimated using radiocarbon dating, but this is not possible with the red stencils (García-Diez 2015:5). However, in some of the caves bearing hand stencils, calcite flowstone growths have formed, and these can be dated from the radioactive decay of the uranium-series isotopes they contain (Pike 2012). In some places, a flowstone growth has formed over a particular image, and this allows us to estimate the minimum age of that image. For example, the red dot marked in figure 8.32 is at least ~41,000 years old, and hand stencil 12 is more than ~37,000 years old (Pike 2012:table 1). Because the stencils are similar to each other, and all close together, it has been inferred that they were all made around the same time, before ~37 kya (García-Diez 2015:5). The bison outline that overlays hand 12 is dated to ~28 kya, based on its style (García-Diez 2015:5), and this is consistent with it overlaying hand 12.

a succession of events

For the very small part of El Castillo Cave marked in figure 8.32, we can imagine that some time before about 41,000 years ago, someone made the red dot on the cave wall, and they perhaps made some other dots as well. Then, maybe about 4,000 years later, someone else made hand stencil number 12. They were possibly in a mixed group of males and females, with a range of ages, who possibly made some other hand prints as well. Maybe about 9,000 years after that, someone else drew the bison outline over hands 12, 13, and 14. It's possible that this person was also in a mixed group, but, unlike flutings and stencils, figurative drawings don't give personal information about their makers (Williams 2018:219).

socially binding activities

Taken together, the footprints, the flutings, and the hand stencils are strong evidence that the decorated European caves were social spaces, accessible to all members of the community – males and females, adults and children, even infants. Cave decoration was a social activity, in which all were eligible to participate and collaborate, and no one was excluded (Assaf 2025:3, Fernández-Navarro 2022:8). Each individual was "*contributing to communal, social and creative acts*", which were all part of a "*community of practice*" (Williams 2018:234). The involvement of everyone has been seen as suggesting that cave decoration was "*connected with an aim of group cohesion and reaffirmation through art, fostering unity, and collective identity*", and also serving as a "*means to transmit knowledge, traditions, and cultural values from generation to generation*" (Fernández-Navarro 2022:9, and quotes from 2025:17).

Thus, we can see non-figurative "art" – flutings and hand stencils – as activities and creations that helped to bind the community together, so they could think and function as one "social organism".

Figure 8.34. A large panel in Chauvet cave, showing a variety of animals. Image from http://www.ancient-wisdom.com/francechauvet.htm with permission.

representational art

We come, finally, to representational art, taking a large wall panel from Chauvet Cave as an example (figure 8.34). Now we can admire the artistry and make stylistic comparisons and inferences, but we can say nothing about the individual artists. However, if we take the representational art as following on seamlessly from the flutings and hand stencils, then we infer that the animals in the panel shown in the figure were not secret or hidden creations, but were open for all to see and share.

If we set artistic considerations to one side, we can consider the work in terms of shared cognition. From this viewpoint, we can see that the artists were confident their work would be recognised and understood by others as part of a shared imagined world of living things with their own intentions. This is a sign that they were starting to use 5th level mentalising.

(c) monumental constructions - Göbekli Tepe

We have applied behavioural tests to the archaeological record to locate two transitions in our ancestors' cognitive evolution. First, we concluded that around 2−2½ million years ago, Oldowan hominins passed the theory of mind threshold, and became capable of 2nd level mentalising (section 8.6.2). Then, we concluded that around 100,000 years ago, Early Humans became capable of 4th level mentalising (section 8.11.5).

a behavioural test for 5th level mentalising

Now, we can use the reasoning explained in section 8.10.4(d) to devise a behavioural test for 5th level mentalising – the last stage in our cognitive evolution. Accordingly, we can say that a community using 5th level mentalising will be (1) engaging in large-scale and long-term construction projects, which (2) are not directly related to everyday subsistence, to (3) bring their shared imagined world of intentional beings into everyday existence so all live their daily lives within it.

The humans of Upper Palaeolithic Europe around 40 kya were meeting some of these criteria. Their burial practices are signs of a shared belief in an imagined spirit-world, and their cave art was a long-term exercise in communal imagination that was not directly related to everyday subsistence.

But their cave art was in natural spaces that were dark and hidden away from the everyday world, and could only be seen and shared in special visits. In this final section, we will see how communities created their own "built environments", which brought their shared imagined world into everyday existence. I see this as the sign that humans had made the final step to full 5th level mentalising.

This transition occurred in south-west Asia, also called the Near East, around 12,000 years ago (12 kya), at the end of the Epipalaeolithic-Neolithic transition.

the Epipalaeolithic-Neolithic transition in south-west Asia

The Epipalaeolithic-Neolithic transition in south-west Asia lasted from around 25−10 kya, and marks a profound change in human strategies for settlement and subsistence (Gamble 2014:chapter 7, Watkins 2010a and 2010b, 2012, 2024). The overall transition was from nomadic hunter-gatherers to settled farmers and herders, and the whole "Neolithisation" process lasted around 15,000 years, or 500−600 generations, with a diverse mix of lifestyles co-existing in different places at the same time (Belfer-Cohen 2011, Goring-Morris 2011, Watkins 2024).

This is also called the agricultural revolution (Christian 2018:chapter 8, Gamble 2014:chapter 7, Harari 2015:chapter 5, Mithen 1998:248). It marks a profound shift in the relationship between humans and the natural world. This is where "*Homo sapiens went from plucking the fruit from the tree, to toiling and sowing the ground*" (Klaus Schmidt in Thomas 2022). People had given up grazing from nature's table and were now deciding for themselves what would be on the menu.

Humans were starting to make permanent settlements and live within artificial "*built environments*" (Watkins 2004a:10, 2004b). These were shared by the whole community and were large-scale in space and time, so they are collectively known as "monumental architecture" (Notroff 2014, Watkins 2020). People were creating and living in their own built environment, which embodied their shared imaginary world.

In this final section, we will look at the early Neolithic community of Göbekli Tepe. This community still followed a nomadic lifestyle of hunting and foraging, yet was settled in one place, the hill-top site at Göbekli Tepe, where they constructed a remarkable built environment. We will see that this community passes each part of the behavioural test for 5th level mentalising.

Göbekli Tepe

Göbekli Tepe is situated in south-eastern Turkey, near the border with Syria, and close to the modern city of Şanlıurfa. The Turkish word *tepe* means a knoll or artificial mound (Schmidt 2000:46), and the name *Göbekli Tepe* translates as "Potbelly Hill" (Knitter 2019:72).

The settlement is sited at the highest point of an extended mountain range and is a "*dominating landmark for a distance of more than 20 km*", as shown in figure 8.35 (Schmidt 2000:46). This elevated position enabled the residents to survey the surrounding landscape and monitor the movements of the game animals they hunted (Braun 2018). At the time of the first settlement, the local terrain was a relatively open forest-steppe landscape, bearing stands of pistachio and almond trees, and populated with aurochs (a wild form of cow), wild sheep and goats, and gazelles (Knitter 2019:78, Dietrich 2019:27).

Figure 8.35. Göbekli Tepe seen from the south-east (Tepe Telegrams).

The site's hill-top location is unusual, for Neolithic settlements are typically found near water sources (Dietrich 2019:26). There is a seasonal stream ~3 km away, and springs ~5 km away from the current site, and the local geology does not allow for artesian springs at the site itself (Dietrich 2015:83, 2019:26). Excavations have found pits that may have been cisterns for harvesting water (Dietrich 2015:83, Clare 2020:85, Clare in Curry 2021). These might have provided sufficient water storage during the wet winters, but probably not during the rainless summers (Dietrich 2015:83).

The hill-top site provides a durable limestone that is easily accessible and is highly suitable for building and for sculpting with flint tools. This limestone lies in layers with thicknesses varying between 0.6 and 1.5 metres, so it can be cut into slabs to make monolithic columns, which only need to be transported a short distance to the nearby buildings – at most ~500 metres (Schmidt 2010:241, Banning 2011:622, Dietrich 2016a).

Trevor Watkins points out that the site had a prominent position and easily accessible limestone, but "*the immediate environs are completely unhelpful for supporting a permanently settled community*" (Watkins 2017:133). Oliver Dietrich has described the site's location as "*hostile to settlement*" (Dietrich 2016d). This supported the initial view of Göbekli Tepe as a purely ritual site (Banning 2023:2), but modern findings suggest that it was a "*settlement site with a focus on hunting*" (Braun 2018, and see also Çelik 2022:150). The region around Göbekli Tepe had "*a significantly richer and more productive natural environment than arid regions to the south … This encouraged people to establish permanent settlements and liberated them from mere dietary concerns. Their newfound freedom allowed them to focus on endeavors beyond sustenance and shelter and on what we might define as true artistic pursuits*." (Özdoğan in Ildun 2024).

The first constructions at Göbekli Tepe date from ~11.5 kya, in the Early Neolithic period, and the site was occupied for ~1,500 years until ~10 kya (Dietrich 2013:37 and figure 2, Knitter 2019:2, Clare 2019:528, 2020:81, Breuers 2022:472, Tepe telegrams). This is shown in the timeline in figure 8.42(c).

a community engaged in long-term collaborative construction …

Figure 8.36 shows a view of part of the archaeological site, showing four of the large enclosures with T-shaped pillars that were named in the order of their discovery (Schmidt 2010:figure 3, Dietrich 2012:figure 2, Notroff 2016, Tepe Telegrams).

From the first excavations in 1994, Göbekli Tepe presented a "*great paradox*" because the large special buildings, with their giant megalithic pillars, were constructed by communities that were still living as hunters and foragers (Clare 2020:82, and quote from Clare 2024:28). No signs of domesticated plant or animal species have been found at the site (Dietrich 2012:684, Clare 2024:7), and the domestic food waste found at the lowest levels tell us that those people were still living as hunter-foragers (Peters 2004:207).

Göbekli Tepe was first seen as a hill-top sanctuary, where people came together to join in religious rituals (Clare 2020:82), but it's now regarded as a residential settlement from the earliest times, with a mix of domestic dwellings and special, communal structures (Braun 2018, Clare 2019:546, Clare 2020:83, Kinzel 2020:32). All we see now is the walled enclosures, open to the sky, but in their time they were "special buildings", reserved for communal use, and possibly roofed over. These special buildings are among oldest megalithic buildings known from the Early Neolithic (Clare 2019:523, 2024:10, Kinzel 2020:30).

Figure 8.37 shows how the site might have appeared around ~11.2 kya, with two large special buildings, surrounded by domestic dwellings that were built on higher ground (Kinzel 2021:23).

The construction of a protective canopy in 2017 required deep foundations, and this gave archaeologists the chance to examine the lowest layers of the site. "*It was like keyhole surgery, going straight down through the deposits. … In deep soundings, we went right down to the natural levels of the mound. … We found middens, fireplaces, hearths, lithics – all smelling very domestic. For me, there was domestic activity from the beginning right to the very end*" (Clare in Curry 2021, and also see Braun 2018). However, unlike Körtik Tepe, no structures for food storage have been found (Dietrich 2019:27).

Figure 8.36. A view of part of the Göbekli Tepe site looking South (Tepe Telegrams). The special buildings were named in order of their discovery. In the foreground is enclosure D; beyond and to the left is enclosure C; to the right of C is enclosure B, and beyond B is A, the most distant. Enclosure D has two central pillars: pillar 18 on the left (east) and pillar 31 on the right (west). This view can be compared with the plan in Clare 2024:figure 4.

Göbekli Tepe is now seen as having eight distinct building phases (described in Kinzel 2020:32, 2021, and shown in Breuers 2022:figure 1 and Clare 2024:figure 4). The special buildings appear to have been in use for centuries, with some being added to more than 500 years after they were started ~11.5 kya (Knitter 2019:73, Kinzel 2020:20, Clare 2020:85). The site was occupied for around 1,500 years, and was continually being renewed and extended (Kinzel 2020:37). There appear to have been two earthquakes and two landslides during this time, which caused structural damage, after which buildings were modified and rebuilt (Kinzel 2024:figure 14).

It's clear that the large special buildings, with their huge pillars, could only have been constructed by many people working together. Initial estimates were that a very large number, perhaps even hundreds, of people would be needed (Schmidt 2005:14 and 2011:53, Banning

2011:623, 632 and 2023:6). However, careful reconstructions tell us that a much smaller number would be adequate. For example, it's been estimated that two dozen adults would be able to sustain themselves from day to day, and also build the dry-stone walls found at the site (Kinzel 2020:37). The pillars in the special buildings are a more demanding proposition (Banning 2011:632, Dietrich 2015:86). They have various heights, and weigh between about 2 and 6 metric tons, while the two central pillars in special building D are the biggest, being ~5.5 m high and weighing ~8 tons each (Tepe Telegrams). It's thought that a team of about 20 adults would be able to move all but the largest pillars (Banning 2011:632, 2023:6). However, it has been estimated that it would take around 30 experienced Neolithic adults working for 4−5 months to cut a single T-pillar from the bedrock (Dietrich 2017:113).

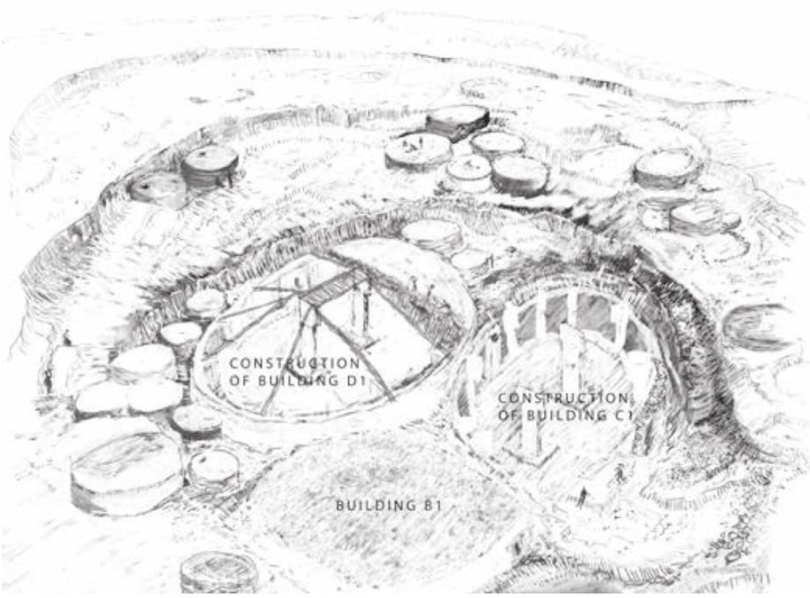


Figure 8.37. A view of Göbekli Tepe around 11.2 kya, seen from the west (Kinzel 2021:figure 10).

Parietal rock art can be created in a short time, and by only a few people, but the construction of the huge special buildings and their monoliths at Göbekli Tepe would have taken a long time, and required the collaboration of very many people, possibly needing the participation of other hunter-gatherer groups (Peters 2004:213, Notroff 2014:97). This "*implies division of labour and involved a considerable number of skilled people. It also implies a large, sedentary, well-organised hierarchical community, willing to invest in the materialization of its complex immaterial world over many generations and at a considerable cost in energy*" (Peters 2004:215).

… not directly related to everyday subsistence …

There are around 20 large structures all over the hill-top site of Göbekli Tepe, named alphabetically in the order of their discovery (Dietrich 2012:675). These structures are typically roughly circular dry-stone-walled enclosures, about 10−20 metres across, with stone benches and pillars in the walls, and two large central T-pillars. Enclosures D and C can be seen in the foreground of figure 8.36, and figure 8.38 shows an aerial view of enclosure C.

When the enclosures were discovered, they were filled with debris, comprising limestone fragments, stone artefacts, such as grind-stones,tools, and animal bones (Schmidt 2010:242, Kinzel 2020:10). At first, it was thought that they had been deliberately decommissioned by back-filling (Schmidt 2010:242, Notroff 2014:85). The practice of decommissioning buildings by demolition, burning or filling in was fairly common in the region at that time (Karul 2021:21). However, it's now thought that at Göbekli Tepe, situated on a sloping hill-side, the buildings were inundated by the slippage of soil and debris from higher ground, perhaps triggered by heavy rain or earthquakes (Kinzel 2020:10 and 19, Clare 2020:86 and 2024:13). It has been suggested that there were a number of "high energy" events during the lifetime of the settlement, caused by slope-slides and seismic activity (Kinzel 2024:32 and figure 14). In figure 8.37, we can see domestic dwellings surrounding and overlooking special buildings C and D, and an impression of a landslide event is shown in Kinzel 2024:figure 16.

Special buildings A−D were "*extremely long-lived structures with elaborate biographies*" (Kinzel 2020:32), and were still being modified around five centuries after their first construction (Clare 2020:85). It's estimated that around 25−30 people could comfortably fit into each of the special buildings, standing in the central area and sitting on the peripheral benches (Clare 2024:23).

Here we'll take a look at building C, shown in figure 8.38. The floor is natural limestone bedrock, which had been carefully levelled and smoothed, and cut away to create low pedestals into which the two central pillars were slotted (Schmidt 2010:243, Kinzel 2021:13, Clare 2024:12). The first wall to be built was the outermost wall, some of which can be seen in the figure. Then, over many centuries, successive building phases worked inwards, constructing new walls, some of which incorporated pillars. In the final phase, after a landslide, the innermost wall was constructed with its built-in pillars and benches (Kinzel 2020:32 and figure 3.2, 2024:figure 14, Clare 2024:figure 4).

Figure 8.38. An aerial view of enclosure C. The compass direction has been added (Schmidt 2010:figure 22).

It appears that the special buildings were not designed to be lived in, for there are no fireplaces or ovens, or any other signs of domestic life (Notroff 2014:93, Dietrich 2019:26). Despite careful searching, archaeologists have found "*no trace of the installations that typify a domestic environment, or of any activities of any kind on their smooth, hard floors*" (Watkins 2017:133, and also see page 138). The enclosures at Göbekli Tepe are evidence of the community investing "*quite unprecedented levels of attention and effort in more and more elaborate and expensive cultural activities that seem to serve no straightforward economic, ecological or ergonomic purpose*" (Watkins 2017:130).

… creating a shared imagined world of intentional beings

It's now thought that the enclosures were roofed over, possibly as shown in figure 8.37, but this conclusion is still tentative (Breuers 2022:473, Banning 2023:6, Clare 2024:23). If they had roofs, then the special buildings would have been places of artificial darkness, and this would have encouraged communal ritual activities. Traditional societies have "day talk" and "night talk", which involve quite different social interactions

(Clare 2024:23, Wiessner 2014, and also see the section "*fire and socialising*" on page 416). Day talk is largely about economic matters and regulating social relations. Night talk draws people into "*virtual communities, whether human or supernatural, via stories and ritual*" (Wiessner 2014:14033).

The inhabitants of Göbekli Tepe projected their shared world of imagined beings onto the sandstone pillars they quarried from the hilltop. Figures 8.39 and 8.40 show a very small selection of what has been found on the pillars, and I'll look at three aspects of these: animals, humans, and abstract symbols.

animals

The people of Göbekli Tepe hunted and ate a wide range of animals; gazelles were by far the most favoured species, followed by aurochs, wild asses, foxes, sheep, and boars (Peters 2004:182 and table 1). They ate very few birds, preferring crows, jackdaws, and cranes (Peters 2004:207 and table 3). They ate hardly any aquatic birds or fish, which is understandable, since running water was so far away.

The pillars in enclosures A−D portray a wide range of recognisable animals, mostly in a naturalistic style (Peters 2004:183 and table 2, Notroff 2017a:figure 4 and 2017b). Enclosure D has the greatest diversity of animals, more than the other three enclosures combined (Peters 2004 table 2). For example, figure 8.39(a) shows a dense assembly of 55 creatures on pillar 56 in enclosure H, which we can call pillar H56 (Dietrich 2016c, and 2017:figure 5.19). We can see outlines of snakes, predatory wild cats, and many water birds, such as ducks and cranes. All are facing outwards from the enclosure, except for one large bird of prey (numbered 15) and a snake (22), which are looking inwards; this may or may not be significant (Dietrich 2016c).

What is significant is that none of these animals were popular choices for eating. A survey of the creatures depicted in enclosures A−D found that snakes are by far the most common species (~28%), followed by foxes (~15%), boars (~9%), and cranes (~6%), with all other species each at <5% (Peters 2004:table 2). Where an animal's sex can be determined, it is always male (Peters 2004:215, Schmidt 2010:245, Tepe Telegrams).

In general, the selection of animals that were portrayed was quite different from the selection of animals that were eaten. For example, gazelles appear most on the menu, but hardly figure on the pillars (~1%), while snakes are everywhere on the pillars, but were not on the menu. Foxes feature quite highly in both lists, and this may be due to them being hunted for their skins, as we shall see later.

So, the creatures on the pillars don't represent the dietary environment of the inhabitants of Göbekli Tepe, but give us a view of their shared symbolic world. In this respect, it may be significant that the incidence of animals in the different enclosures does not appear to be random (Notroff 2017a:figure 4 and 2017b). For example, snakes predominate in enclosure A, and appear in enclosures B and D, but not at all in C. Boars appear in only enclosure C, and arthropods, such as scorpions, appear only in enclosure D. Foxes are the favoured animal for the central pillars of enclosures B, C, and D.

Some pillars bear images of animals alongside abstract images. For example, figure 8.39(b) shows Pillar D43, which bears images of a scorpion and birds, and other abstract images, some of which may be decorative (Dietrich 2016b, Notroff 2016, Schmidt 2010:figure 10).

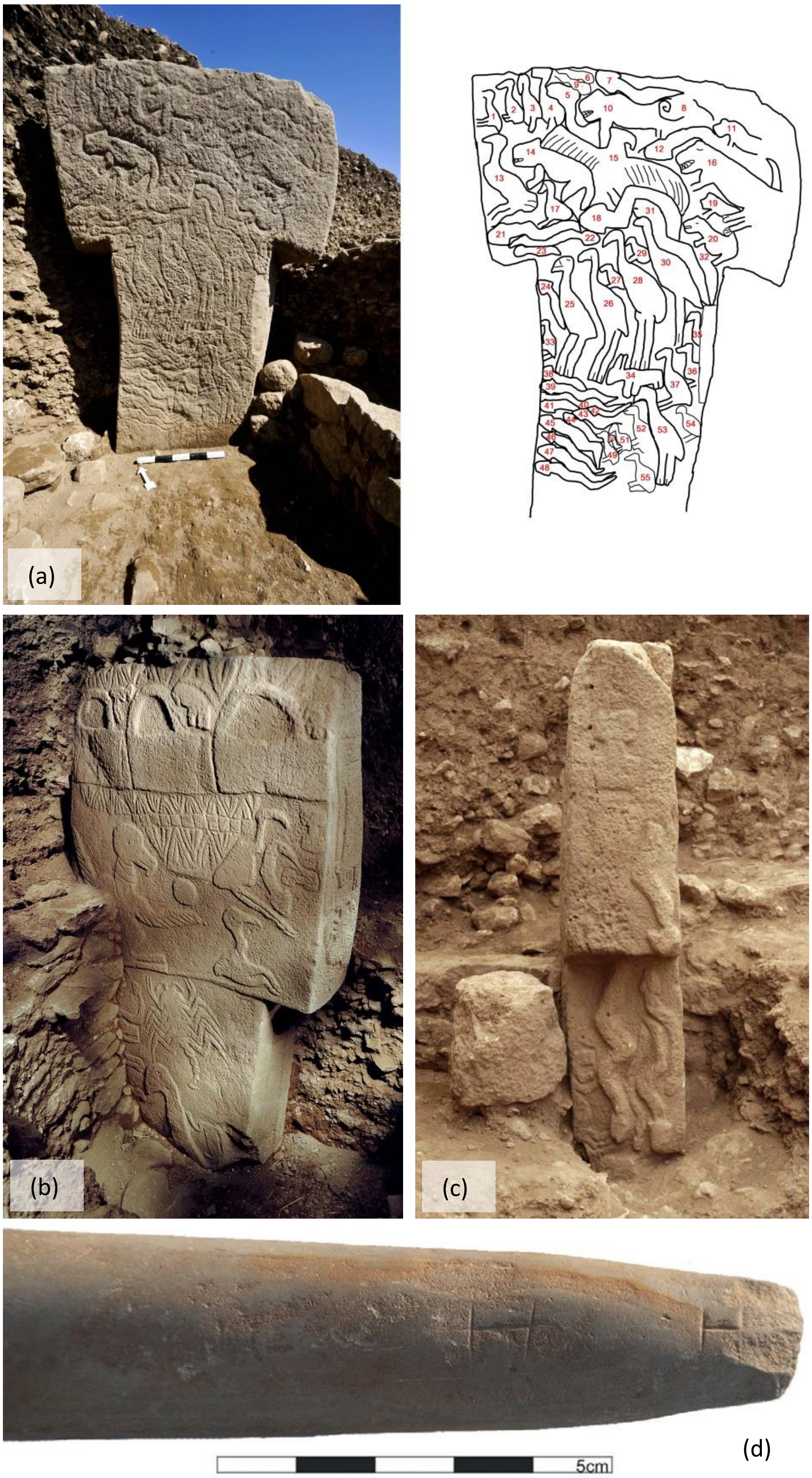


Figure 8.39. Images of animals and abstract symbols on pillars. (a) snakes and birds on pillar H56 (Dietrich 2016c); (b) animals and abstract symbols on pillar D43 (Notroff 2016); (c) an abstract symbol "H" dominates pillar D30 (Notroff 2017c); (d) two "H" symbols on a stone sceptre (Clare 2024, figure 24).

Figure 8.40. The eastern central pillar in enclosure D – pillar D18. (a) a 3D-scan view of the whole pillar (Dietrich 2016e); (b) the front of the pillar, showing the belt buckle and fox skin pelt (Tepe Telegrams); (c) the fox in the crook of the elbow (Schmidt 2010:figure 6); (d) detail of the hands, belt, and buckle (Watkins 2020:figure 2.5); (e) detail of the symbols at the neck (Schmidt 2011:figure 32).

humans

The people of Göbekli Tepe were quite capable of making natural representations of humans, for they made statues and masks (Dietrich 2016d, Notroff 2018). But there are no realistic depictions of humans in enclosures A−C, and only a few on the peripheral pillars of enclosure D. However, the two central pillars in enclosure D appear to be anthropomorphic – stylised representations of humans (Schmidt 2010:244, Notroff 2016, Clare 2019:530, Tepe Telegrams).

These two central pillars are Pillar 18 (East) and Pillar 31 (West), and can be seen in figures 8.36 and 8.41. Figure 8.40 shows several views of Pillar D18. Part (a) shows the whole pillar, with its T-shaped "head" at the top, something hanging below the "chin", a right arm enclosing a fox, two sets of fingers, and below these is some kind of belt, bearing symbols, from which hangs a fox pelt (Notroff 2016, Dietrich 2016e). Part (b) shows the front side of the pillar, and now we can clearly see the fox pelt that hangs like a loin-cloth from the belt. We can also see the ducks carved in relief on the pedestal, which has been carved out of the natural sandstone bed-rock (this pillar is also shown in Schmidt 2010:fig. 8 and 2011:46, Dietrich 2012:figure 8, Watkins 2020:figure 2.4). Part (c) shows the fox that rests in the crook of the pillar's right arm. It's likely that foxes were hunted for their pelts, and this might be why they are fairly high up the lists of the animals on the menu and on the pillars (Peters 2004:209). Part (d) is a close-up view of the two hands and the decorated belt.

The pillar represents a human-like figure, for it has arms and hands, and wears a belt and a loincloth. Yet it is highly abstracted, for it has no eyes or nose or mouth, and its enormous size makes it a very imposing presence. The figure would seem to have no individuality, but it carries a fox in the crook of one arm, and there are carved abstract symbols below its chin, where one would wear a necklace, shown in figure 8.40(e).

The other central pillar in enclosure D, Pillar 31, is also anthropomorphic, but carries no fox, and around its neck it wears a carved stylised skull of an ox, known as a bucranium (Schmidt 2010:244, Schmidt 2011:46 and figure 36).

It's agreed that Pillars 18 and 31 are anthropomorphic, but it's uncertain whether they represent generic figures or specific individuals. Trevor Watkins says they may be "*inscrutable divinities, perhaps the first culturally postulated superhuman agents*" (Watkins 2017:137). However, the differences between the two pillars suggest that they might represent real individuals who were once part of the community at Göbekli Tepe (Clare 2019:530). Whether they were imagined superhuman beings or real ancestors, they would have been a towering presence in the communal space of the special building.

abstract symbols

One symbol that frequently appears in the enclosures comprises two parallel lines joined by an orthogonal line, which looks like the letter "H" or the letter "I", depending on its orientation (Clare 2024:27). This symbol appears in many contexts, on its own, and as part of a larger pattern. For example, it appears in both orientations as a minor element on the edge of pillar D43, in figure 8.39(b). It appears as the major feature on Pillar D30, shown in figure 8.39(c), and on the edge of the stone slab holding up the boar statue in figure 8.41(c).

The "H" symbol is a recurring feature on the belt of the human-like figure represented by Pillar D18, shown in figure 8.40(d). It appears in both orientations on either side of the buckle at the front, and also along the side, where it sits between two curved brackets. A stone sceptre has been found at Göbekli Tepe, which bears two "H" symbols carefully incised into one end, shown in figure 8.39(d). Finally, two "H" symbols have been found inscribed into the bed-rock floor of enclosure D (Clare 2024:28).

From all this, we can infer that the "H" motif was not just a decorative feature, but had a symbolic meaning.

the wild boar wall

I'll end this section by looking at how special building D was constructed to create a natural focus for the attention of the people inside. Figure 8.41 shows the north wall of enclosure D, which is known as the wild boar wall (Clare 2024:13). Part (a) is an aerial view of the enclosure, and if we sit, in our imagination, on the bench in the south wall, then we see the view shown in part (b). Now we are directly facing the boar statue, sitting on its shelf in front of Pillar 67, which is positioned so it provides a backdrop. The statue is nearly life-size, about 1.35 metres long, and bears traces of red pigment around its mouth and black pigment on its body (Clare 2024:14). It's thought that the boar was placed in special building D in a late phase of building, at some time between 10.5 and 10 kya (Clare 2024:15). This is around the time of the final construction work, which was done on the walls around Pillars 42 and 43 (Kinzel 2021:20).

Figure 8.41. The wild boar wall in enclosure D. (a) an aerial view, with numbers in the original image, and compass direction added (Clare 2024:figure 7); (b) the full boar wall, following completion of excavations in 2023 (Clare 2024:figure 9); (c) the wild boar statue, about 1.35 metres long (Clare 2024:figure 10). The final building work on enclosure D was done about 10.5 kya, on the wall behind pillars P42 and P43 (Kinzel 2021:20).

In this section, we have seen some of the features of the shared imagined world of the Göbekli Tepe community, which includes a wide variety of animals, imposing human-like beings, and symbols with abstract meanings. "*The depictions of wild animals, humans and symbols represent 'petrified' oral narratives, thus providing a unique record of the myths, beliefs and worldviews of hunter-forager society*". It's widely accepted that these worldviews were rooted in animism, which is "*the belief that all natural things, such as plants, animals and even such phenomena as thunder, have intentionality (or a vital force) and can have influence on human lives*" (quotes from Clare 2024:21 and 22, and see back to section 8.10.1(g)).

(e) Cognitively Modern Humans

humanity had achieved 5th level mentalising

At the start of the section on Göbekli Tepe, I proposed a behavioural test for 5th level mentalising. We should look in the archaeological record for communities that were engaging in large-scale and long-term construction projects, which were not directly related to everyday subsistence, to bring their shared imagined world of intentional beings into everyday existence, so all could live their daily lives within it. We have seen that the people of Göbekli Tepe have fulfilled all of these conditions, and so we can conclude they were using 5th level mentalising to sustain their community lifestyle.

The people of Göbekli Tepe were not alone, for there were many other similar communities in that region of south-west Asia (Schmidt 2005:15, Clare 2019:546, Caletti 2020:103, Çelik 2022:145). There are many nearby sites, dated between about 11.5 and 10 kya, which show "*residential and specialised workshop areas, and special buildings or open courtyards for communal and ritual purposes, as well as evidence for extensive feasting*" (Dietrich 2012:675). Many sites have been found with T-pillars, and the region has become known as *Taş Tepeler*, or the Stone Hills (Banning 2011:632, 2023:10, Clare 2019:546). So, we can infer that across south-west Asia, there were many communities that had crossed the 5th level mentalising threshold.

These communities were thinking and behaving in a wholly modern way (Watkins 2012:38), so we can call them Cognitively Modern Humans. Figure 8.42(c) shows their emergence around 12 kya.

a cognitive transition

It is widely recognised that the Neolithic communities in south-west Asia were undergoing an important cognitive and social transition, and this has been described from different viewpoints.

Marion Benz and Joachim Bauer saw Neolithic communities "*beginning to free themselves from nature, from natural mutability ('domestication of time'), and from nature as sole creator of communal space*" (Benz 2013:5).

Some have viewed the transition in more spiritual terms. Klaus Schmidt understood the "*change of the hunter-gatherer societies to the Neolithic way of life, not only through economic or ecological reasons, but by the impact of a transcendental sphere*" (Schmidt 2000:49). In this context, Göbekli Tepe plays a rôle as a "*boundary zone between this world and the next*" (Dietrich 2015:85), and so the site becomes "*the world's first known centre of congregation*", to which "*people come from near and far to meet and undertake exchanges of a symbolic nature, often in the course of ritual activity*" (Renfrew 2013:30). The archaeological findings lent themselves to a view of Göbekli Tepe as a religious site, and Lee Clare takes the view that "*it was the archaeologists themselves who delivered and subsequently cultivated the now popular opinion that Göbekli Tepe is the site of the ≫World's First Temples≪*" (Clare 2020:82).

Others have taken a secular view, seeing the transition in terms of social organisation. So, the buildings and activities at Göbekli Tepe "*created social and ideological cohesion*" (Dietrich 2012:674). The circular enclosures expressed "*a common ideology, iconography, and a congregational layout*", whose effect was to "*emphasize a collective unity accentuating cooperative action and ritual*" (Notroff 2014:97). Trevor Watkins has argued that "*through the medium of architecture, sculpture and imagery, and the repeated rituals of building, maintenance, reconstruction and final closure, the first large-scale communities forged the collective memory that affirmed their collective identity and assured their pro-sociality*" (Watkins 2017:139).

Trevor Watkins views Göbekli Tepe in the context of the development of human cognition, so that communities became able to construct a shared imagined world. Thus, the early Neolithic communities were "*literally constructing new worlds of the imagination that they could inhabit*" (Watkins 2006:23). These communities were "*new, complex and large social organisms, which were only possible because people had evolved the cognitive and cultural facility to construct symbolic communities inhabiting rich cultural environments*" (Watkins 2009:647). Human cognitive and cultural evolution "*had reached a stage where it could readily be triggered into the development of powerful new forms of symbolic representation in material form. The material form that proposed itself was in the construction and use of buildings*" (Watkins 2004b:12). The environment they built was "*an inhabited representation of themselves, the structure of their community and their relations with each other and their world*" (Watkins 2009:657). Neolithic communities used this built environment as "*a frame of symbolic reference, imbued with meaning and significance. For the first time in human history, they had devised a means of embodying abstract concepts, beliefs and ideas about themselves and their world in externalised, permanent forms*" (Watkins 2004a:1). On this basis, Trevor Watkins concludes that "*these were the first communities of which we can say that they were behaviourally "modern"*" (Watkins 2012:38).

What underlies and connects all these related views of the Neolithic transition is the attainment of 5th level mentalising. With this, the Neolithic communities were able to construct "*new worlds of the imagination*", which represented "*the structure of their community and their relations with each other and their world*". They were only able to do this once they had the mutual assurance that they all lived in the same shared imagined spirit-world of intentional beings.

the evolution of human mentalising

We can now review the evolution of human mentalising, and this is shown in the three timelines in figure 8.42.

Part (a) shows the full timeline, with its four cognitive thresholds, all based on the archaeological record, as far as possible. There are uncertainties in the dates of all the transitions, but these diminish as we approach the present. So, all but the last transition are marked with brackets to indicate a spread of possible dates. The 2nd transition appears to have been a long, drawn out process. The 3rd transition has no obvious archaeological markers, as far as I can see, so its date is very uncertain.

The dates of these cognitive transitions are not inconsistent with the dates inferred from fossil brain sizes, discussed in section 8.11.2. The brain size approach puts the 3rd transition somewhere between 2 and 1 mya, the 4th transition after 0.5 mya (500 kya), and the 5th transition after 0.2 mya (200 kya). However, the archaeological record gives more recent dates for the last two transitions. Generally, it shows a cognitive development that is speeding up, rather like the timeline of brain size in figure 8.13.

Part (b) covers the emergence of Anatomically Modern Humans and the archaeological evidence for the 4th cognitive transition. We have seen that 4th level mentalising enables the use of socially shared symbols (section 8.10.3), and so their widespread appearance in the archaeological record around 100 kya is a sign of humans reaching this level. However, by the same reasoning, without 4th level mentalising, shared symbols are literally inconceivable, and so there are no symbolic objects found before this time. Their absence is not anomalous, but is the natural outcome of the development of hominin mentalising.

Finally, part (c) covers the 5th transition and the emergence of Cognitively Modern Humans about 12,000 years ago in south-west Asia.

We have been evolving, physically and cognitively, for 2−2½ million years, but we became Anatomically Modern Humans around 100,000 years ago, and we made the final transition to become Cognitively Modern Humans only about 12,000 years ago.

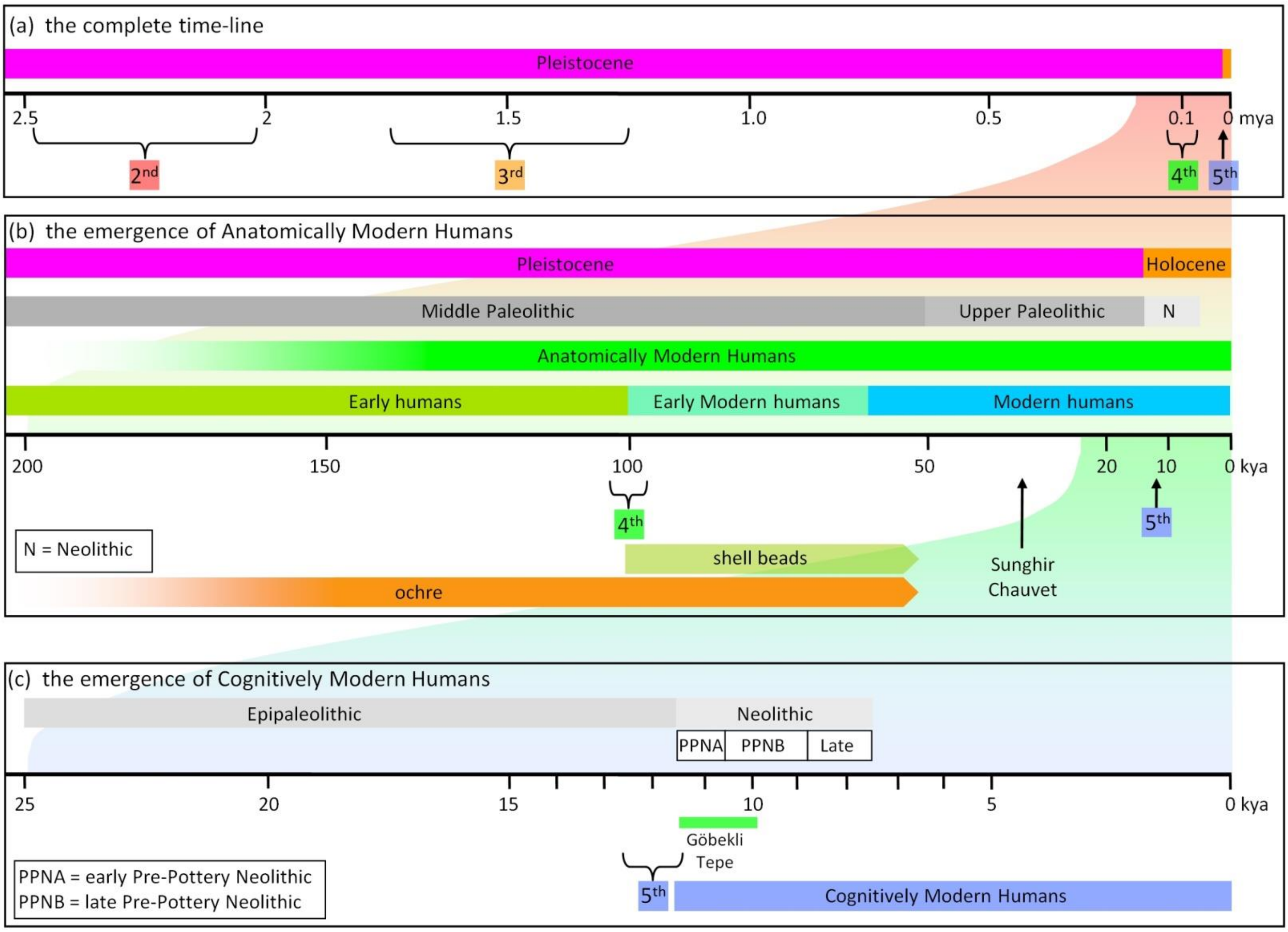


Figure 8.42. A timeline for the evolution of human mentalising, based on the archaeological record. (a) the full timeline, (b) the emergence of Anatomically Modern Humans, and the passing of the 4th transition, (c) the passing of the 5th transition and the emergence of Cognitively Modern Humans. All dates are in millions of years (mya) and thousands of years (kya) before the present. In part (b), the distinction between Early Humans, Early Modern Humans, and Modern Humans is from Mithen 1998 (see section 8.11.5). The date of the emergence of Anatomically Modern Humans is from Dunbar 2014a:217 and Gamble 2014:28 (see section 8.11.5). The dates for the different stages of the Neolithic are from Watkins 2024:6.

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