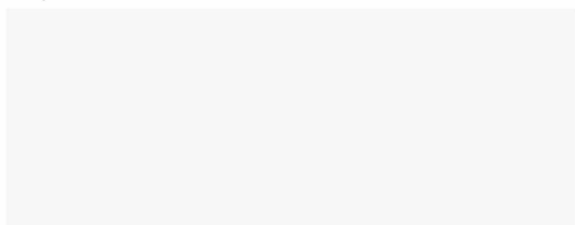


NATURE VIA NURTURE

*Genes, Experience, and
What Makes Us Human*

Matt Ridley



HarperCollins Publishers

NATURE VIA NURTURE. Copyright © 2003 Matt Ridley. All rights reserved. Printed in the United States of America. No part of this book may be used or reproduced in any manner whatsoever without written permission except in the case of brief quotations embodied in critical articles and reviews. For information, address HarperCollins Publishers Inc., 10 East 53rd Street, New York, NY 10022.

HarperCollins books may be purchased for educational, business, or sales promotional use. For information, please write: Special Markets Department, HarperCollins Publishers Inc., 10 East 53rd Street, New York, NY 10022.

FIRST EDITION

Published in Great Britain in 2003 by Fourth Estate, a Division of
HarperCollins Publishers Inc.

Printed on acid-free paper

Library of Congress Cataloging-in-Publication Data

Ridley, Matt.

Nature via nurture : genes, experience, and what makes us
human / Matt Ridley.—1st ed.

p. cm.

Includes bibliographical references (p.).

ISBN 0-06-000678-1

1. Nature and nurture. 2. Human genetics. I. Title.

QH438.5.R535 2003

155.7—dc21

2003040687

03 04 05 06 07 NMSG/RRD 10 9 8 7 6 5 4 3 2 1

C O N T E N T S

Prologue: Twelve Hairy Men	I
1. The Paragon of Animals	7
2. A Plethora of Instincts	38
3. A Convenient Jingle	69
4. The Madness of Causes	98
5. Genes in the Fourth Dimension	125
6. Formative Years	151
7. Learning Lessons	177
8. Conundrums of Culture	201
9. The Seven Meanings of "Gene"	231
10. A Budget of Paradoxical Morals	249
Epilogue: <i>Homo stramineus</i> : The Straw Man	277
Acknowledgments	281
Endnotes	283
Index	307

P R O L O G U E

Twelve hairy men

Perverse Mankind! Whose wills, created free,
Charge all their woes on absolute Decree;
All to the dooming Gods their guilt translate,
And follies are miscall'd the crimes of Fate.

Homer's *Odyssey*, translated by
Alexander Pope¹

“Revealed: the secret of human behaviour,” read the banner headline in the British Sunday newspaper the *Observer* on 11 February 2001. “Environment, not genes, key to our acts.” The source of the story was Craig Venter, the self-made man of genes who had built a private company to read the full sequence of the human genome (his own) in competition with an international consortium funded by taxes and charities. That sequence—a string of three billion letters composed in a four-letter alphabet containing the complete recipe for building and running a human body—was to be published later in the week. The first analysis had revealed that there were just 30,000 genes in the human genome, not the 100,000 that many had been estimating up until a few months before.

Details had already been circulated to journalists, though under an

embargo. But Venter spilled the story at an open meeting in Lyon on 9 February. Robin McKie of the *Observer* was in the audience and recognized at once that the figure 30,000 was now public. He went up to Venter and asked him if he realized that this broke the embargo; he did. Not for the first time in the increasingly bitter rivalry over the genome project, Venter's version of the story would hit the headlines before that of his rivals. "We simply do not have enough genes for this idea of biological determinism to be right," Venter said to McKie. "The wonderful diversity of the human species is not hard-wired in our genetic code. Our environments are critical."²

Seeing the *Observer's* first edition, other newspapers followed suit. "Genome discovery shocks scientists: genetic blueprint contains far fewer genes than thought—DNA's importance downplayed," proclaimed the *San Francisco Chronicle* later that Sunday.³ The scientific journals promptly lifted the embargo and the story was in newspapers around the world. "Analysis of human genome discovers far fewer genes," intoned the *New York Times*.⁴ Not only had McKie scooped the story; Venter had set the theme.

This was the making of a new myth. In truth, the number of human genes changed nothing. Venter's remarks concealed two massive non sequiturs: first, that fewer genes implied more environmental influences; and second, that 30,000 genes were "too few" to explain human nature where 100,000 would have been enough. As Sir John Sulston, one of the leaders of the human genome project, put it to me a few weeks later, just 33 genes, each coming in just two varieties (such as on or off), would be enough to make every human being in the world unique. There are more than 10 billion ways of flipping a coin 33 times. So 30,000 is not such a small number after all. Two multiplied by itself 30,000 times produces a number larger than the total number of particles in the known universe. Besides, if fewer genes meant more free will, that would make fruit flies freer than people, bacteria freer still, and viruses the John Stuart Mills of biology.

Fortunately, there was no need for such sophisticated calculations to reassure the population. People were not seen weeping in the street at the humiliating news that our genome had fewer than twice as many

genes as a worm's. Nothing had been hung on the number 100,000, which was just a bad guess. But it was fitting after a century of increasingly repetitive argument over environment versus heredity that the publication of the human genome should be broken on the procrustean bed of nature versus nurture. It was, with the possible exception of the Irish question, the intellectual argument that had changed least in the century just ended. It had divided fascists from communists as neatly as their politics. It had continued unabated through the discovery of chromosomes, DNA, and Prozac. It was fated to be just as bitterly debated in 2003 as it was in 1953, the year of the discovery of the structure of the gene, or in 1900, the year modern genetics began. Even the human genome, at its birth, was being claimed for nurture versus nature.

For more than 50 years sane voices have called for an end to the debate. Nature versus nurture has been declared everything from dead and finished to futile and wrong—a false dichotomy. Everybody with an ounce of common sense knows that human beings are a product of a transaction between the two. Yet nobody could stop the argument. Immediately after calling the debate futile or dead, the typical protagonist would charge into the battle himself and start accusing others of overemphasizing one or the other extreme. The two sides of this argument are the nativists, whom I will sometimes call geneticists, hereditarians, or naturians; and the empiricists, whom I will sometimes call environmentalists or nurturists.

Let me at once put my cards faceup. I believe human behavior has to be explained by both nature and nurture. I am not backing one side or the other. But that does not mean I am taking a “middle of the road” compromise. As Jim Hightower, a Texas politician, once said: “There ain’t nothing in the middle of the road but a yellow line and a dead armadillo.” I intend to make the case that the genome has indeed changed everything, not by closing the argument or winning the battle for one side or the other, but by enriching the argument from both ends till they meet in the middle. The discovery of how genes actually influence human behavior, and how human behavior influences genes, is about to recast the debate entirely. No longer is it nature versus nur-

ture but nature via nurture. Genes are designed to take their cues from nurture. To appreciate what has happened, you will have to abandon cherished notions and open your mind. You will have to enter a world where your genes are not puppet masters pulling the strings of your behavior but puppets at the mercy of your behavior; a world where instinct is not the opposite of learning, where environmental influences are sometimes less reversible than genetic ones, and where nature is designed for nurture. These cheap and seemingly empty phrases are coming to life for the first time in science. I intend to tell bizarre stories from the deepest recesses of the genome to show how the human brain is built for nurture. My argument in a nutshell is this: the more we lift the lid on the genome, the more vulnerable to experience genes appear to be.

I imagine a photograph taken in the year 1903. It is of a group of men gathered at some international meeting, in a fashionable spot like Baden-Baden or Biarritz, perhaps. “Men” is not quite the right word, for though there are no women, there is one little boy, along with one baby and one ghost; but the rest are middle-aged or elderly men, mostly rich and all white. There are 12 of them and, as befits the time, there is a great deal of facial hair. There are two Americans, two Austrians, two Britons, two Germans, one Dutchman, one Frenchman, one Russian, and one Swiss.

It is, alas, an imaginary photograph, for most of these people never met each other. But, like the famous group photograph of physicists at Solvay in 1927—the one that includes Einstein and Bohr and Marie Curie and Planck and Schrödinger and Heisenberg and Dirac—my picture would capture that moment of ferment when a scientific endeavor throws up a host of new ideas.⁵ My 12 men were the ones who put together the chief theories of human nature that came to dominate the twentieth century.

The ghost hovering overhead is Charles Darwin, dead for 11 years by the time of the photograph, and with the longest beard of all. Darwin’s idea is to seek the character of man in the behavior of the ape and to demonstrate that there are universal features of human behavior, like smiling. The elderly gent sitting bolt upright on the far left is Darwin’s

cousin, Francis Galton, 81 years old but going strong; Galton's whiskers hang down the sides of his face like white mice. Galton is the fervent champion of heredity. Next to him sits the American William James, 61, with a square, untidy beard. He is a champion of instinct and maintains that human beings have more impulses than other animals, not fewer. On Galton's right is a botanist, out of place in a group concerned with human nature, and frowning unhappily behind his straggly beard. He is Hugo De Vries, 55, the Dutchman who discovered the laws of heredity only to realize that he had been beaten to them more than 30 years before by a Moravian monk named Gregor Mendel. Beside De Vries is a Russian, Ivan Pavlov, 54, his beard full and gray. He is a champion of empiricism, believing that the key to the human mind lies in the conditioned reflex. At his feet, uniquely clean-shaven, sits John Broadus Watson, who will turn Pavlov's ideas into "behaviorism" and famously claim to be able to alter personality at will merely by training. To Pavlov's right stand the plump, bespectacled, mustachioed German Emil Kraepelin and the neatly bearded Viennese, Sigmund Freud, both 47 and both in the throes of influencing generations of psychiatrists away from "biological" explanations and toward two very different notions of personal history. Beside Freud is the pioneer of sociology, the Frenchman Émile Durkheim, 45 and especially bushy in beard, insisting on the reality of social facts as more than the sum of their parts. His soul mate in this regard is standing next to him: a German-American (he emigrated in 1885), the dashing Franz Boas, 45, with drooping mustaches and a dueling scar; Boas is increasingly inclined to insist that culture shapes human nature, not the other way around. The little boy in the front is the Swiss Jean Piaget, whose theories of imitation and learning will come to fruition, beardless, in mid-century. The baby in the carriage is the Austrian Konrad Lorenz, who in the 1930s will revive the study of instinct and describe the vital concept of imprinting, while growing a fine white goatee.

I am not going to claim that these were necessarily the greatest students of human nature, or that they were all equally brilliant. There are many, both dead and unborn, who would otherwise deserve inclusion in the photograph. David Hume and Immanuel Kant ought to be

there, but they had died long ago (only Darwin manages to cheat death for the occasion); so should the modern theorists George Williams, William Hamilton, and Noam Chomsky, but they were unborn. So should Jane Goodall, who discovered individuality in apes. So perhaps should some of the more perceptive novelists and playwrights.

But I am going to claim something rather surprising about these 12 men. They were right. Not right all the time, not even wholly right, and I do not mean morally right. They nearly all went too far in trumpeting their own ideas and criticizing each other's. One or two of them deliberately or accidentally give birth to grotesque perversions of "scientific" policy that will haunt their reputations forever. But they were right in the sense that they all contributed an original idea with a germ of truth in it; they each placed a brick in the wall.

Human nature is indeed a combination of Darwin's universals, Galton's heredity, James's instincts, De Vries's genes, Pavlov's reflexes, Watson's associations, Kraepelin's history, Freud's formative experience, Boas's culture, Durkheim's division of labor, Piaget's development, and Lorenz's imprinting. You can find all these things going on in the human mind. No account of human nature would be complete without them all.

But—and here is where I begin to tread new ground—it is entirely misleading to place these phenomena on a spectrum from nature to nurture, from genetic to environmental. Instead, to understand each and every one of them, you need to understand genes. It is genes that allow the human mind to learn, to remember, to imitate, to imprint, to absorb culture, and to express instincts. Genes are not puppet masters or blueprints. Nor are they just the carriers of heredity. They are active during life; they switch each other on and off; they respond to the environment. They may direct the construction of the body and brain in the womb, but then they set about dismantling and rebuilding what they have made almost at once—in response to experience. They are both cause and consequence of our actions. Somehow the adherents of the "nurture" side of the argument have scared themselves silly at the power and inevitability of genes and missed the greatest lesson of all: the genes are on their side.

C H A P T E R O N E

The paragon of animals

Is man no more than this? Consider him well: Thou owest the worm no silk, the beast no hide, the sheep no wool, the cat no perfume:—Ha! here's three of us are sophisticated!—Thou art the thing itself: unaccommodated man is no more but such a poor, bare, forked animal as thou art. *King Lear*¹

Similarity is the shadow of difference. Two things are similar by virtue of their difference from another; or different by virtue of one's similarity to a third. So it is with individuals. A short man is different from a tall man, but two men seem similar if contrasted with a woman. So it is with species. A man and a woman may be very different, but by comparison with a chimpanzee, it is their similarities that strike the eye—the hairless skin, the upright stance, the prominent nose. A chimpanzee, in turn, is similar to a human being when contrasted with a dog: the face, the hands, the 32 teeth, and so on. And a dog is like a person to the extent that both are unlike a fish. Difference is the shadow of similarity.

Consider, then, the feelings of a naive young man, as he stepped ashore in Tierra del Fuego on 18 December 1832 for his first encounter with what we would now call hunter-gatherers, or what he

would call “man in a state of nature.” Better still, let him tell us the story:

It was without exception the most curious & interesting spectacle I ever beheld. I would not have believed how entire the difference between savage & civilized man is. It is much greater than between a wild & domesticated animal, in as much as in man there is greater power of improvement. . . . [I] believe if the world was searched, no lower grade of man could be found.²

The effect on Charles Darwin was all the more shocking because these were not the first Fuegian natives he had seen. He had shared a ship with three who had been transported to Britain, dressed in frocks and coats, and taken to meet the king. To Darwin they were just as human as any other person. Yet here were their relatives, suddenly seeming so much less human. They reminded him of . . . well, of animals. A month later, on finding the campsite of a single Fuegian limpet hunter in an even more remote spot, he wrote in his diary: “We found the place where he had slept—it positively afforded no more protection than the form of a hare. How very little are the habits of such a being superior to those of an animal.”³ Suddenly, Darwin is writing not just about difference (between civilized and savage man) but about similarity—the affinity between such a man and an animal. The Fuegian is so different from the Cambridge graduate that he begins to seem similar to an animal.

Six years after his encounter with the Fuegian natives, in the spring of 1838, Darwin visited London zoo and there for the first time saw a great ape. It was an orangutan named Jenny, and she was the second ape to be brought to the zoo. Her predecessor, Tommy, a chimpanzee, had been exhibited at the zoo for a few months in 1835 before he died of tuberculosis. Jenny was acquired by the zoo in 1837, and like Tommy she caused a small sensation in London society. She seemed such a human animal, or was it such a beastly person? Apes suggested uncomfortable questions about the distinction between people and animals, between reason and instinct. Jenny featured on the cover of the *Penny Magazine of the Society for the Diffusion of Useful Knowledge*; an edi-

torial reassured readers that “extraordinary as the Orang may be compared with its fellows of the brute creation, still in nothing does it trench upon the moral or mental provinces of man.” Queen Victoria, who saw a different orangutan at the zoo in 1842, begged to differ. She described it as “frightful and painfully and disagreeably human.”⁴

After his first encounter with Jenny in 1838, Darwin returned to the zoo twice more a few months later. He came armed with a mouth organ, some peppermint, and a sprig of verbena. Jenny seemed to appreciate all three. She seemed “astonished beyond measure” at her reflection in a mirror. He wrote in his notebook: “Let man visit Ouran-outang in domestication . . . see its intelligence . . . and then let him boast of his proud pre-eminence . . . Man in his arrogance thinks himself a great work, worthy the interposition of a deity. More humble and I believe true to consider him created from animals.” Darwin was applying to animals what he had been taught to apply to geology: the uniformitarian principle that the forces shaping the landscape today are the same as those that shaped the distant past. Later that September, while reading Malthus’s essay on population, he had his sudden insight into what we now know as natural selection.

Jenny had played her part. When she took the mouth organ from him and placed it to her lips, she had helped him realize how high above the brute some animals could rise, just as the Fuegians had made him realize how low beneath civilization some humans could sink. Was there a gap at all?

He was not the first person to think this way. Indeed, a Scottish judge, Lord Monboddo, had speculated in the 1790s that orangutans could speak—if educated. Jean-Jacques Rousseau was only one of several Enlightenment philosophers who wondered if apes were not continuous with “savages.” But it was Darwin who changed the way human beings think of their own nature. Within his lifetime, he saw educated opinion come to accept that human bodies were those of just another ape modified by descent from a common ancestor.

But Darwin had less success in persuading his fellow human beings that the same argument could apply to the mind. His consistent view, from his earliest notebooks written after he read David Hume’s

Treatise of Human Nature to his last book, about earthworms, was that there was similarity, rather than difference, between human and animal behavior. He tried the same mirror test on his children that he had tried on Jenny. He continually speculated on the animal parallels and evolutionary origins of human emotions, gestures, motives, and habits. As he stated plainly, the mind as much as the body needed evolution.

But in this he was deserted by many of his supporters, the psychologist William James being a notable exception. Alfred Russel Wallace, for example, the co-discoverer of the principle of natural selection, argued that the human mind was too complex to be the product of natural selection. It must instead be a supernatural creation. Wallace's reasoning was both attractive and logical. It was based, again, on similarity and difference. Wallace was remarkable for his time in being mostly devoid of racial prejudice. He had lived among natives of South America and southeast Asia, and he thought of them as equals, morally if not always intellectually. This led him to the belief that all races of humanity had similar mental abilities, which puzzled him because it implied that in most "primitive" societies, the great part of human intelligence went unused. What was the point of being able to read or do long division if you were going to spend all your life in a tropical jungle? Ergo, said Wallace, "some higher intelligence directed the process by which the human race was developed."⁵

We now know that Wallace's assumption was entirely right, where Darwin's was wrong. The gap between the "lowest" human and the "highest" ape is enormous. Genealogically, we all descend from a very recent common ancestor who lived just 150,000 years ago, whereas our last common ancestor with a chimpanzee lived at least 5 million years ago. Genetically, the differences between a human being and a chimpanzee are at least 10 times as numerous as those between the two most dissimilar human beings. But Wallace's deduction from this assumption, that therefore the human mind required a different kind of explanation from the animal mind, is not warranted. The fact that two animals are different does not mean they cannot also be similar.

René Descartes had decreed firmly in the seventeenth century that

people were rational and animals were automata. Animals “act not from knowledge but from the disposition of their organs. . . . Brutes not only have a smaller degree of reason than men, but are wholly lacking in it.”⁶ Darwin dented this Cartesian distinction for a while. Freed at last from the need to think of the human mind as a divine creation, some of Darwin’s contemporaries, the “instinctivists,” began to think of humans as automatons driven by instinct; others, the “mentalists,” began to credit the animal brain with reason and thought.

The mentalists’ anthropomorphism reached its apogee in the work of the Victorian psychologist George Romanes, who eulogized the intelligence of pets, such as dogs that could lift latches and cats that seemed to understand their masters. Romanes believed that the only explanation for their behavior was conscious choice. He went on to argue that each species of animal had a mind just like the human mind, only frozen at a stage equivalent to a child of a certain age. Therefore, a chimpanzee had the mind of a young teenager, while a dog was equivalent to a younger child, and so on.⁷

Ignorance of wild animals sustained this notion. So little was known about the behavior of apes that it was easy to go on thinking of them as primitive versions of people, rather than sophisticated animals that were brilliantly good at being apes. Especially with the discovery of the seemingly fierce gorilla in 1847, encounters between human beings and wild apes were exclusively brief and violent. When apes were brought to zoos, they had little opportunity to show their repertoire of wild habits, and their keepers seemed to evince more interest in their ability to “ape” human customs than in what came naturally to them. For instance, from the very first arrival of chimpanzees in Europe, there seems to have been an obsession with serving them tea. The great French naturalist Georges Leclerc, Comte de Buffon, was one of the first “scientists” to see a captive chimp, in about 1790. What did he find worth remarking? That he watched it “take a cup and saucer and lay them on the table, put in sugar, pour out its tea, leave it to cool without drinking.”⁸ Thomas Bewick, a few years later, reported breathlessly that an ape “shewn in the London some years ago was taught to sit at table, make use of a spoon or fork in eating its victuals.”⁹ And when Tommy

and Jenny reached the London zoo in the 1830s, they were quickly taught to eat and drink at the table for the benefit of a paying audience. The tradition of the chimpanzee tea party was born. By the 1920s it was a daily ritual at the London zoo; the chimps were trained both to ape human customs and to break them: "There was the ever present danger that their table manners would become too polished."¹⁰ The chimpanzee tea parties at zoos ran for 50 years. In 1956, the Brooke Bond company made the first of many hugely successful television commercials for its tea using a chimps' tea party, and Tetley did not drop its advertisements showing chimps' tea parties until 2002. By 1960, human beings still knew more about chimps' ability to learn tea-table manners than about how the animals behaved in the wild. No wonder apes were viewed as ridiculous apprentice people.

In psychology, mentalism was soon ridiculed and demolished. The early twentieth-century psychologist Edward Thorndike demonstrated that Romanes's dogs invariably learned their clever tricks by accident. They did not understand how a door latch worked; they simply repeated any action that accidentally enabled them to open the door. In reaction to the credulity of mentalism, psychologists began to make the opposite assumption: that animal behavior was unconscious, automatic, and reflexive. The assumption soon became a creed. The radical behaviorists who brushed aside the mentalists in the same decade as the Bolsheviks brushed aside the Mensheviks asserted brusquely that animals did not think, reflect, or reason; they just responded to stimuli. It became heresy even to talk about animals' having mental states, let alone to attribute human understanding to them. Soon, under Burrhus Skinner, the behaviorists would apply the same logic to human beings. After all, people do not just anthropomorphize animals; they accuse toasters of perversity and thunderstorms of fury. They also anthropomorphize other people, crediting them with too much reason and too little habit. Try reasoning with a nicotine addict.

But since nobody took Skinner all that seriously on the subject of people, the behaviorists had unwittingly restored the distinction between the human and the animal mind to exactly where Descartes had placed it. Sociologists and anthropologists, with their emphasis on

the peculiarly human attribute called culture, had outlawed all talk of human instinct. By the middle of the twentieth century, it was heresy to speak of animal minds and heresy to speak of human instincts. Difference, not similarity, was all.

THE SIMIAN SOAP OPERA

That was all to change in 1960, when a young woman virtually untrained in science began to watch chimpanzees on the shores of Lake Tanganyika. As she later wrote:

How naïve I was. As I had not had an undergraduate science education I didn't realise that animals were not supposed to have personalities, or to think, or to feel emotions or pain. . . . Not knowing, I freely made use of all those forbidden terms and concepts in my initial attempts to describe, to the best of my ability, the amazing things I had observed at Gombe.¹¹

As a result, Jane Goodall's account of life among the chimps of Gombe reads like a soap opera about the Wars of the Roses written by Jane Austen—all conflict and character. We feel the ambition, the jealousy, the deception, and the affection; we distinguish personalities; we sense motives; we cannot help empathizing:

Gradually, Evered's confidence returned—partly, no doubt, because Figan was by no means always with his brother: Faben was still friendly with Humphrey, and Figan, wisely, steered clear of the powerful male. Moreover, even when the brothers were together, Faben did not *always* help Figan: sometimes he just sat and watched.¹²

Though few realized it until later, Goodall's anthropomorphism had driven a stake through the heart of human exceptionalism. Apes were revealed not as blundering, primitive automatons, who were bad at being people, but as beings with social lives as complex and subtle

as ours. Either human beings must be more instinctive, or animals must be more conscious than we had previously suspected. The similarities, not the differences, were what caught the attention.

Of course, the news that Goodall had narrowed the Cartesian gap traveled very slowly across the divide between animal and human sciences. Even though the very purpose of Goodall's study, as conceived by her mentor, the anthropologist Louis Leakey, was to shed light on the behavior of ancient human ancestors, anthropologists and sociologists were trained to ignore animal findings as irrelevant. When Desmond Morris spelled out the similarities in his book *The Naked Ape* in 1967, he was generally dismissed as a sensationalist by most students of humankind.

Defining human uniqueness had been a cottage industry for philosophers for centuries. Aristotle said man was a political animal. Descartes said we were the only creature that could reason. Marx said we alone were capable of conscious choice. Now only by heroically narrow definitions of these concepts could Goodall's chimps be excluded.

Saint Augustine said we were the only creature to have sex for pleasure rather than procreation. (A reformed libertine should know.) Chimpanzees begged to differ, and their southern relatives, bonobos, were soon to blow the definition to smithereens. Bonobos have sex to celebrate a good meal, to end an argument, or to cement a friendship. Since much of this sex is homosexual or with juveniles, procreation cannot even be an accidental side effect.

Then we thought we were the only species to make and use tools. One of the first things Jane Goodall observed was chimpanzees fashioning stalks of grass to extract termites, or crushing sponges of leaves to get drinking water. Leakey telegraphed her ecstatically: "Now we must redefine tool, redefine man, or accept chimpanzees as humans."

Next we told ourselves that we alone had culture: the ability to transmit acquired habits from one generation to the next by imitation. But what are we to make of the chimpanzees of the Tai forest in west Africa, which for many generations have taught their young to crack