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How Many Friends Does One Person Need?

Dunbar's Number and Other Evolutionary Quirks

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Chapter 1

In the Beginning

We share a history, you and I. A history in which our respective stories snake back through time, edging ever closer to each other until finally they meet up in a common ancestor. Perhaps our lineages meet up only a few generations back, or maybe it was a thousand years ago. Perhaps it was so long ago that it predates history – though even that could not have been more than two hundred thousand years ago, a mere twinkle in earth time. For we modern humans all descend from a common ancestor who roamed the plains of Africa a mere ten thousand generations ago, ten thousand mothers giving birth to ten thousand daughters . . . no more than would fit in a town of very modest size today.

For us, that has two important implications. One is that we share most of our traits in common. From Alaska to Tasmania, and Tierra del Fuego to Spitzbergen, we are a single family, one biological species united by common ancestry. The other is that those traits we share are, nonetheless, the product of evolution, honed by the demands of the lives that our ancestors led. Sometimes, they are the product of deep evolutionary time, traits we share with the other members of our biological family,

the great apes, and especially the African great apes. Sometimes, those traits are of more recent origin, wrought in the fire of the particular circumstances that our more immediate ancestors faced in the battle for life, traits that mark us out as human – not special, because we are just one of many tens of thousands of individually unique species of animals, but unique in that we alone possess them. Some of these give us the capacity for culture, that remarkable product of the human mind that has made us what we are – those traits that allowed us to break away from our biological roots, that allowed human history to be what it is.

Yet, in our enthusiasm for the wonders of human culture, we sometimes overlook just how much of our behaviour is rooted in our biological evolution. The human mind is surely one of the wonders of the natural world, yet sometimes it seems so pedestrian and constrained that it is hard to see how we differ from any of the other primates. We live in massive conurbations numbering tens of millions of individuals, a product of our cultural flexibility if ever there was one. We have lived in villages only for the last ten thousand years, and cities the size of Bombay or Rio de Janeiro only for the last century at most. These are novel innovations, a product of our capacity to invent ways of making do. Yet, at the same time, our social world is still what it was several hundred thousand years ago. The number of people we know personally, whom we can trust, whom we feel some emotional affinity for, is no more than 150, Dunbar's Number. It has been 150 for as long as we have been a species. And it is 150 because our minds lack the capacity to make it any larger. We are

as much the product of our evolutionary history as any other species is.

I probably owe my interest in evolution to my American grandmother. Though a fiercely God-fearing Presbyterian missionary, she was also a surgeon and sufficiently well-versed in science to be an enthusiast for the new discoveries in human evolution that were emerging from Africa during the 1950s. When I was ten or eleven, she sent me a series of Audubon Society booklets on every imaginable subject to do with the natural world, complete with sticky stamps to paste in. One was on evolution, and covered everything from dinosaurs to humans. I became hooked on the story of human evolution. Some years later, I read Darwin's *Origin of Species*, having found it by chance in the school library. It was interesting, but I can't say I got a great deal out of it at the time. I was becoming more interested in philosophy, and science wasn't really my thing.

Then, five or six years later as a postgraduate student, I was thrust willy-nilly back into Darwin's world. I was deeply engaged in studying the behaviour of monkeys in the wild, spending several years doing fieldwork in Africa during the early 1970s. At the time, evolutionary thinking in the behavioural sciences was apt to be somewhat loose and wayward. We returned from fieldwork in Ethiopia in late 1975 to find the world had been turned upside down. Edward O. Wilson had just published his *Sociobiology: The New Synthesis* and Richard Dawkins would publish *The Selfish Gene* the following year. It was a life-changing experience for all of us. Overnight, we were made to think about evolutionary processes in a much more rigorous way. We were being asked to return

to a more strictly Darwinian view, after decades of increasingly lax, often speculative, thinking that had come to characterise much of organismic biology in mid-century. Of course, neither book invented something that was novel. What both, in their different ways, did was to lay out in stark detail the ideas that evolutionary biologists had slowly been developing over the previous decades.

The big intellectual change was a shift away from thinking that evolution was for the benefit of the species to one in which evolution was for the benefit of the genes that underpinned a trait, whether that trait was physical or behavioural. This should not be taken to imply that behaviour is hardwired, determined by the genes you inherit. Few traits are ever that simple in biology. But taking a gene's-eye view in which the benefits of a trait are costed out in terms of the impact they have on how often a particular gene is represented in the next generation brings us closer to Darwin's original conception of the theory of evolution by natural selection. More importantly, perhaps, it moved us away from the naïve genes-determine-all-behaviour view that has so often bedevilled thinking in this area to one in which an individual's freely made decisions on how to behave, free of any direct genetic input, could still be understood in a Darwinian framework. The following decades saw a veritable explosion of research. We learned so much in so short a space of time. Looking back, it is difficult now to convey the excitement of the time. So much of what was then novel is now accepted as fact.

Charles Darwin did not, of course, invent the theory of evolution. It had already had a long history within European biology dating back at least a century before

young Charles was even a twinkle in his mother's eye. In fact, his own polymath of a grandfather, Erasmus Darwin, had himself made a seminal contribution to promoting the idea of evolution in one of his own best sellers. If anyone deserves the credit for inventing the theory of evolution it should probably be the great eighteenth-century French biologists – Cuvier, Buffon, Lamarck, among others. But they had been locked into a medieval mindset that had its origins in the views of Aristotle and Plato, filtered through the intellectual spectacles of the Church Fathers, a seminal group of medieval Christian theologians who established the core tenets of modern Christian theology. Building on the thinking of their Greek predecessors, they saw evolution as progressive, with each species inexorably climbing slowly but surely up the 'Great Chain of Being' from primitive life forms to join the angels just below God, who, at least as far as they were concerned, inevitably stood at the pinnacle of it all.

The publication of Darwin's book *On the Origin of Species* in 1859 set aside the old *scala natura*, or Great Chain of Being, that had been the linchpin of evolutionary thinking ever since Plato. Darwin set in train a new way of thinking about the natural world, a world whose history is driven by the demands of successful biological reproduction. In the process, of course, he upset quite a few apple carts, not least because his new vision of evolution challenged Victorian beliefs about the established order. Not only were Englishmen not the high point of evolution, but there wasn't that much room at the top for God either.

Darwin's great genius was to recognise that natural selection is the engine that drives evolution. In doing so,

he dragged the theory of evolution out of the medieval doldrums into the modern world. He provided a mechanism that could explain how life on earth could have evolved without need for a creator. And it was a mechanism that, at the same time, could explain how and why a species might have evolved particular traits, traits that enabled individual animals to reproduce more successfully.

As with all scientific ideas, Darwin's theory underwent extensive development in the decades after the publication of the *Origin*. He expanded his ideas on natural selection to include sexual selection (selection for traits that enhance attractiveness to prospective mates). He applied his ideas to the nascent discipline of psychology – commenting at length on topics such as music, language, emotions and physical attractiveness – and even finally the evolution of Man.

Nor did his theory come to a halt with his death in 1882. It continued to be developed by those who came after him. We know so much more now than Darwin himself ever did, but the core of modern evolutionary theory and its many intellectual derivatives still lies firmly in Darwin's elegantly simple idea: organisms behave in ways that tend to enhance the frequencies with which the genes they carry are passed on to future generations.

It was into this heady atmosphere that I was thrust as a young researcher in the 1970s. We were galvanised and excited by the opportunities on offer, by the heady mix of new Darwinian theories whose strong predictions could guide our research and give us new questions we could ask that no one had thought of asking before. Looking

back on three decades or so of this research is to realise what a privileged generation we had been. We witnessed a genuine scientific revolution as it happened. Our ways of thinking were changed for ever, just as the Victorians had had their worldview changed by Darwin. New conceptions of how animals behaved and evolved emerged that challenged our long-held assumptions about how the world was. A decade or so later, we began to apply these same ideas to human behaviour.

In the chapters that follow, I try to convey some of that excitement. Much of the research I will talk about is my own, or was done by members of my research group. But some of it will draw, somewhat idiosyncratically no doubt, on research by others that bears on the topics that have driven my own research over the past decade – why humans behave as they do, what it is to be human.

So, let me now invite you to explore with me those parts of you that, in the words of the advertisement, even the most proverbially exotic beers can never reach – how many friends you have, whether you have your father's brain or your mother's, whether morning sickness might actually be good for you (or, at least, for your baby), why Barack Obama's victory in the 2008 US presidential campaign was a foregone conclusion, why Shakespeare really was a genius, what Gaelic has to do with frankincense, and why we laugh. In the process, we'll examine the role of religion in human evolution, the fact that most of us have unexpectedly famous ancestors, and the reason why men and women never seem able to see eye to eye about colours. I'll couch all this in terms of evolution and Darwin's great

insights, something that will make us ponder the very bases of science itself. But let's begin with the very core of what makes us human . . . our big brains.

Chapter 2

The Monogamous Brain

Of all the traits that natural selection has managed to evolve for us, our brains are surely the most valuable. Brains are the greatest evolutionary invention of all time. They were designed to free us from the worst of the evolutionary grind to which the rest of brute nature is subjected by allowing us to fine-tune our behaviour to circumstances. We can consider the options, weigh up the pros and cons, worry about the implications of behaving one way or the other, and then choose what seems like the most sensible thing to do. Thus it is that we rise above brute nature – a paragon of evolution. Or, at least, so it seems. In reality, brains are more complex than you might think. Yet, they are not quite as flexible and omniscient as we would like them to be. And we owe a good deal more of our brains to the vagaries of evolutionary history than we might wish.

Romeo, Romeo, wherefore art thou . . .?

Our brains are massively expensive, consuming about twenty per cent of our total energy intake even though they only account for about two per cent of our total body

weight. That's a massive cost to bear, so brains really need to be spectacularly useful if they are going to be worth the cost. The consensus, at least for the primate family, is that we have our big brains to enable us to cope with the complexities of our social world. However, that story has recently acquired an interesting new twist as a result of studies on birds and other groups of mammals that my colleague Susanne Shultz and I have done. It seems that it is pairbonding that is the real drain on the brain. So let me ask: have you been struggling yet again with your partner's foibles? If you find relationships really hard work, then it seems you are in very good company. Among the birds and mammals in general, the species with the biggest brains relative to body size are precisely those that mate monogamously. Those that live in large anonymous flocks or herds and mate promiscuously have much smaller brains.

The birds make it especially clear that the real issue is strong, resilient, long-lasting pairbonds. Birds that mate monogamously come in two quite different kinds. There are those, like many common garden birds such as robins and tits, that choose a new mate each breeding season. But there are many others, such as many birds of prey, the owls and most of the crow and parrot families, that mate for life. It is this second group which have the biggest brains of all among the birds, far bigger than those that are seasonally monogamous, and this is true even when we control for differences in lifestyle, diet, and body size.

Among mammals, monogamy is much rarer (only about five per cent of mammals mate monogamously), but here too those that do so – including the many species of the dog/wolf/fox family, and antelope like the little klip-

springer and the diminutive dikdik – have bigger brains than those that live in larger social groups where mating is promiscuous.

Biologists probably wouldn't get so excited about having a big brain, were it not for the fact that brain tissue is extremely expensive to grow and maintain – only your heart, liver and guts are more expensive. Evolving a bigger brain is thus no idle matter in evolutionary terms. And, given what brains do, this suggests that something about pairbonded relationships is significantly more taxing than life in the large anonymous flocks of shorebirds or the herds of deer and plains antelope. So what makes monogamous pairbonds so cognitively demanding?

One likely reason is that lifelong monogamy carries enormous risks. A poor choice of mate – one who is infertile, a lazy parent or prone to infidelity – risks jeopardising your contribution to the species' gene pool. Since, biologically speaking, that is what life is all about, it is not difficult to see that there are enormous evolutionary advantages to paying the cost of having a brain big enough to enable you to recognise the signs of a bad prospect when you see one. That way, you get to avoid a whole lot of trouble, and do better for yourself in the evolutionary stakes.

But there is another aspect to monogamy that might be just as important, and that's your ability to co-ordinate your behaviour with that of your mate. Consider the case of the average songbird in your garden. The business of mate choice is over, the female has laid her eggs, and now comes the tough bit – the long job of sitting on the nest while the eggs incubate, and the feeding of the fledglings that follow. Now, were it the case that one or other of the

pair spent the whole of its day down at the avian equivalent of the pub, its mate would soon end up with the invidious choice between abandoning the eggs to cooling and predation so that it can feed, or staying on the nest and starving. For a small bird that has to eat its own body weight in food each day just to stay alive, this is no mean issue. In short, you need a mate that is smart enough to figure out what your needs are, and when it should return and take over its share of the nesting duties.

So perhaps it's the need to be able to factor your mate's perspective in to your own that is so cognitively demanding. Our own experiences would tell us that keeping a relationship on course through the years is a very delicate business, requiring a lot of fancy footwork to anticipate and see off at the pass all those potential sources of disagreement. Or, when they come from left field and we don't see them until they hit us, it's being able to see how to mend the fences and restore the equilibrium once again.

So as you struggle to figure out why your spouse has behaved so badly yet again, console yourself with the thought that evolution has blessed you with one of its crowning glories – a brain capable of figuring out how to get the best out of a bad job. After that, it's all plain sailing. Even the humble birds on your garden table can sort that one out.

Whose brain is it anyway?

Think about it: you have two parents, who each provide you with one set of genes, a complete set for everything about you. But you aren't just a fifty–fifty mixture of each of them. In most traits, you tend to resemble one or the

other, so that by and large you end up as a kind of mosaic – your mother's nose, your father's chin, perhaps even your grandfather's hair through some quirk of a throwback to earlier generations. All this is pretty well understood, thanks mainly to the pioneering efforts in the 1850s of that indefatigable scientist-monk, Gregor Mendel, the founding father of modern genetics.

Now, one might expect that you would be a random mosaic of bits inherited from your two parents, and that these would vary between individuals – half the population would inherit a particular trait from their fathers, and the rest would inherit it from their mothers. It seems not. Instead, it turns out that some bits are always inherited from your mother and other bits always inherited from your father. The genes seem to know where they have come from, and which of them should switch themselves off (be 'silent' in the technical jargon).

The surprise is what happens in your brain. In an experimental study of natural genetic deficits in rats, Barry Keverne and his colleagues at Cambridge University found that animals with no maternal chromosomes lacked a fully developed neocortex, whereas those with no paternal chromosomes lacked a fully developed limbic system. This process whereby one set of genes is always 'silenced' is known as 'genomic imprinting'. Although the mechanisms involved are not yet fully understood, it seems that, in effect, individual genes 'know' whether they were paternal or maternal genes.

This finding gels rather neatly with another recent study. Rob Barton from Durham University and his colleagues have shown that, across the broad range of primate species, the size of a species' neocortex correlates best

with the number of females in the group, whereas the size of the limbic system (part of the emotional response mechanism) correlates better with the number of males in the group. Since the number of females that a species can sustain in a typical group mainly reflects the females' social skills, this makes sense because the neocortex is related to social skills. On the other hand, in most primate species, male–male relationships are based more on competition for dominance rank (which is what allows males to be successful in the mating game), and this understandably has much more to do with males' willingness to fight.

The fact that the genomic imprinting is this particular way around is intriguing. In most primate species, the key to a female's reproductive success is the support she elicits from the sisterhood. For females to make their social relationships work, they need to be able to negotiate their way through a complex social world. Analysis of more than three decades of family histories from the population of baboons in Kenya's Amboseli National Park has shown that the females who are socially most successful also have the largest number of surviving offspring at the end of their lifetime.

But for males, the issue is much less about social skills than about willingness to keep slugging it out in a fight. Now, any sensible individual who gets involved in a fight will quickly realise that discretion is invariably the better part of valour and retire gracefully to live (and maybe fight) another day. But in the mating game, those who retire from the fray don't get the girl. So a mechanism that stops males thinking too much and lets the red mist take over usually works better. There may be a risk of injury or even death, but in a winner-takes-all game there

is no point in being second. A small neocortex and a big limbic system is just what you want. If you have to fight for a living, best to bite first and think afterwards.

In effect, the females have won the battle over who controls the neocortex because social skills are more valuable to them, whereas males have won the battle over who controls the limbic system because it pays not to think too much about what you are doing if you get into a fight. The evolutionary battle of the sexes ends up being about control over the bits of the brain, though it is still something of a mystery as to how this is brought about. On second thoughts, I'm not so sure that I like the drift of this conversation . . . Perhaps we'll change the subject.

Four eyes better than three

Did you know that our eyes are actually part of our brain? They are an outgrowth of the brain that developed a sensitivity to light, came to the surface and, in doing so, allow us to see what's going on out there in the external world in a way that touch and smell cannot. As those who go blind through old age or accident know only too well, our life is ruled by vision – and especially the wonders of colour vision.

So, let me for a moment speak confidentially to the men. Have you, I wonder, become exasperated by your wife's fussing that the colours of her outfit clash when they seem perfectly fine to you? Well, she may be right: it seems that about a third of women see the world in four basic colours, whereas men only have the standard three (red, blue and green). These tetrachromatic (four-

colour) women have an extra shade of green or an extra shade of red. Heaven forfend – some even have all five colours. It seems that some women really do see a very different world from the rest of us.

According to the standard story that they told us in school biology classes, we have two kinds of vision cells in the retina (the light-sensitive layer at the back of our eyeballs): rods give us the black-and-white vision that we use at night, and the cones give us colour that we use by day. The conventional wisdom is that there are three kinds of cones, each sensitive to a slightly different wavelength of light. These are red, blue and green, just as they are in the screen of your TV. We perceive the colours of the rainbow by the way the intensities of these three colours mix.

Now, the genes for two of these colours (the red–green dimension) are on the X chromosome, and those for blue are elsewhere, on chromosome seven. And this explains why men – but only very rarely women – are sometimes colour-blind and why this is usually red-blindness and almost never blue-blindness. Men only have one X chromosome (inherited from their mother), and if that chromosome is a bit dodgy, they don't have a back-up for any of the genes that are on it. Since women have two X chromosomes (one inherited from each parent), they always have a back-up in case of emergencies.

And this provides us with a very simple explanation for the four- (or five-) colour effect. Slight mutations of the genes that code for the colour-sensitive pigments in the retina can mean that different people see slightly different shades of red or green. For men, whatever shade you get from your single X chromosome is what you get: that's

how you see the world. But women can end up with two slightly different shades of red or green on their two X chromosomes. If both X chromosomes become active during the development of the eyes, these women can have cones that code for both pigment sensitivities, and so end up with an extra colour dimension, in some cases even two extra ones – blue, red, shifted red, green and shifted green, five colours in all.

Now, here's where the tricky bit comes in. All this would be fine, because it would just mean that women live in a richer colour world than men, and who cares about that? But Mark Changizi and his colleagues at the California Institute of Technology in Pasadena now have an uncomfortable twist on this. Sex differences in colour sensitivity of this kind are far from unknown in primates: one particularly well-known one is the fact that, among the New World monkeys, females are trichromats (they have three-colour vision) but males see only two colours. Changizi and his colleagues noticed that sex difference in colour sensitivity in primates correlates with the amount of bare facial skin that a species has. Species which have large areas of bare skin that can change colour as a result of increased or decreased blood flow are precisely those that have full three-colour vision. They make the obvious connection: is the fact that humans are a 'naked ape' related to our good colour vision?

And here is where the salt gets rubbed into the wound. Perhaps women's sensitivity to colour (and especially reds) has something to do with their apparently mysterious capacity to know exactly when your protestations about where you have been all evening are, shall we say, just a little liberal with the truth. In short, do women

know when men are lying because they can pick up much finer shades of blushing than their partners think they are giving away? How unkind can evolution possibly be?