

R.J. BERRY AND MALCOLM JEEVES

The Nature of Human Nature

Our traditional understanding of humanness has been radically affected by two factors: we now see ourselves as a product of a history that stretches back millions rather than hundreds of years, thus opening the possibility of change from our original state; and over the past few decades we have learnt much about the evolutionary and genetic influences that have formed us, raising acute questions as to how we interpret biblical descriptions of our nature and how we relate to the Creator. We believe that these developments do not conflict with the biblical accounts of humankind, so long as we are open to fresh interpretations when and where new evidence justifies them.

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Introduction

Are we apes on the way up? Angels on the way down? Sinners for whom Christ died or helpless pawns in a post-modern jungle? Pilgrims on a journey or flotsam in a flood? Are we embodied souls or mere DNA reproducing machines driven by deterministic physico-chemical reactions? The nature of humanness is central to anthropology, psychology, sociology – never mind theology, soteriology and eschatology. Any conclusions we make about humanness will necessarily be tentative, but they will be insecure if they are not firmly grounded in the underlying reality of the human body itself – a biological entity produced by the fusion of two genome-carrying gametes, nurtured in a womb for nine months or so, and modified by a gamut of influences: an ‘it’ as well as an ‘I’. We are not in any way claiming that our conclusions will be all-encompassing, but we are clear that it is only when we can agree about the issues raised by these basic facts that we can sensibly examine questions about the interaction of individuals – sociology, social psychology and so on.¹

Unsurprisingly, scholars down the ages have wrestled to define the characteristics of humanness, ranging from Confucius in the fifth century BC [‘By nature all men are alike; through practice they have become far apart’], to

1 ‘Contemporary discussions of science and religion often have a narrow focus as if science and religion were the only sources of knowledge and wisdom. In fact science and religion are members of a far wider array of human faculties, an array that also includes art, architecture, music, drama, law, medicine, history and literature. I find it strange that science should be singled out as a partner of religion... If we look for insights into human nature to guide the future of religion, we shall find more such insights in the novels of Dostoevsky than in the journals of cognitive science’ (Dyson, 2005: 53).

Richard Dawkins in the twentieth century AD [‘Science offers you the privilege before you die of understanding why you were born in the first place’]. Notable recent attempts to grapple with the subject include those by Ed Wilson (1978, 1998), Jared Diamond (1991, 1997), Francis Crick (1994), John Avise (1998), Paul Ehrlich (2000), Francis Fukuyama (2002), Steven Pinker (1999, 2002), the Church of England Doctrine Commission (2003), Daniel Dennett (2006), Malcolm Jeeves (2006), Wentzel Van Huyssteen (2006), Lewis Wolpert (2006) and Frans De Waal (2006).

Perhaps the commonest rationalisation has been to treat science and religion as areas of knowledge that are distinct and mutually independent. This was stated explicitly by John Henry Newman (1873: 389) (‘being separate they cannot on the whole contradict each other’) in his exposition of the nature of a university and was followed by Stephen Jay Gould in his *Rocks of Ages* (1999), where he distinguishes between the realms (or ‘magisteria’ as he calls them) of science [‘the empirical realm: what is the universe made of (fact) and why does it work this way (theory)’] and religion [which ‘extends over questions of ultimate meaning and moral value’]. For Gould, ‘These two magisteria do not overlap, nor do they encompass all enquiry (consider, for example, the magisterium of art and the meaning of beauty). To cite the old clichés, science gets the age of the rocks, and religion the rock of ages; science studies how the heavens go, religion how to go to heaven.’

Newman and Gould represent a very common approach: a surprising number of people keep different areas of understanding in separate compartments and are almost offended when (or if) they find links between them. Christians, alas, easily fall into this temptation; sadly they are capable of denying well-established scientific facts on the grounds that they conflict with their assumptions or traditions. And as Augustine of Hippo wrote in *The Literal Meaning of Genesis* (394 AD):

It is a disgraceful and dangerous thing for an infidel to hear a Christian, presumably giving the meaning of Holy Scripture, talking nonsense on these topics [the earth, the heavens... about the kinds of animals, shrubs, stones, and so forth], which knowledge he holds to as being certain from reason and experience... Reckless and incompetent expounders of Holy Scripture bring untold trouble and sorrow on their wiser brethren when they are caught in one of their mischievous false opinions and are taken to task by those who are not bound by the authority of our sacred books.

A key feature of conventional Christian understanding of humanness has been of a divine image (usually an immaterial, immortal soul) enshrined within a human frame. But we have to be prepared to examine this when faced with new information. As Derek Kidner (1967: 31) commented, ‘it was Galileo’s telescope, not his church, that conclusively refuted the interpretation of Psalm 96:10 [‘The world is fixed immovably’] as a proof-text against the earth’s rotation’.

This is a timely reminder. Jonathan Edwards, one of the strongest champions of biblical orthodoxy ‘regarded Scripture alone as truly authoritative, so earlier interpreters could be revised. The project of understanding scripture’s true meaning was an ongoing progressive enterprise to which Edwards hoped to contribute’ (Marsden, 2003: 474) (our emphasis). It is the Bible that is authoritative not the interpretation given by any particular group of Christians at any particular time. That applies to everything we say in the remainder of this paper.

We have two aims in this paper: to try to reduce error by distinguishing statements in the Bible and their legitimate interpretation from improper extrapolations thereof; and, more positively, to suggest how advances in scientific knowledge can help us to know more of ourselves and the one who ‘fashioned my inward parts and knitted me together in my mother’s womb’. Whilst we have tried to reflect current scientific understanding of human nature (or ‘humanness’), we make no claim that this is a comprehensive review of all the relevant disciplines involved.

Context

Debates about human nature have tended to have two focuses: our origins and antiquity on the one hand, and our intrinsic make-up on the other. The latter has often appeared in debates about whether we are bipartite or tripartite creatures and what makes us uniquely and distinctively human – do we have a soul and if so what is meant by it?

Until the end of the eighteenth century, few Christians doubted that the world was created around six or seven thousand years ago (Archbishop Ussher’s oft-quoted date of 4004 BC was only one of many suggestions), even though the actual ‘days of creation’ in Genesis 1 were often understood non-literally.

For almost two millennia most Christians assumed that we are made up of body and soul, or perhaps body, soul and spirit; theological libraries groan under competing biblical justifications for a bipartite *versus* a tripartite nature. Such understandings can no longer be sustained. Neuropsychological research emphasises how human beings are a psychophysical unity.² Notwithstanding, there are philosophers who accept the idea of psychophysical unity but still manage to hold sophisticated versions of dualism.

In contrast to these interpretations based on past understandings of science, the Bible description of humanness is of creatures uniquely ‘in the image and

2 Markers of this changing emphasis as it impacted on theology can be seen in the works of Robinson (1925), Cullmann (1958), Reichenbach (1978), Colwell (1988), Cooper (1989), Green (1999). Many others could be cited.

likeness of God' (Gen 1: 26). We will return to this in detail, but first we review common perceptions (and misconceptions) of humanness.

Antiquity and origins

In the eighteenth and early nineteenth centuries, the growing acceptance that fossils are the remains of once living organisms, that they characterise different rock strata (and were not merely the results of Noah's Flood) and that geological change is still occurring, forced a recognition that the Earth was much older than previously assumed (Lewis & Knell, 2001). Despite this, human origins were still assumed to be around 6000 years ago, since this was when the biblical genealogies that go back to Adam begin (Gen. 5: 1-3; 1 Chron. 1: 1; Lk 3: 38). However, even this was not straightforward. Isaac de La Peyrère (1655) argued that the Bible taught that Adam and Eve were not the first human beings, but merely the parents of the Jewish people. In other words there were 'pre-Adamites', which helped to explain how Cain found a wife and who had peopled the land of Nod (Gen 4: 16). La Peyrère was heavily criticised, but the idea of pre-Adamites persisted; in the Americas in particular it helped with the question as to how the native inhabitants related to those of the biblical world (Livingstone, 1992; Nelson, 2003).

In 1774, Henry Home suggested that different races were created for different environments, that is to say that God created separate races of humans in different lands (*polygenism*), although Home later rejected this idea in favour of a miraculous origin of diversity at the Tower of Babel. Notwithstanding, polygenism remained popular, especially in the United States (q.v. Nott & Gliddon, 1854), ingenuously associated with the notion that some races were inferior to others. This debate rumbled on in the secular world for more than a century (e.g. Gould, 1981). For Christians it was complicated by the publication (and general acceptance) of Darwin's ideas, plus evidence appearing around the same time from the excavation of Kent's cavern (near Torquay) that humans once lived among now extinct creatures (Grayson, 1983) and the discovery in 1856 of fossils of an apparently primitive form of human in the Neander Valley near Dusseldorf. Some Christians resolutely refused to accept that human origins were earlier than six thousand years or so (e.g. Dawson, 1873; Whitcomb & Morris, 1961; Ashton, 1999), but more and more were forced to believe that pre-Adamic fossils had to be taken seriously. The problem was integrating them with the biblical record.

For many years the leading British geologist of the mid-nineteenth century, Charles Lyell, resisted the assertion of his friend Charles Darwin that *Homo sapiens* had emerged from another (ancestral) species. He vehemently opposed the notion that humans had shown any 'progress' in their history (Lyell, 1863). By implication Lyell's stance meant that Adam and Eve could be dated at around the biblical six thousand years, particularly if they were truly Neolithic

farmers as the Genesis text indicates.³ But during the same period, the public was being introduced to other Great Apes by zoos and Thomas Henry Huxley was giving highly popular lectures on 'Man's Place in Nature' (published in book form in 1863). In his book, Huxley included what became the much-reproduced illustration of a 'grim and grotesque procession' of ape skeletons from gibbon, orang-utan, chimpanzee, gorilla to man; implicitly putting humans at the summit of a progressive continuum. He showed that the anatomist Richard Owen was wrong to claim that humans are unique in possessing a hippocampus (a brain structure). In 1864 Fritz Müller and in 1866 Ernst Haeckel put forward ideas of 'recapitulation': that every individual repeats their evolutionary history during development; in popular language, we all 'climb our evolutionary tree' (an idea not finally undone until Gavin De Beer's demolition of it in 1930). Both comparative anatomy and embryology strengthened the notion that we are the latest stage in mammalian evolution. In the *Descent of Man* in 1871 Darwin concluded 'the time will before long come when it will be thought wonderful that naturalists who were well acquainted with the comparative structure and development of man and other mammals, should have believed that each was the work of a separate act of creation'.

When the *Descent of Man* appeared there were virtually no human fossils known. Since then, many putative hominoid and hominid fossils have been discovered to the extent that it is fair to claim that the human 'line' is better known than almost any other lineage. Its history of mis- and over-interpretations is extensive, but not relevant here; modern stratigraphical and direct (radioactive decay) dating techniques have made reconstruction of the past increasingly more reliable (Jobling, Hurles & Tyler-Smith, 2004). The palaeoanthropological consensus is that the primate line emerged from a rather primitive insectivore-like mammal around 65 million years ago; the New World monkeys split away in the mid-Eocene *c.*45 million years ago; and the primates became distinct from the Old World monkeys *c.*35 million years ago, represented by *Aegyptopithecus* and *Propoliopithecus* from the Fayum Depression, 60 kms south of Cairo. Because of the sediments in which it is found and its skeleton, *Aegyptopithecus* seems to have been a tree-living fruit-eater (Simons, 1992; Soshani, Groves, Simons & Gunnell, 1996).

Ten to fifteen million years later, a widespread quadruped called *Proconsul* occurred in Kenya and Uganda; it was similar to *Aegyptopithecus* and very variable, ranging in size from that of a large monkey to that of a gorilla. It is generally considered to be on (or near) the early primate line. Other ape-like skeletons have been found in Spain, Hungary, Italy, Greece, Turkey, Indo-Pakistan and China from the late Miocene (5-10 million years ago); most disappeared from the fossil record around the end of the Miocene. However, related

³ Adam was 'put in the garden of Eden to till it and look after it' (Gen 2: 15); his sons Cain and Abel were respectively a shepherd and a farmer (Gen 4: 2); Cain lived in a town (Gen 4: 17); seven generations later, Tubal-Cain was living in the Bronze Age (Gen 4: 22).

fossils are found in South and East Africa from about the same time and show a split between the modern apes and our apparently more direct ancestors, the australopithecines. The latter had small brains but, like *Homo*, had reduced canine teeth and limbs capable of bipedalism.

The first fossils classified in the genus *Homo* occurred between 2.0 and 1.6 million years ago in strata from east and south Africa; they are named *Homo habilis*. About 1.8 million years ago, a new form of *Homo* appeared in eastern Africa, *H. erectus*. It persisted in Africa for more than a million years ago, but also spread out of Africa into Asia (Finlayson, 2005). It seems likely that this movement was a response to drought conditions and presumed food shortages in Africa (Cohen et al., 2007). *H. erectus* had a brain size (or more strictly, cranial volume) of 800-900 ml, about a third greater than *H. habilis*, and a less projecting face. It was formerly assumed to be a direct descendant of *H. habilis* but the discovery that the two species existed together in Kenya for half a million years makes this less likely (Spoor et al., 2007). Four hundred thousand years ago, the earliest fossils regarded as *H. sapiens* (brain c.1100-1300 ml) occur. They have been found in Africa, Europe and China. 'Neanderthal man' appeared c.200,000 years ago in Europe and SW Asia. It is now regarded as at least sub-specifically different from *H. sapiens*, and coexisted with the latter until disappearing 30,000 to 40,000 years ago (Stringer, 2002). There is still much to be found out about the *Homo* lineage (the relationships of a dwarf form from Indonesia, *H. floresiensis* [nick-named 'the Hobbit'] which apparently survived until at least 18,000 years ago, are still not understood: Brown et al., 2004), but the main line of *Homo* descent seems to be robust.

Human nature as seen by scientists: common descent

Fossils of the genus *Homo* show fairly consistent trends in increasing brain and decreasing tooth size. Some changes were rapid. For example, brain size increased by about 50 per cent between the earliest *Australopithecus* and the earliest *H. erectus*, and by 50 per cent again between *H. erectus* and the present. Assuming that *Homo* and *Australopithecus* share a common ancestor, this must be a genetic difference. The second period was only half as long as the first. Cavalli-Sforza & Bodmer (1971: 692) have calculated that the second phase of increase could be achieved with a selection differential of only 0.00004 per generation, which is very small compared to other selection pressures operating in the wild (10,000 times less than observed in the Galapagos Islands finches: Boyd & Silk, 2006: 21). Notwithstanding, they comment that the evolution of human brain size is among the most rapid of known evolutionary processes.

Whilst there can be no absolute proof that the various 'fossil man' taxa are genetically related to each other, knowledge of the universality of the genetic code and the extraordinary (and unexpected) amount of continuity in coding sequences among very different organisms makes it incredible (in the literal

sense of that word) that all primates, all mammals, indeed all vertebrates do not have a common ancestry (Jobling, Hurles & Tyler-Smith, 2004). With the advent of rapid DNA sequencing methodologies, molecular phylogenetics has advanced from the crude comparison of a few macromolecules in different organisms to a science capable of identifying the quantitative difference between primary gene products and the timing of these in relation to assumed branching events (Awise, 1994; Rokas & Holland, 2000; Carroll, 2003). For example, many of the genes concerned with olfaction are inactive in humans but in none of the other primates; the same molecular change in humans, chimps and gorillas means all lack a functioning α -fucosyltransferase enzyme, although orangs and monkeys have a functional version of the enzyme; all the apes and the Old World monkeys have a cytochrome b gene which is not carried by the New World monkeys (Finlay, 2003). Information about many more such examples is given in the standard textbooks of biochemical genetics (Sebat, 2007). They can be used to construct robust pedigrees, much more certain than those based on morphological features that are equivocal, because the latter traits can have different genetic origins.

A particularly striking example is the *Hox* (homeotic) series of genes. They were first identified in the fruit fly *Drosophila melanogaster*, where mutants in them produce organs in the 'wrong' place, such as legs on the head or an extra pair of wings. In insects, there are two *Hox* clusters, one with three and the other with five loci; these eight genes control sequential segments along the body. All eight share a very similar sequence of 180 or so nucleotide bases, around 20 per cent of the total length of each gene. This sequence is almost identical to one found in bacteria and yeast, where it regulates a whole suite of enzymes; remarkably, the same sequence is also found in amphibia and mammals – and in flowering plants. The protochordate, *Amphioxus*, has one cluster of *Hox* genes; all the vertebrates have four clusters (with the exception of the jawless agnatha, which have three), each similar to the insect group and arranged in the same order, albeit on separate chromosomes. The vertebrate situation must have arisen through repeated duplication of the original *Hox* cluster, enabling greater versatility in development and reducing the need for embryological determinism; this flexibility has been particularly significant in the evolution of the head and brain of vertebrates (Holland et al., 1992; Furlong & Holland, 2004).

Genome maps enable the total genetic constitutions of different organisms to be compared. The earlier calculation that humans and chimps share 98.4 per cent of their genes has been refined now that both genomes have been sequenced; nevertheless there is identity between more than 95 per cent of the genes in the two species. Notwithstanding, our DNA differences from the chimpanzees amount to around 10,000 nucleotide changes (Britten, 2002; Saitou, 2005), most of them in DNA regions that do not encode proteins, some of these regions being involved in regulation of the activity of protein coding sequences; they are largely due to fairly small duplications in the human genome, other differences are small insertions or deletions (Cheng et al., 2005). Over 90 per

cent of the genes that are common to mouse and human are in conserved blocks (i.e. in the same order in the two species).

There is no evidence that there are many novel genes in the human genome (Boffelli et al., 2003). Around eight per cent of the human genome apparently consists of retroviral inserts influencing gene regulation in significant ways (Medstand et al., 2005; Biemont & Vieira, 2006). Bustamante et al., (2005) examined 11,624 loci which had different alleles in chimp and human and found that one in ten were apparently affected by natural selection: 304 by positive selection while another 813 had apparently been subjected to negative or stabilising selection. Pollard et al., (2006) have shown that virtually all the genomic regions which show the greatest divergence are ones concerned with regulation of coding sequences, a particularly significant one being a locus expressed in the developing brain cortex between two and four gestational months (differing from the chimp in 18 substitutions compared with an expected rate of 0.27 based on the rate in other amniotes). One of the most intriguing results that has so far emerged from comparative molecular genetics is that since the human and chimpanzee lines separated around 6 million years ago, a third more chimpanzee genes show signs of selection than do human ones (Bakewell, Shi & Zhang, 2007). An implication of these results is that chimpanzees are more specialised than humans; we are generalists, they are adapted to a particular niche. There is no scientific support for the notion that we have been propelled towards a predetermined end by either a Blind or a Divine Watchmaker.

Putative relationships can be derived from chromosomes as well as genes (O'Brien et al., 1999). All the great apes except humans have 24 pairs of chromosomes; humans have 23 pairs. Individual chromosomes can be identified cytochemically. The large human chromosome no. 2 is the result of an end-to-end (telomeric) fusion of two individual ape chromosomes (Ijdo et al., 1991). Such 'Robertsonian translocations' are not infrequent between (and within) species.

Reconstructing human evolution by whatever criteria is, of course, speculative – albeit informed speculation. Notwithstanding, there is a wide consensus that a key human characteristic is the complexity of language (e.g. Hinde, 1987). Many people have argued that the key difference between chimpanzees and us is our ability to communicate in a spoken language with a large vocabulary, while the apes are apparently incapable of uttering some of the commonest vowel sounds. The neuropsychologists George Ettlenger and Richard Passingham agree that significant aspects of language are 'the ability to represent information *within* an individual's mind' (Ettlenger, 1984) and 'our ability to represent words to ourselves; to manipulate internal systems' (Passingham, 1982). Jared Diamond (1991: 47) suggests that a significant stage in human differentiation involved 'the structure of the larynx, tongue and associated muscles that give us fine control over spoken sounds... The missing ingredient [which prevented the chimps developing more complex speech] may have

been some modification of the proto-human vocal tract to give us finer control and permit formation of a much greater variety of sounds.'

The human supralaryngeal pathway is entirely different from all other mammals. We do not know when this change occurred; it was probably in the early history of the human lineage. Between 10,000 and 100,000 years ago, two nucleotide differences appeared in the human line in a gene ('forkhead box P2' or *FOXP2*) which codes for a transcription factor controlling genes affecting grammar, speech production, non-verbal intelligence, and non-speech related movement of the mouth and face, plus cerebellar development. This gene is highly conserved: mice and primates differ in only one out of its 715 amino acids (Enard et al., 2002). Intriguingly, a single point mutation on the long arm of chromosome 7 [the same section involved in the determination of a tendency to autism] carried by 15 out of 31 individuals in three generations of a human family produced a complex of symptoms, including an inability to speak intelligibly. An induced mutation in the homologous segment in mice leads to a failure to produce ultrasonic sounds and also to cerebellar defects, probably as a result of effects on neuronal migration during cerebellar maturation (Shu et al., 2005). We return to a more up to date and detailed consideration of some of these issues in our discussion of evolutionary psychology (below).

Another approach to human distinctiveness has been to compare the overall biologies of apes and humans. An outstanding difference is in development time: humans take twice as long to mature post-natally as do chimpanzees or gorillas, although their gestation lengths are similar (Abbie, 1958; Gómez, 2004). For example, the human primary dentition appears at around 6 months and the secondary dentition at about 6 years, as compared with 3 months and 3 years respectively in chimpanzees. Humans grow for 20 years and live for 70 years, compared to 10 and 35 years in the apes. Sexual maturity in human females takes place at 12 years of age, compared with 6-8 years in the apes. Mutations producing similar 'neotenuous' changes are known in many organisms. Studies of fossil skull size and tooth eruption order indicate that the change in growth pattern took place in *Homo erectus* about a million years ago.

The large brain of humans is possible because of its post-natal growth: the human skull is not ossified at birth and this allows the brain to continue to increase in size – which it does for a year compared to only a month or two in chimpanzees. However, large brains require large amounts of energy: about 20 per cent of resting metabolism in humans supports brain metabolism, compared with 9 per cent in chimpanzees and 2 per cent in marsupials. Larger brains have a low tolerance for variations in temperature, blood pressure and oxygenation, and possessing them may involve obstetric risks (Smith, 1990). This means there must have been an acute need (and therefore strong selection) to increase energy intake (Leonard & Robertson, 1997). The likelihood is that a shift from vegetarianism to carnivory was important in the survival of the large-brained line (Milton, 1999; Berry, 2006); a hominid feeding on animals could significantly increase his caloric input. The occurrence of animal

bones and stone tools at early *Homo* sites is probably significant (Bunn & Kroll, 1986), as is the reduction of prognathism and posterior tooth size at the same time, consistent with a reduction from tough and fibrous foods. This in turn would be likely to encourage social grouping for defence and food storage and an increase in male-female bonding for increased stability (Wrangham et al., 1999).

It is uncertain when humanness (however defined) first arose. Claims have been made that it is shown by formalised burials, implying a belief in life after death; beads and body ornaments; cave paintings; or the origins of agriculture and animal domestication (Maringer, 1960; Mithen, 1996; Noss, 1964; Van Huyssteen, 2006). McBrearty & Brooks (2000) present evidence that many of the components of 'humanness' can be recognised in the African archaeological record 40,000 to 50,000 years ago (stone tools, specialised hunting, use of aquatic resources, long distance trade, art and decoration). They argue that its origins were spread over a long period. Bouzougger et al., (2007) have described a painted necklace from Morocco dated 80,000 years ago. Brooks (2007) cites the description of a toothless 1.77 million year old skull by Lordipandze et al., (2005) and suggests that 'signs of empathy may also be evident in the survival of individuals with crippling injuries or major deficits, who could not have survived long on their own'. Notwithstanding, none of this changes the general acknowledgement that the process of 'humanisation' depended crucially on sophisticated communication, most importantly the development of language (Diamond & Bellwood, 2003). Mithen (2006) has argued that 'language as we understand it' evolved through 'segmentation' of phrases, capable of recombination to create an infinite array of utterances (see also Wray, 1998; Hauser, Chomsky & Fitch, 2002). This in turn facilitated 'social intelligence' (Dunbar, 2004).

Alison Brooks (2007) posits that such 'social intelligence' must involve at least six different faculties: abstract thought, the ability to cooperate in forward planning, problem solving through behavioural, economic and technological innovation, 'imagined communities', symbolic thinking, and a 'theory of mind'. A key feature of such a theory of mind is the ability to understand that other individuals may have ideas and desires different from one's own. The existence of mind in this sense is now established by experiment (see below); but the way that culture has emerged from linking genetic lineage and cognitive ability must, for the present, remain hypothetical (Bishop, 2002). Brooks believes that the appearance of humanness has been a gradual process; she points out that 'the more we know, the harder it is to draw a line between human and nonhuman or pre-human'. She concludes that 'capacities for some of the most human qualities: creativity, empathy, reverence, spirituality, aesthetic appreciation, abstract thought, and problem-solving (rationality) were already evident soon after the emergence of our species'. However the appearance of language may have been relatively recent, perhaps in the past 40,000 years or even later (Mithen, 2006). Partial answers to some of these uncertainties come from studies in evolutionary psychology, as we shall see in later

sections. They blur the behavioural distinctiveness of humans whilst recognising that the differences between the apes and us are so great that they may be seen as qualitative.

Human uniqueness as seen by scientists: evolutionary psychology

Genetics and psychology as formal disciplines within science only appeared at the end of the nineteenth century: in 1900, Mendel's results were 'rediscovered' and in 1901 William James (1902) delivered his ground-breaking Gifford Lectures on the 'Varieties of Religious Experience'. In 1899, Lloyd Morgan was the first psychologist to be elected to the Royal Society of London.

Lloyd Morgan's comparative studies would today be called evolutionary psychology. In his time, the aim was to link the increasing complexity of the brain and central nervous system with more elaborate behaviours and learning capacities, producing a scale to link changes in sensory processes and learning to an animal's phylogenetic position. But what about our uniqueness? Evolutionary psychology has no interest in seeking to deny the uniqueness which Christians claim comes from God's gracious invitation to have a personal relationship with Him. That is not to say that individual scientists do not have their personal beliefs about such issues. This is well illustrated by differing emphases on the significance of the ability of an individual to respond to assumptions it makes about the beliefs and desires of another individual rather than responding directly to its overt behaviour ('being able to mind read'). This idea derives from work by Premack and Woodruff (1978) describing animals with the apparent ability to understand the mind of another animal.

Whiten & Byrne (1997) suggest that clever looking behaviour in some non-human primates which looks like mind-reading in humans, results from a rapid increase in neo-cortical volume. Richard Byrne (2006) has commented:

Quite what benefits a large neo-cortex brings to the underlying cognitive basis of monkey and ape social sophistication is not straightforward. It is tempting, but may be utterly wrong, to assume that an animal that works over many months to build-up a friendly relationship has some idea of the effect its behaviour is having on the mind of the other...We assume the agent realises that by producing a false belief in his victim may risk losing a friend or gaining an enemy. The alternative is a more prosaic mixture of genetic predisposition and rapid learning – and often this is more likely.

He warns, 'Researchers have to be very cautious in attributing to non-human primates the ability to understand social behaviour or how things work in the mechanistic way of adult humans.'

This is an area fraught with misunderstanding and misrepresentation. For example, Fisher (2005), writing as a theologian, sought to summarise the sci-

entific evidence about human distinctiveness. In an otherwise excellent review of trends in evolutionary psychology, he identified as a key question whether animals have a theory of mind, but was snared by the temptation of appealing to science to settle a theological issue. In his paper, he records that Daniel Povinelli found 'no evidence that chimpanzees reason about intentions as internal states' (Povinelli, Bering & Giambrone, 2000) and quotes another leading worker in the field, Michael Tomasello (2000), as seeing 'the social nature of human cognition more than anything else as unique to the human mind'. Unfortunately for Fisher, both Povinelli and Tomasello have since changed their minds (Povinelli & Vonk, 2003; Tomasello, Call & Hare, 2003) because of field data gathered by Byrne and Whiten (1988). Tomasello has written:

in our 1997 book *Primate Cognition* we reviewed all the available evidence and concluded that nonhuman primates understand much about behaviour of conspecifics but nothing about their psychological states [but] in the last five years new data have emerged that require modification of this hypothesis. The form that a new hypothesis should take is not entirely clear *but we are now convinced that at least some nonhuman primates – the research is mainly on chimpanzees – do understand at least some psychological states in others* (Our italics).

But it is not only theologians who respond in this sort of way. The same happens to ideological reductionists seduced by the ever present lure of 'nothing buttery'. When similarities between the behaviour of humans and some non-human primates are identified, they have an automatic temptation to say that humans are 'nothing but' unusually complex primates and ignore the distinctiveness of the ethical, moral and religious aspects of human cognition and behaviour. Frans De Waal (1996) has cautioned against such unthinking reductionism:

to communicate intentions and feelings is one thing; and to clarify what is right, and why, and what is wrong, and why, is quite something else. Animals are no moral philosophers... the fact that the human moral sense goes so far back in evolutionary history that other species show signs of it, plants morality firmly near to the centre of our much maligned nature... humankind's uniqueness is embodied in a suite of features that include ethical behaviour and religious beliefs.

In similar vein, Richard Byrne, commenting on a reported trend for step-fathers to murder their partner's babies under three years old, warns about forcing such findings into assumptions about so-called evolutionary stable strategies: 'these are not carefully thought out by beasts... They are human applied labels based on the superficial appearance of the actions of individual animals whose behaviour is partially governed by genes... natural selection is a mechanistic process and thus morally neutral; discovering a genetic influence on murder does not condone it...' (Byrne, 2006). For Alison Brooks (2007): 'Psychologists (evolutionary and otherwise) focus on the expression in humans

of such characters as “theory of mind”, “ability to imitate”, “empathy”, “problem solving abilities”, and so on, *but in every case at least one of the great apes (and other animals as well) has shown a degree of these features that will not permit an absolute distinction between humans and other animals*’ (our italics).

Despite the concern of some Christians about the apparent narrowing of the gap between ourselves and the non-human primates, we believe that there are no great theological issues at stake in such research. A Christian can be enthusiastically open-minded about developments in evolutionary psychology, glimpsing fresh pointers to the greatness of the Creator in the wonders of his creation. We can embrace research in this area as having potential implications for understanding distressing human conditions. For example, mind-reading behaviour is often deficient in autism; fuller knowledge may make ways possible to help sufferers. Rightly applied, scientific results in evolutionary psychology hold out promise of enabling us better to fulfil our caring stewardship.

Problems raised by scientific models of human nature

1. Determinism: dualism, monism and freedom

Most scientists whether Christian or not have no doubt that they have chosen to be scientists and focus their energies on specific scientific problems. They recognise, however, that aspects of their understanding (for example, the links between mind and brain) have been interpreted as meaning that we are not as free to act and to think as is commonly assumed. From the time of William Harvey and the discovery of the circulation of the blood (particularly the role of the heart as a pump), the human body has been increasingly seen as a machine. A result was that ‘people made a sharp soul-body distinction, and the soul fell beyond the scope of science – so everything to do with human inwardness and personal and social behaviour remained the province of the preacher and moralist’ (Cupitt, 1984:59). This strengthened classical assumptions: Plato, Aristotle, Origen and Nemesius assumed that we have a bipartite nature (body plus soul); Augustine (354-430) believed we are tripartite – a rational soul *using* a mortal and material body, rather than simply being imprisoned in a body. For Aquinas (1225-74) nearly a thousand years later, the soul was an ‘incomplete’ substance produced by special creation at the moment the embryonic organism was able to receive it. With Descartes the classical tripartite division of body, mind and soul reverted to a bipartite separation of material and thinking substances.

For long dualism remained both scientific and theological orthodoxy. It was even supported (tenuously) by scientific experiment. An American physician calculated that the average weight of the soul was seven ounces (21 gm), based on the average weight loss of six men as they died; 15 presumably soulless dogs showed no change in weight at death (MacDougall, 1907).

Cartesian dualism is implicit in the statement of Pope John Paul II (1996) that while 'evolution is no longer a mere hypothesis, theories of evolution which consider the mind as emerging from the forces of living matter or as a mere epiphenomenon of matter, are incompatible with the truth about man. Nor are they able to ground the dignity of the person.' Oxford Professor of the Philosophy of the Christian Religion, Richard Swinburne (1996) claimed to find the arguments for dualism 'inescapable'. In contrast, Stuart Hampshire (2004) wrote, 'There is a tendency to think of the body and brain as the substrate or ground upon which thought is based. This cannot be right, because the two attributes are complementary and completely equal and co-extensive within the one substance, and neither of them can be reduced to the other or causally related to the other.'

Some, most influentially the Nobel Laureate, John Eccles (1989 and elsewhere), have claimed that Heisenberg's uncertainty principle provides a mechanism safeguarding freedom to choose and act. His view is both essentially dualistic and intrinsically unlikely: the brain is organised on a teamwork principle, so the unpredictable behaviour of a single brain cell is unlikely to make a significant difference to the overall functioning of the brain. At the sub-atomic level this may have a substantial effect, but it becomes increasingly negligible with bigger objects: fluctuations in the brain due to other influences will far outweigh it. Attempts to invoke chaos theory run into similar problems.

Eccles leaned heavily on the work of the neurophysiologist Libet (1973) who reported that a short train of pulses applied to the cortex of a conscious patient may elicit a sensation 'backdated' to the time of onset, although a train of one or two pulses alone produces nothing. Eccles (Popper & Eccles, 1977) inferred from this that 'there can be a temporal discrepancy between neural events and experiences of the self-conscious mind'. But as MacKay (1991, esp. Chapter 3) pointed out the data could equally be interpreted as showing that the direct neural correlates of the elicited sensation were in some different region of the brain, and a simple conditional coding operation could allow the time label to be computed by a backward extrapolation from the output of the integrated process to the putative start of the stimulus. Libet's findings have not stood the test of time (Gomes, 2002).

Hobson (2004) has suggested that Eccles maintained his dualism because he failed to come to terms with evidence from sleep research; Hobson claimed that 'all available evidence is that consciousness, including what we might call spirit or soul, is a brain function'. He believes that diehard dualists like Eccles retreat to the position of Descartes by insisting that the relationship of mind and brain is best understood as two perfectly synchronised watches, set in parallel motion by God and evidencing God's remarkable creative process. However, for Hobson, 'no evidence whatsoever exists to favour this hypothesis over the integrationist view that mind and brain are two levels of a uniform system'.

In 1950, Peter Laslett edited a book on *The Physical Basis of Mind* in which a number of distinguished biological scientists came near to a consensus that

the neural activity of the brain somehow interacts with the private world of the mind. They left unresolved the extent to which it was necessary to hold a dualist view in order to safeguard individual freedom. This uncertainty has now changed to a growing consensus that the most fruitful approach is to treat mental activity as embodied in brain activity rather than arising from it or identical with it. In other words, to regard mental activity and correlated brain activity as inner and outer aspects of the same complex of events which constitute conscious human agency, the two approaches demonstrating logical complementarity. It seems likely that establishing any causal linkages between a person's belief and any corresponding physical change in the brain will require generations of research effort. Notwithstanding there is no *prima facie* case for assuming extra-scientific ideas such as mind exerting power over matter. What needs to be explained is how the physical correlates of particular mental events have the effects they do in terms of the laws of biophysics, biochemistry and neuropsychology. The danger is mixing our categories from different levels when we seek to trace scientific chains of causation.

Notwithstanding the increasing scientific persuasion to avoid dualist views of mind and body, dualism of body and soul has remained attractive to Christian apologists because it seems implicit in the Bible. Indeed, through the centuries biblical expositors have regarded the 'soul' as an essential part of humanness. But it is an assumption that does not withstand close scrutiny. Colwell writing on 'anthropology' in the IVP *New Dictionary of Theology* (Ferguson & Wright, 1988) describes the biblical words traditionally translated 'soul' (*nephesh, psyche*) as 'an interpreters' minefield'. For example, *nephesh* occurs 754 times in the Old Testament, and may mean: appetite, throat, person, self, corpse. On 19 occasions it is used of animals; for 280 times, it merely means 'me'; in 120, the word is connected with emotions. Overall it refers either to a whole person or some aspect such as feelings, mind, personality; the only common factor is that it never refers to something external to a person.⁴

Joel Green (2002) identified 'one of the primary pillars in the argument for some form of dualistic portrayal of the human person [is] the presumption of the centrality to biblical eschatology of a disembodied intermediate state'. This led him to analyse the key passages that deal with Sheol and its inhabitants: the Parable of Dives and Lazarus; Jesus' exchange with the criminal on the Cross (Lk 23: 40-43); and Paul's teaching in 2 Cor 5: 1-10. Green points out that they are all concerned more with resurrection hope than with death. He concludes that we 'have to face the reality that a coherent 'biblical' eschatology in which a disembodied, intermediate state plays a central role, is actually an extra-biblical construct against which the biblical evidence must be set'. He finds 'the dominant view of the human person in the New Testament is that of

4 'If the immortality of the soul and hence dualism, are essential to Christian thought, then the Church should be bracing for an encounter with science far overshadowing debates about creation and evolution' (Stone, 2004: 48).

ontological monism. Such notions as 'escape from the body' or 'disembodied soul' falling outside the parameters of New Testament thought'.

Modern expositors tend to be circumspect in their use of 'soul'. Karl Barth (1960: 350) speaks rather gnomically of the human being as 'bodily soul, as he is also besouled body', 'to call man "soul" is simply to say in the first place that he is the life which is essentially necessary for the body'. Ray Anderson (1998: 179) is unequivocal that 'the concept of an immortal soul is without clear biblical support'. Tom Wright (1999) agrees:

The language of soul is telling us a story: the trouble with shorthands is that they can become absolutised. The story is of a person living with God and towards God, 'departing and being with Christ'. I prefer not to go beyond where scripture takes us on such things; Paul does not speculate as to what precisely happens when one has departed. In 2 Corinthians 5: 1-5 he is stressing that the eventual goal is a totally renewed body, not a disembodied spirit. It is natural for us to use the language of separation of body and soul, in order that we can then have a word available to talk about the person who is still alive in the presence of God while the body is decomposing. But we should not talk about 'the soul' as 'a part' of the person that was always, so to speak, waiting to be separated off like the curds from the whey.⁵

Returning to science, we find neuropsychologists stress the unity of the human person, and the links between physical or chemical damage and personality changes. The neurologist Antonio Damasio (1994) has declared 'the distinction between diseases of brain and mind and between neurological problems and psychological/psychiatric ones, is an unfortunate cultural inheritance that permeates society and medicine. It reflects a basic ignorance of the relation between brain and mind.'

For psychiatrists, the unity of mind-body-soul is poignantly clear in clinical phenomena like the moral and religious breakdown of some individuals with Alzheimer's Disease, the hyper-religiosity of some with temporal lobe epilepsy, or spiritual depression following physical disorder (Weaver, 2004; Davies, 2004). All these demand a unitary understanding of humanness, one which converges towards the more robust attitude now coming from biblical scholars. As Joel Green (1998: 152) comments, 'the findings of colleagues in evolutionary biology, genetics and cognitive psychology... speaking of "a capacity for ethics", "moral accountability" or "personal relatedness" come close to a fundamental concern witnessed throughout the biblical canon with the full embodi-

5 Part of the reluctance of Christians to forgo 'soul language' is probably the felt need to counter attacks like that of Francis Crick (1994): "You", your joys and sorrows, your memories and your ambitions, your sense of identity and free will, are in fact no more than the behaviour of a vast assembly of nerve cells and their associated molecules... The idea that man has a disembodied soul is as unnecessary as the old idea that there was a Life Force. This is in head-on contradiction to the religious beliefs of billions of human beings alive today.'

ment of humanity in relation to all creation, the full integration of the human being within the human body...'

2. Determinism: genes and behaviour

What about personal autonomy in the light of evidence from genetics? Are we the prisoners of our genes – or indeed, of our past experiences?

As regards genetics, an important starting point is that we are much more than the sum of our genes (Nuffield Council on Bioethics, 2002). It is not true that the blueprint laid down by the fusion of egg and sperm decides our desires, abilities and moral quirks as well as such characteristics as sex and size. Assumptions about genetic determinism owe more to Aldous Huxley's *Brave New World* (first published in 1932) than to the science of genetics. An interesting by-product of the Human Genome Project has been the recognition that we have 20,000 to 25,000 coding genes, far too few for there to be a one to one relationship between gene and character. It is vastly over-simplistic to treat any phenotypic trait as 'determined' by a particular gene; virtually all characters are 'epigenetic' – the result of the interaction of genes and consequently subject to environmental influences. Only a very small number of our traits (such as eye colour and blood groups) can be directly related to primary gene action. Simply inherited chemical defects such as phenylketonuria can cause gross mental handicap, but most mental disability is the consequence of interactions between many genes and with the environment. A range of behavioural traits (including sensation seeking, attention deficit hyperactivity syndrome, liability to addiction – both to gambling and smoking) are associated with variants of a dopamine receptor gene (DRD4) (Ebstein, Benjamin & Belmaker, 2000; Cloninger, 2002). Many intrauterine nutritional and hormonal factors influence a range of illnesses in later life (Lee & Kerrigan, 2004; Van Assche, Holemans & Aerts, 2005). Caspi et al., 2003 found that liability to clinical depression in some people is affected by variation in a serotonin transporter gene. The association with genetic variation is not consistent, indicating that not all depression is caused by serotonin variants. Cloninger (2000) summarises: 'Even when we get to the level of molecular genetics, we find extensive epistatic interaction among multiple loci influencing variation in each trait... We need to shift away from linear causal thinking about one or two variables at a time and certainly give up exclusive reliance on categorical labelling of personality disorders.'

These considerations mean that any complex trait is likely to have evolved through the accumulation of many individual steps. Darwin himself proposed this in the *Origin of Species* and some of the details have been worked out for both the mammalian ear and the mammalian eye. Nilsson & Pelger (1994) calculate that around 1800 steps were probably needed to produce an eye, and some of these would have been subject to fairly intense selection. About 130 different genes are involved, but crucially some of the key ones involved are com-

mon to both insects and mammals and consequently available for selection (Gehring, 2002). Fossils showing the evolution of the ears of mammals from the lower jaw bones of reptiles have been long known. Remarkably it seems that these changes happened independently in both the monotremes (egg-laying mammals) and the true mammals (Rich et al., 2005). The key is adaptive function, not the genes that contribute to it.

A corollary is that claims for 'a' gene for any complex trait are almost certainly incorrect. When it was discovered that there was a high proportion of tall men in detention for criminal aggression who had an XYY chromosome complement rather than the normal XY, there were claims that their behaviour was the result of genes on the Y chromosome. However, it was soon found that there were many XYY men in the general population with no unusual symptoms (Jacobs, 1975).

Likewise, it has not been possible to establish that there is a 'gay gene' despite considerable research effort. Although twin studies suggest an inherited component to homosexuality with nearly half of identical twin pairs having both members homosexual, it has to be recognised that the other 50 per cent show no concordance (Kendler et al., 2000). A genomewide search for linkage between any gene and homosexual behaviour in males produced nothing significant (Mustanski et al., 2005). There has been no confirmation of a report (LeVay, 1991) that there are differences at *post mortem* in the brains of homosexuals and non-homosexuals (One of the problems in the original study was that many of the brains from homosexuals were from men who had died from AIDS). For David Myers (1998: 380) 'perhaps biological factors predispose the temperament that influences sexuality in the context of individual learning and experience. The consistency of the genetic, prenatal and brain findings has swung the pendulum towards a physiological explanation.'

These points about (non)determinism extend to virtually all behavioural and mental traits. Two of the leading neuroanatomists of the eighteenth century, Gall and Spurzheim, were phrenologists, associating particular mental processes with particular parts of the brain. In 1861, Paul Broca provided clues to the localisation of speech in the left cerebral hemisphere. A century and a half later, the development of imaging techniques has greatly tightened the link between measurable neural activity and specific behavioural responses (Tancredi, 2005). All this has led to a widespread belief that there is a fixity about the neural embodiment of cognitive and conceptual abilities – a fixity often described as specificity. This can easily be overstated. Fifty years ago, research began to show how the physical and social environments of animals can shape and mould their brains as they grow to adulthood (e.g. Rosenzweig, Kretch & Bennett, 1958). More recently, Matthews et al. (2001) have demonstrated the long-term effects of the early environment on adult behaviour through quite specific changes in the biochemistry of the brain and concentrations of different neurotransmitters.

The converse is that sustained behavioural therapy may produce neuronal

changes. The title of a paper in the journal *NeuroImage* well illustrates this: 'Change the mind and you change the brain: effects of cognitive behaviour therapy on the neural correlates of spider phobia'. The authors concluded that '... changes made at the mind level, within a psychotherapeutic context, are able to functionally 'rewire' the brain' (Paquette et al., 2003: 408). Advances in brain scanning technology have shown how the brain can be 'moulded' or 'sculptured' by cognitive processes (including habitual behaviour) as well as the social and the physical environments (Robertson, 1999). Changes in cognition may be paralleled by localised changes in the brain. An intriguing example of this is in London taxi drivers. Noting that licensed London taxi drivers are renowned for their extensive and detailed navigation skills, Maguire et al. (2000) undertook structural MRIs of the brains of a group of taxi drivers and matched controls, and found that the anterior hippocampi of the former were significantly larger after two years of intensive training. Furthermore, the volume of grey matter in the right hippocampus correlated significantly with the amount of time spent as a taxi driver. They concluded '... it seems that there is a capacity for local plastic changes in the structure of the healthy adult human brain in response to environmental demands'.

Perhaps, unsurprisingly, a book with the title *Train your Mind, Change your Brain* (Begley, 2004) soon appeared, offering a popular account of the accumulating evidence for neuroplasticity. It reported continuing work on the well established placebo effects of inert pills but reminded readers that the effects of placebo treatment may be due to activity in different parts of the brain from the real medicines. In this instance it was an antidepressant, paroxetine, that was administered to depressed adults whilst others underwent 15 to 20 sessions of cognitive behaviour therapy. When the brains of both groups were scanned the results showed muted overactivity in the frontal cortex in the cognitive behaviour therapy group but raised activity in the antidepressant group. The conclusion was 'with cognitive therapy the brain is rewired to adopt different thinking circuits' (Begley, 2007).

Dramatic links between brain and behaviour appear occasionally in the clinical literature. A recent example described a schoolteacher who had begun collecting sex magazines and visiting pornographic websites, something which he claimed unable to stop himself doing (Burns & Swerdlow, 2003). He was arrested for child molestation, convicted and underwent a rehabilitation programme which was unsuccessful. The day before his final sentencing he went voluntarily to a hospital emergency department complaining of a severe headache. He was distraught and contemplating suicide; he was unable to control his impulses to the extent that he propositioned nurses in the hospital. An MRI scan of his brain revealed a large tumour pressing on his right frontal lobe. When this was removed, his lewd behaviour and paedophilia faded away. A year later he began to manifest paedophilia again. New MRI scans showed that the tumour was beginning to regrow. It was removed and once again his urges subsided. More recently, further evidence of how the capacity for making moral judgments may be severely compromised when there is damage to an

area of the brain behind the forehead has been published (Koenig et al., 2007). The authors reported that patients with damage to the ventromedial pre-frontal cortex were twice as likely as controls to make 'immoral decisions' (as simulated in experimental tasks) which could seriously harm others.

Cases like this have been used to argue that much behaviour is organic and not the 'fault' of its perpetrators. Brunner et al. (1993) studied a large Dutch family in which many of the males showed aggressive criminality. They found this was associated with a mutation in the gene for monoamine oxidase A. Changes in the blood concentrations of a number of neurochemicals such as dopamine and serotonin may produce aggressive or anti-social behaviour (Faraone et al., 2001; Schumacher et al., 2007). Findings like these have led to attempts to use 'genetic predisposition' as a defence in criminal prosecutions (Joseph, 2001; Lowenstein, 2003).

Localisation of functions within the brain can lead to serious misunderstanding about the plasticity of the developing brain. This frequently appears in the work of Steven Pinker (1999). Pinker bases his arguments mainly from adult neuropsychological data and from genetic disorders involving language. Karmiloff-Smith (2002) has pointed out that Pinker's interpretations are based on a static model of the human brain that ignores the complexities of gene expression and the dynamics of post-natal development. She has shown in detail that the brain is neither hardwired nor a blank slate, but that both genes and environment interact in complex ways, highlighting the fact that an adult neuropsychological model is inappropriate for explaining developmental disorders (see also Rutter, 2005).

A similar point has been made by Nancy Kanwisher and Galit Yovel (2006). They review knowledge about neural mechanisms involving the 'fusiform face area' (the face-specific processing region of the brain). From studies of individuals born with dense bilateral cataracts, they conclude 'that very early experience is crucial in the development of normal adult face recognition... indicating important roles for both genetic factors and specific early experience'.

3. Ethical behaviour and God genes

Within every religion and humanistic ethical system there are widespread beliefs about appropriate ways of behaving. In a religious community, certain behaviours are regarded as acceptable and honouring to God whilst others are unacceptable and dishonour their high calling. But is it easier, because of different genetic make-ups and different brain mechanisms for some to love more, to be compassionate, to control their anger and their sexual drives, than for others (Jeeves, 2004)? We readily blame our genes and/or the environment for our failures whilst being all too ready to take credit for our successes.

Francisco Ayala (1998) has argued that the emergence of ethical behaviour is the consequence of ability to respond to moral challenges rather than an

innate tendency to choose right (or wrong). He suggests moral choice may have been an incidental (or 'pleiotropic') effect of other genetic changes, perhaps similar to the emergence of language through the availability of a suitable larynx (see above).⁶ Certainly, our spirituality develops, is maintained and expresses itself in community; it is fully embedded in our physical, cultural and social environments. This contrasts with the focus on a 'God' gene or genes which are said to predispose some individuals to religious responses. Such a 'God-receptor' has been proposed by a numbers of workers (reviewed by Jeeves, 2005), most recently Dean Hamer (2004). Hamer found that people with high and low scores for 'self-transcendence' (defined as the ability to become so wrapped up in an experience as to lose one's sense of self; Hamer equated this with spirituality) had different variants of a gene VMAT2 (vesicular monoamine transporter-2; the gene has also been associated with the liability to depression and cocaine use).

If there is a gene that predisposes the embracing of religious beliefs and behaviour, its manifestation is clearly affected significantly by social and religious environments. For example, church attendance is much higher in the US than in Canada or Britain. A Gallup poll in 1998 reported that nearly two thirds of Americans said they were members of a church, synagogue or mosque compared to only 44 per cent of Canadians. If a God gene is a major factor in determining our religious commitments, why the large differences in self reported religious activity of Americans and Canadians living either side of a line on a map marking national frontiers?

Christians do not have a stake in denying the possibility of genetic factors affecting religious adherence. Indeed it is Christians such as Linden Eaves who have been leaders in careful research in this area. Using twin studies, Eaves (2004) found 'there is a small but significant role of genetic factors (15 to 35 per cent of the total variation, depending on sex and nationality) in the creation of individual differences in church attendance'. He suggested that there is 'a strong *prima facie* case for some role of genes in the origin of significant dimensions of religion and values', but that 'there is a temptation for the significance of such studies to be overstated and exploited'. Doreen Boomsma et al. (1999) concluded that 'the expression of genetic differences is not fixed but contingent on environmental context, in this case family religion, in which the genotypes are embedded and... in the more permissive environment of the non-religious family facilitates expression of genetic effects that may still be present but unexpressed in the more religious family'.⁷

6 If true, this could be an interesting parallel to the anthropic principle, implying that cultural norms or laws are God-given in the same way as the anthropic principle suggests that the fundamental physical constants are.

7 Richard Dawkins (2003: 117) has popularised 'memes' as cultural replicators, (named by analogy with 'genes') and termed religions 'mind parasites' that 'leap infectiously from mind to mind'. Alistair McGrath (2005) has pointed out that there is no evidence that memes exist nor that cultural evolution is Darwinian.

How free are humans?

This leads us back to the connection between mind and brain. Adam Zeman (2002: 150) has noted ‘the powerful human tendency to conceive of mind as an immaterial substance, an ethereal being that breathes psychological life into the physical body... Whatever its source, the belief is seriously challenged by the wealth of evidence that damaging the brain can damage and fragment consciousness. It may be arrogant to deny that consciousness can ever slip its moorings in the brain – after all much of the world’s population believes firmly that it can – but the evidence in favour of this happening is tenuous at least’. John Polkinghorne (1986: 92) makes the point that the answer is easy if one is a thoroughgoing reductionist, since for such a person ‘mind is an epiphenomenon of brain, a mere symptom of its physical activity... but the reductionist programme in the end subverts itself’, since it destroys rationality and thought is identified with electro-chemical neural events. Such events cannot confront each other in rational discourse: they are neither right nor wrong – they just happen. Polkinghorne writes, ‘If our mental life is nothing but the humming activity of an immensely complexly connected computer, who is to say whether the programme running on the intricate machine is correct or not?... The very assertions of the reductionist himself are nothing but blips in the neural network of his brain.’ Four decades earlier, J.B.S. Haldane (1927: 209) made exactly the same point, ‘If my mental processes are determined wholly by the motions of the atoms in my brain, I have no reason to suppose that my beliefs are true... and hence I have no reason for supposing my brain to be composed of atoms.’

The tighter the links between mind and brain, the more difficult it becomes to understand free will. Two possibilities have been recognised since the time of David Hume. They are:

- a liberty of spontaneity, implying subjective non-compulsion; and
- a liberty of indifference, implying objective indeterminacy.

Polkinghorne (1994: 12) has argued that a liberty of indifference is necessary if we are to understand our rationality; MacKay (1991: 194-204) denied this constraint, pointing out that it is persons, not brains that choose. For him, there was an indeterminacy at the level of our conscious experience, irrespective of any determinacy at the brain level (q.v. Jeeves, 1998). Doye et al. (1995) wrestled with a range of proposed approaches; they comment that ‘the liberty of spontaneity can be more easily reconciled with God’s sovereignty than the liberty of indifference’.

It may be that we are asking the wrong questions in trying to dissect the components of free will (Torrance, 2004; Palmer, 2005). Warren Brown (2004; see also Brown, Murphy & Malony, 1998; Murphy & Brown, 2007) begins from the premise that humans are only one substance – a physical body, a position of monism (or physicalism). Traditionally, monism implies determinism; Brown qualifies his view as ‘non-reductive physicalism’, implying that con-

scious decisions and will act as an emergent role and exert a top-down causal influence on neurophysiological brain processes.⁸ We suggest that it is more helpful to talk about interdependence between brain and mind, rather than an identity or interaction. Mental activity and correlated brain activity may be regarded as inner and outer aspects of one complex set of events that together constitute conscious human agency. Two accounts can be written about such a complex set of events, the mental story and the brain story; together these demonstrate logical complementarity.

This seems to be the most realistic model currently available. It is not far removed from the long-standing analogy of the brain as a computer which has to be programmed in order to function. But we must beware lest we are tempted to turn the analogy into a causal explanation. As MacKay was wont to point out, the hardware and software pictures are correlates, not translations (MacKay, 1991; MacKay & MacKay, 1992). The error we must avoid in both science and theology is *identifying* the model with the reality it expresses (Jeeves & Berry, 1998: 87).

Human distinctiveness as seen by theologians: made in the image of God

The traditional way of defining 'humanness' is to seek particular criteria allegedly unique to the human condition: bipedalism, opposable thumbs, tool-making, learning ability, abstract thought, shame, play, artistic sense. Some have seen the statement of the author of the letter to the Hebrews where we are called 'brothers in the family of God' (Heb 3: 1) as implying that we are qualitatively distinct from the Great Apes. The Bible's distinction between mankind and all other animals is completely different. It is simply and starkly that we are made 'in the image and likeness of God' (Gen 1: 26).

James Barr (1993:157) identifies five ways in which the image of God, the *imago Dei* has been interpreted:

- rationality, argued by Augustine and Aquinas, and accepted by Luther and many of the Reformers;
- the possession of a 'soul';
- physical distinctiveness (bipedalism, etc);
- functionality – dominion over the world (associated particularly with von Rad): the *imago Dei* is not what we *are* but what we are *called to do*; and
- the capacity for relationship – with God and with other creatures, an idea

8 Kim (1994) argued that mental properties are reducible to physical properties unless some sort of downward causation is involved. Murphy (1999) has pointed out that this is only so if the hierarchy of complexity in biological systems is ignored: only within larger systems do the patterns of information that exist have 'top-down' impacts on lower levels.

developed by Barth, for whom the *imago Dei* becomes not just an ability for relationship, but the relationship itself: a relationship with God and with each other, most clearly exemplified in Jesus who alone is fully the image of God.

In his Gifford Lectures, Wentzel Van Huyssteen suggested that

the intellectual history of ideas that have shaped the *imago Dei* over centuries can be categorized into various distinct patterns. One of the most important and widely accepted categorizations is the focus on a three-phase development that historically leads from *substantive* interpretations, to *functional* interpretations, to *relational* interpretations of this crucial, canonical concept. In addition, this well-known triad has also been modified and amplified to include *existential* and *eschatological* interpretations of the *imago Dei* (Van Huyssteen, 2006: 126).

He refers to the views of Pannenberg and Moltmann who added an eschatological dimension to the relationship idea. A key word for Pannenberg is *exocentricity*, emphasising that we are constantly reaching beyond our experiences of the present world in a search for fulfilment and meaning. Together with Moltmann, Pannenberg believes that there is a fundamental self-transcendence which will ultimately find its proper identity only in Jesus Christ, who fulfils the image of God in its entirety.

There is now a general agreement that the *imago Dei* is not anatomical, genetic, neurological or behavioural, and that it combines functional and structural elements (Middleton, 2005).⁹ Chris Wright (2004:119) puts it well,

We should not think of the image of God as an independent ‘thing’ that we somehow possess. God did not *give* to human beings the image of God. Rather it is a dimension of our very creation. The expression ‘in our image’ is adverbial (that is, it describes the way God made us), not adjectival (that is, as if it simply described a quality we possess). The image of God is not so much something we possess, as *what we are*. *To be human is to be the image of God*.

Clearly we must discount the idea that ‘in-breathing’ should be equated with the acquisition of a ‘soul’. Joel Green (2004: 196) comments on the word translated ‘soul’ in Genesis 2: 7 (‘The Lord God formed a human being of the dust of the ground, breathed into his nostrils the breath of life, and the human being became a living soul’):

in fact, the same term (a living soul) is used only a few verses earlier with reference to ‘every beast of the earth’, ‘every bird of the air’ and ‘every thing that creeps on the earth’ – that is, to everything in which there is life,

⁹ There is also a representational aspect of ‘image’ which is pertinent to our witness in the world, but is not relevant here.

demonstrating incontrovertibly that ‘soul’ is not, under this accounting, a unique characteristic of the human person... Genesis does not define humanity in essentialist terms but in relational – more specifically identifying the human person as Yahweh’s partner.

For Claus Westermann (1984: 158): ‘The relationship to God is not something which is added to human existence; humans are created in such a way that their very existence is intended to be their relationship to God’; in the Genesis account, only ‘the man’ is addressed directly by God (Gen. 1: 28). Following Karl Barth, H.D. MacDonald (1981) argued that ‘image should be taken as indicating ‘sonship’ which holds together both the ontological and relational aspects of the image’. David Booth (2007) has suggested that the only way to understand image is through its manifestation in the working out of our physical nature through interaction and sharing in community and culture. Joel Green (2008) has pointed to the fallacy of separating intellect and affect (i.e. emotion) or mind and behaviour, leading him to an ‘inescapable conclusion that human formation is a process’. C.F.D. Moule (1964) saw image as ‘basically responsibility’. The relationship of mankind with God was disrupted by the Fall (‘The man and the woman hid’ from God – Gen. 3: 8), although the capacity for relationship remained (Gen. 9:6; 1 Cor. 11:7).

Thus whilst we can unhesitatingly affirm that we are descended from apes and differ substantively from them in being ‘in God’s image’, the meaning of ‘being made in God’s image’ remains, as the quotation from James Barr above shows, the focus of debate. In addition to Barr’s list we could add others we have looked at elsewhere in this paper, such as the capacity for moral agency. Such claims are at variance with models proposed by, for example, evolutionary psychologists and neuropsychologists.

What can we learn about ‘being made in God’s image’ from the biblical accounts of creation? Genesis 1 uses the Hebrew word *bara* to describe it, as well as the creation of matter and the great sea monsters.¹⁰ Henri Blocher (1984:61) notes that: ‘The verb which we translate ‘create’ (*bara*) carries very substantial force in Hebrew. The Old Testament uses it most sparingly and, in that form, exclusively of the God of Israel. Never is any material mentioned. The creative act appears supremely effortless and its result sometimes miraculous (Ex. 34:10), frequently new (Pss. 51:10; 104:30; Is. 48:7; 65:17; Jer. 31:22).’ Wenham (1987:14) points out that ‘it is clear that it is not a term reserved for creation out of nothing... [But] as with the word ‘create’ in English, there is a stress on the artist’s freedom and power – the more so as in the Hebrew, the word is used solely for God’s activity.’

Another and more general word (*asah*) is also used in Genesis 1 to refer to

¹⁰ Ernest Lucas (2001: 99) suggests the explanation for the inclusion of the ‘sea monsters here is that in the Babylonian creation myths they were indicators of a chaos which had to be subdued before the gods could create; in the Genesis account, they are part of God’s creation.

works of creation. Westermann (1984:86) asks the question, 'What is the relation of *asah* and *bara* to each other?' His answer is that '*Bara* is given prominence in the title of the chapter and in the concluding verses and in the creation of humans. A preference is shown here for the verb *bara* over the more manual *asah*. The reason is theological, because the verb is only used with God as the subject.' Later he writes, 'One cannot draw conclusions from the word [*bara*] itself but only from the contexts in which it is used... The text is speaking about an action of God and not about the nature of humanity.' Ernest Lucas (2001:100) makes a similar point, insisting that 'the more closely one looks at Genesis 1 in the light of the religious ideas with which the Hebrews had to do battle, the clearer it is that the meaning of the passage is essentially theological, not historical or scientific'.

The important fact is that we are 'in God's image' through a divine and sovereign act of the creator. The biblical record does not make clear:

- whether God created humans *de novo*, with no continuity with the rest of creation;
- whether the *imago* appeared as an emergent property; or
- whether it was 'implanted' as a specific act of God.

Does studying the book of creation afford any checks and balances to our thinking about these issues?

The option that God created humans *de novo* is impossible to disprove, although it is only held today by those who reject the fossil record and the significance of the genetic traces linking but separating humankind and the other great apes. A century and a half ago Philip Gosse (1857) argued that God had created the world (including humankind) a few thousand years ago, but 'as if' it had a great age. This implied God was deceiving His creatures. Gosse failed to convince even his contemporaries. One review castigated the book as containing 'idle speculations, fit only to please a philosopher in his hours of relaxation, but hardly worth of the serious attentions of any earnest man, whether scientific or not'. Most copies of Gosse's book were pulped (Thwaites, 2002).

The second is whether what makes us, according to scripture distinctively human (i.e. the acquisition of the *imago Dei*), emerged gradually or suddenly. It would be dangerous to build too much on the use of *bara* (which might be taken to indicate a sudden origin) as opposed to *asah* (which might indicate an evolutionary process). Scripture's view is that it is a divine work. In the Bible there is no clear demarcation between God's works in nature and his works in history; he is sovereign in both (Barclay, 2006).¹¹ Westermann (1964: 21) comments:

11 Day (1998: 118) complains 'Many evangelicals find it difficult to abandon special creation and seek to reserve God's right to "insert a soul".' He castigates this as 'semi-deism'.

the meaning is indisputable. Man in his entirety... is to be designated as a creature in God's image... [It] serves to underline the uniqueness of man's creation. The creation of man is something far different from the creation of the rest of the world. One can almost say that this ruptures the framework of the course of creation in which all the other works of creation are included.¹²

Biblical scholars debate the correct exegesis of references to 'Adam' in Genesis in the light of Paul's epistles. Certainly the word translated 'Adam' may be taken to mean collective humanity and James Dunn (1988: 289) probably speaks for most interpreters when he writes of Paul's use in Romans 5 of the 'one man' by whom sin came into the world:

in introducing the drama in these terms, Paul indicated he wants this figure to be seen not so much as an individual in his own right, but as more than an individual figure, what we might call an 'epochal figure' – that is, as one who initiated the first major phase of human history and thereby determined the character of that phase for those belonging to it.

James Barr (1993: 166) dissents from this view on linguistic grounds. He points out that Paul makes much of the distinction in Galatians 3:16 between 'seed' or offspring (singular) and 'seeds' (plural), and hence, so he believes, Paul would be unlikely to mean men (plural) in Romans 5 where he repeatedly speaks of 'one man'.

Could Adam have been a historic individual?¹³ John Stott (1994: 163) argues for this:

Scripture clearly intends us to accept their [Adam and Eve's] historicity as the original human pair: the biblical genealogies trace the human race back to Adam, Jesus himself taught that 'at the beginning the Creator made them male and female' and then instituted marriage, Paul told the Athenian philosophers that God had made every nation from 'one man', and in particular, Paul's carefully constructed analogy between Adam and Christ depends for its validity on the equal historicity of both.

12 John Stott (1972: 63) has suggested that it may be semantically useful to recognise humankind in God's image as *Homo divinus*, thus distinguishing from the biological species *Homo sapiens*.

13 The human species has gone through various bottlenecks in number through its history, as shown by the low genetic variability of some populations (Garrigan & Hammer, 2006). A particularly significant one was the result of migration out of Africa, with modern African populations showing very considerable inherited variation (notably in mitochondrial types, which are transmitted wholly through the female line), while extra-Africans have very little mitochondrial variation (Cann, Stoneking & Wilson, 1987). The common female ancestor of all these mitochondrial lines has been called 'mitochondrial Eve', but she should not be equated with the biblical Eve. All that is implied by mitochondrial Eve is that she has had an unbroken line of female descendants (Sykes, 2001). Based on the rate of differentiation of existing population groups, mitochondrial Eve lived around 200,000 years ago (Loewe & Scherer, 1997), which accords well with the palaeontological findings of migration from Africa. If the 'biblical Eve' truly lived in the Neolithic era (see note 3), she would have been around ten to twenty thousand years ago.

Leon Morris (1988: 228) whilst asserting that, 'the one man [Adam] is very important and underlies the whole discussion' [in Romans 5], nevertheless warns that 'Paul's argument in Romans 5 is very condensed and in all translations and comments we must allow for the possibility that Paul's meaning may at some point be other than we think'. He points out nevertheless that 'twelve times in verses 12-19 we have the word *one*; repeatedly Paul refers to the one man Adam (and to one sin of that one man) and opposes to him (and it) the one man Jesus Christ (and his one world of grace). The one man and his sin and the one Savior and his salvation are critical to the discussion.'

James Dunn (1988: 272) whilst discussing and rejecting the possibility that Adam can be regarded as merely a representative man, writes that, 'Paul does not use *anthropos* here to characterize humankind as a whole; the concept of corporate responsibility is more of a hindrance than a help'; he cites H.W. Robinson and F.F. Bruce in support. However, unlike John Stott, he argues that, 'Paul's theological point [does not] depend on Adam being a "historical" individual or on his disobedience being a historical event as such. Such an implication does not necessarily follow from the fact that a parallel is drawn from Christ's single act: an act in mythic history can be paralleled to an act in living history without the point of the comparison being lost.'

When we, as scientists, read these 'on the one hand, on the other hand' views of biblical scholars, it becomes clear that resolution of this point must be left to theological debate. Our contribution is to seek evidence from 'the Book of Nature' and to underline the need for both God's Books to sing in harmony. The scientific evidence certainly leans towards a gradual emergence of humanness. For example, Allan Day (1998:115) wrote in this journal that 'neither a strictly literal interpretation [of Scripture] nor one which identifies an individual historic Adam with the biblical Adam, is consistent with the findings of cultural and physical anthropology' (Day, 1998:115). The best current understanding (as reviewed, for example, by Brooks, 2007 – see above) of physical, behavioural and cultural indicators of humanness show that they appeared thousands of years before humans were present in the Middle East. Brooks (2007) argues that 'the capabilities for living in "our heads" [i.e. self-consciousness] were present before 130,000 years ago and developed in a step-wise fashion, possibly in a feedback relationship with our morphology'. The capabilities she includes are 'some of the most human qualities: creativity, empathy, reverence, spirituality, aesthetic appreciation, abstract thought, and problem-solving (rationality). [These] were already evident soon after the emergence of our species'. The meaning of 'reverence' and 'spirituality' may be debated but are relevant in any discussion of the emergence of the *imago Dei*.

Debate will continue about the ways the capacity for humanness and the point at which *Homo* became fully human and should be regarded as different. It may be worth noting that the latter is not necessarily the same as God bringing about his divine purpose of making us in his image. We remain ignorant about the timing and mechanism of God's work in this respect, while re-empha-

sising Dunn's insistence (see above) that 'Paul's theological point [does not] depend on Adam being a 'historical' individual or on his disobedience being a historical event as such'. From our point of view, it is important to recognise that, although the *'imago'* is as intrinsic a part of humanness as eye colour or memory, it is utterly wrong to think of it as inherited or transmitted like a Mendelian trait. This applies whether it was conferred on all of *Homo sapiens* alive at a point in time or on an individual. If it was initially conferred on an individual, there is no reason why it should not spread by divine fiat to all other members of *Homo sapiens* alive at the time. Likewise, the effects of the disobedience of the first pair could also have spread 'laterally', a suggestion made by Derek Kidner in his Tyndale Commentary on Genesis (Kidner, 1967; Berry, 1999). Such an understanding would emphasise the responsibility of individuals to respond to God in obedience, whereas interpreting 'Adam' as corporate humanity minimises personal commitment and the consequences of disobedience. The 'death' that entered the world 'the day that Adam sinned' was, of course, primarily separation from God (e.g. Eph 2: 1-5), a rupture of relationship; physical death was part of creation from the beginning, not least in the Creator's provision of plants for animals to eat (Gen 1: 29, 30; 2: 16).¹⁴ But with Kidner's proposal, we are again in the realm of plausible interpretation rather than certain reality.

***Imago Dei* – should it be linked to unique human capacities?**

When the question how distinct is the human species is asked in a religious context, one of the most persistent claims to distinctiveness is our ability to reason. The 1992 Roman Catholic catechism avers: 'God... can be known... by the natural light of reason... Man has this capacity because he is created "in the image of God"'. This notion reflects the influence of Descartes, who wrote: 'The human mind, by virtue of its rationality, provides evidence both of a kind of image of God and at the same time a criterion of radical discontinuity from the rest of creation. The animals are merely machines.' Unfortunately for this view, we now know that animals can think. There is much evidence for this; recent discussions have concentrated on a so-called 'theory of mind', seen for example in 'mirror self recognition'. This ability is rare in animals, but it has

¹⁴ In his Bridgewater Treatise devoted to the evidences for design in nature, William Buckland (1837) distinguished between animal ('biological') and human death. He argued that there is no foundation in the Bible for the belief that carnivorous animals did not exist in Paradise. He concluded 'that throughout the brute creation death is in no way connected with the moral misconduct of the human race, and that whether Adam had or had not ever transgressed, a termination of death is, and always has been, the condition on which life was given to every individual among the countless myriads of beings inferior to ourselves which God has been pleased to call into existence'. He was criticised for this proposal and responded by expounding Romans 5: 12 in a University Sermon in Oxford on 27 January 1839, entitled 'An Inquiry Whether the Sentence of Death Pronounced at the Fall of Man Included the Whole Animal Creation or Was Restricted to the Human Race'.

been demonstrated in human children, great apes, dolphins, and elephants (Plotnik, de Waal & Reiss, 2006). Frans de Waal commented 'As a result of this (research), the elephant now joins a cognitive élite among animals commensurate with its complex social life and high intelligence.'

Warren Brown (1998: 125) has argued that the key factor in humanness is a capacity for personal relatedness and that such cognitive developments as complex language, mind ('thinking about thinking'), episodic memory, conscious top-down agency, future orientation, and emotional modulation have been crucial for its emergence. The difficulty about even such generalising is highlighted by the realisation that bonobos (pygmy chimps) are capable of 'thinking about thinking' (Savage-Rumbaugh, Shanker & Taylor, 1998). Indeed, Arnold & Zuberbühler (2006) have even reported evidence of a rudimentary capacity to use syntax in non-human primates. Whilst this is not developed language, it does mean that another apparent Rubicon previously separating us from the rest of the animal kingdom has been crossed.

W.H. Thorpe used to maintain that there is no single attribute which can be unequivocally identified as unique to the human species, but because there is such a tremendous chasm – intellectual, artistic, technical, moral, ethical and spiritual – 'there comes a point where "more" creates a "difference"' (Thorpe, 1974: 301). The determining trait for him was a belief that only humans can recognise abstract moral law, 'eternal values which are in themselves good' (Thorpe, 1961). The problem is finding a way to test such a belief.

The temptation to define what makes us uniquely human in terms of some human capacity and then to identify that with the *imago Dei* is not easy to resist. Over the past three decades studies of behaviour in non-human primates have been steadily accumulating, which, if we were to witness them in humans, we would attribute to the possession of a moral sense and moral agency. Self-giving, self-sacrificing behaviour appears in different animals. But that in itself tells us nothing about the mechanisms and thinking patterns that underlie those behaviours. Self-giving behaviour may, for example, occur with or without self-awareness. Jürgen Moltmann (2001) has argued that self-giving is 'God's Trinitarian nature, and is therefore a mark of all his works'. We do not need to deny the emergence of self-giving altruism in primates in order to assert the unique self-emptying sacrifice of Christ. The key question for Christians is whether there is any evidence in Scripture to support the view that the image of God in humans is to be defined in terms of a unique capacity for moral behaviour and moral agency. We know of none.

Anthropologists can produce a model of the descent of humanity which is self-contained and satisfying, and which does not conflict with the biblical record in any obvious way. This does not prove that God is not involved in the process. After all, it is faith, not sight (or scientific discovery) that convinces us of the realities that we do not see, and by which 'we understand that the universe was formed by God's command, so that the visible came forth from the invisible' (Heb. 11:3). The challenge for the believer is in recognising God's

divine upholding of the overall process. For some, the implication that scientific investigation is the only – or the most reliable – path to gain knowledge is anathema and the possibility of a satisfactory ‘natural’ explanation of human evolution is condemned as ‘naturalism’. For Alvin Plantinga (1990: 9), naturalism assumes that ‘there is no God and we human beings are insignificant parts of a giant cosmic machine that proceeds in majestic indifference to us, our hopes and aspirations, our needs and desires, our sense of fairness or fittingness’.¹⁵ In recent years this criticism has been repeatedly urged by a Californian lawyer, Phillip Johnson (1991 and later). While it is true that many who espouse a scientific interpretation of evolution – especially human evolution – accept that it is possible to ‘explain’ evolution without invoking a divine input, this is not the same as asserting there has been no divine involvement. To assume that God has no part in evolution is to be guilty of doctrinaire or ontological reductionism (Ayala, 1974) – the very accusation that is levelled at evolutionists by Johnson. Doctrinaire reductionism must be distinguished from methodological reductionism, which is a necessary part of science, never mind everyday life.

The relationship of God to His creation – especially humankind – is, of course, the crucial issue (Jeeves, 2005). Peters & Hewlett (2003) have helpfully surveyed the main possibilities. A commonly cited model is that God controls gene mutation through quantum processes at the molecular level (Russell, 2003). We do not support this idea because it still involves chance processes and seems to be a rather sophisticated version of the ‘God of the Gaps’. We believe the only satisfactory way of capturing God’s control and oversight is to understand it as complementary, following Michael Polanyi (1969) and Donald MacKay (1991). John Haught (2006) has put forward a very similar idea as ‘layered explanation’, which he contrasts with ‘explanatory monism’. He calls for ‘stereoscopic vision’, ‘looking not only at the data of science but also at a much fuller range of phenomena that impress themselves upon our experience’ (p. 126). Empirically, such approaches encourage the testing of information from different levels against each other. An excellent example of this is shown in the vast amount of biochemical, physiological, anatomical and genetic data assembled by Simon Conway Morris (2003, 2006) on the way that similar organisms and their properties have repeatedly arisen in evolution. Conway Morris believes this shows recurrent ‘cobbling and cooption’. For example, the crystalline proteins of the eye lens have been independently ‘redeployed’ many times since their origin as stress-related proteins in micro-organisms millions

15 This is a philosophically technical definition of naturalism; it is not a new argument (Greene, 2003). It is important not to confuse the possibility of imputing a scientific (or ‘natural’) cause for an event to mean that divine involvement (‘grace’) is thereby excluded; scientific and theological explanations can often be complementary (Berry, 1986; Humphreys, 2003). Nothing that we say in this paper about relationship of humans to other apes or the emptiness of traditional concepts of ‘soul’ or ‘spirit’ should be taken as removing the need or possibility of God’s redeeming or upholding work.

of years before any eye existed (Tomarev & Piatigorsky, 1995). From such data, Conway Morris concludes that since

the roads of evolution are constrained, that not all is possible (in fact the reverse is true: nearly all is impossible) [and this means] that the outcomes of evolution are thereby effectively inevitable... The view that evolution is open-ended, without predictabilities and indeterminate in terms of outcomes is negated... because organisms arrive repeatedly at the same biological solution (the most famous example being the camera-eyes of vertebrates and cephalopods), this provides not only a degree of predictability but more intriguingly point to a deeper structure to life across which evolution must necessarily navigate.

The Bible Creator is a God of order, not of chance. An implication of this is that it is easier to understand Him as one who is intimately and indissolubly associated with all that He has made, as immanent as well as transcendent. By faith, we believe that 'all things are held together in him [God's Son]' (Col. 1: 17); 'he [the Son] sustains the universe by his word of power' (Heb. 1: 3). It is therefore not true that we are the result of chance genetic and ecological processes. Nor are we the outcome of a deistic (and Unitarian) First Cause as implied by Paley's Divine Watchmaker. Aubrey Moore's (1889: 99) comment on the deism of the first half of the nineteenth century as 'leading to a God throned in magnificent inactivity in a remote corner of His universe... and at the moment when it seemed as if He would be thrust out altogether, Darwinism appeared and, under the disguise of a foe, did the work of a friend', remains as relevant today as when it was originally made. These points need constant reiteration, because repeated attacks on evolution have been (and are) made on the grounds that Darwinian mechanisms exclude purpose and design from creation.¹⁶ The reality is that we can ever more confidently acclaim a world of order overseen by a God of purpose – even if we often do not know what His purposes are – and eschew any need to import notions of progress from either biology or philosophy.¹⁷ Nor do we need to fear that empirical tests for 'complex human behaviour' as proposed by Ed Wilson (1998: 246) will destroy 'transcendentalism'.

16 Charles Hodge (1874: 48, 52) condemned Darwinism as atheism on the grounds that 'Darwin rejects all teleology or the doctrine of final causes. He denies design in any of the organisms in the vegetable or animal world... It is this feature of his system which brings it into conflict not only with Christianity, but with the fundamental principles of natural religion.' Interestingly, B.B. Warfield, another Princeton theologian whose name is almost synonymous with 'biblical inerrancy', consistently supported evolution. The key for him was 'a doctrine of providence that saw God working in and with, instead of as a replacement for, the processes of nature... This principle [he called it *concursum*] he felt the Scriptures offered to enable humans both to approach the world fearlessly and to do so for the greater glory of God' (Noll & Livingstone, 2003).

17 The concepts of 'intelligent design' and 'irreducible complexity' are unhelpful and particularly confusing in this context. 'Intelligent design' is an attempt to import deism without naming God (Shanks, 2004), while 'irreducible complexity' is open to disproof by scientific advances (Dembski & Ruse, 2004).

***Imago Dei* – a capacity for moral agency and altruistic behaviour**

Two centuries ago Jonathan Edwards wrote ‘... herein does very much consist that image of God wherein He made man... *viz* in those faculties and principles of nature whereby he is capable of moral agency’. If Edwards was claiming that this capacity was unique to humans then we have to ask how does such a claim stand today in light of developments in evolutionary psychology. As we have seen, evidence has been steadily accumulating of behaviour in non-human primates, which, if we were to witness it in humans, we might attribute to the possession of a moral sense and moral agency. But just because two behaviours are superficially similar is no reason to assume that the underlying mechanisms and thinking patterns are identical.

Self-giving, self-sacrificing behaviour appears in many different groups, particularly in colonial species like bees and ants where the individuals are closely related to each other. Some examples are extreme, such as ‘honey-pot’ worker ants who merely hang from the ceiling of the colony and act as receptacles for honey from other workers, and from which the colony draws when needed. Vampire bats may be fed by unrelated mates if they are in danger of starving because they have failed to obtain a necessary meal of blood.

Darwin (1871: 200) believed that such unselfish or altruistic behaviour was extremely unlikely to spread by natural selection, since ‘He who was ready to sacrifice his life, as many a savage has been, rather than betray his colleagues, would often leave no offspring to inherit his noble nature.’ Half a century later, J.B.S. Haldane (1932) qualified this, pointing out that if individual unselfishness (even to the extent of self-sacrifice) had an inherited basis and helped near relatives, then ‘altruistic genes’ could be selected and therefore spread in families. There could be situations where cooperation (or unselfishness) is an advantage to a group of individuals, even if particular individuals are disadvantaged. W.D. Hamilton (1964) formalised Haldane’s argument as ‘inclusive fitness’ and showed how this could provide a mechanism for the evolution of altruistic behaviour in social insects. This is now assimilated into general biology as ‘sociobiology’. For Peter Singer (1981: 49) ‘Sociobiology... enables us to see ethics as a mode of human reasoning which develops in a group context... so ethics loses its air of mystery. Its principles are not laws written up in Heaven. Nor are they absolute truths about the universe, known by intuition.’

An implication for humans is, as Alexander (1987: 3) has commented, that ‘ethics, morality, human conduct, and the human psyche are to be understood only if societies are seen as collections of individuals seeking their own self-interest’. This problem is lessened if the basic idea of inclusive fitness (or ‘kin selection’ as it is often called) is complemented and extended beyond close relatives by ‘reciprocal altruism’ – that self-sacrifice can be understood as self-interest, providing there was a chance the beneficiary would repay the deed in the future (Trivers, 1971). There has been considerable discussion as to whether this mechanism is really sufficient to explain human behaviour (Clay-

ton & Schloss, 2004). A major problem is that humans cooperate in much larger groups than non-human primates, extending beyond those with whom they interact socially.¹⁸ Responding to this, Gintis et al. (2003) have argued for 'strong reciprocity', by which they mean a predisposition to cooperate with others and to punish those who violate the norms of cooperation, even when it is implausible to expect these costs to be repaid either by others or at a later date. More controversially, David Sloan Wilson (2003) has broadened the idea of altruism between non-relatives even further to 'group selection' which is difficult to explain on orthodox Darwinian theory.

It would be wrong to assume that all altruistic behaviour involves self-awareness. Francisco Ayala (1998) has pointed out that to assume that the motivation behind altruism in (say) insects or birds is the same as human altruistic behaviour involves falling into the naturalistic fallacy.¹⁹ He disagrees with the assumption that human ethical behaviour is causally related to animal social behaviour²⁰ and distinguishes between the capacity for ethics (which he sees as involving an ability to anticipate the results of one's actions; to make value judgments; and to choose between possible courses of action) and the moral norms accepted for guiding actions. He argues that the former is a necessary but secondary consequence of intellectual ability, not because it is adaptive in itself (as sociobiologists maintain), while the latter is wholly a cultural matter.

Within the Christian tradition it is not necessary to deny the emergence of elements of altruistic or self-giving behaviour in non-human primates in order to defend the uniqueness of the self-giving and self-emptying of Christ. The discovery of a fronto-mesolimbic network in the brain which is active when we engage in altruistic behaviour (Moll et al., 2006) does not affect this in the slightest. The self-giving of Christ was unique and by faith we affirm that the ultimate act of Christ's self-giving, by its nature, sets Him and it apart from all others.

18 This is sometimes called 'imagined communities' – ones which include people we have never met; such communities exist in our mind only.

19 Herbert Spencer (1893) was probably the first philosopher in modern times to locate the ground of human morality in biological evolution. He was opposed by Thomas Huxley (1893) who argued that morality involved 'fighting' natural inclinations, although his grandson, Julian, disagreed and believed that we have passed through the biological phase of evolution and entered into a 'psychosocial' one (Huxley, 1957). C.H. Waddington (1960) made a very similar proposal; he called our current environment 'socio-genetic'. Teilhard de Chardin (1959) developed a more surreal version of the same idea. The best known contemporary proponents of a biological basis for human behaviour are Edward Wilson (1975, 1978), Dan Dennett (2006) and Christopher Hitchens (2007).

20 Frans de Waal (1997: 216) has written: 'Even if animals other than ourselves act in ways tantamount to moral behavior, their behavior does not necessarily rest on deliberations of the kind we engage in. It is hard to believe that animals weigh their own interests against the rights of others, that they develop a vision of the greater good of society, or that they feel lifelong guilt about something they should not have done.'

The *imago Dei* as the defining characteristic in Christian anthropology

We believe that a holistic model of the human person does most justice to the scientific understanding of ourselves. Dualisms of parts or substances will not do. There is no scientific evidence for them, and there is no biblical warrant for them. Our unity is central. We know each other, not as brains ensheathed in bodies, but as embodied persons. We are people who relate to each other as beings created in the image of God. This image is not a separate thing. It is not the possession of an immaterial soul nor of a 'God spot' in our brains. It is not the capacity to reason or for moral behaviour.

It is necessary to make a distinction between Christian anthropology and secular anthropology. Christian anthropology is not another member of a list which would include entomology, rodentology, ornithology and so on, an extension of which would lead not to anthropology but rather to primatology. If we are to avoid a category error we must recognise that Christian anthropology is not about social and natural sciences rather it is in the family of christology, ecclesiology, pneumatology and soteriology.²¹

The contemporary focus of theological thinking is that the *imago Dei* shows itself in our capacity for relatedness: to our Creator, to one another and to the creation of which we have been made stewards. To understand and accept this enables us to recognise the need to show greater compassion to those struggling to make and sustain normal interpersonal relations. Any belief that our spirituality is securely protected within an immaterial part of us labelled 'soul' is most obviously challenged by sufferers of Alzheimer's disease. Some deeply religious people have suffered agonising distress as they experience the fragmentation of some of the most precious aspects of their religious life and experience.

The consequences to the individual of the development of Alzheimer's dementia may vary widely. Glen Weaver (2004) has listed some of the experiences of changes in self-identity during the progress of the disease. He describes the experiences of a Presbyterian minister, diagnosed with Alzheimer's dementia at the height of his ministerial career, at the age of 53. With the help of his wife he wrote a remarkable account of his spiritual experiences well into the middle stages of the disease. How his progressive brain disease affected his spirituality is graphically illustrated in his own words. He wrote,

My spiritual life was miserable. I could not read the Bible. I could not pray as I wanted to because my emotions were dead and cut off. There was no

²¹ 'The image is not located in any of these [possession of a soul, etc] but in our human vocation, given and enabled by God, to relate to God as God's partner in covenant, and to join in companionship of the human family and in relation to the whole cosmos in ways that reflect the covenant love of God. This is realized in and modeled supremely in Jesus Christ' (Green, 2004: 197).

feedback from God the Holy Spirit. My mind raced about, grasping for the comfort of the Saviour whom I knew and loved and the emotional peace that He could give me, but finding nothing. I concluded that the only reason for such darkness must be spiritual. Unnamed guilt filled me. Yet the only guilt I could put a name on was failure to read my Bible. But I could not read, and would God condemn me for this? I could only lie there and cry 'Oh God, why? why?' (Davies, 1989).

When the fundamental capacity for inter-personal relatedness is impaired through brain disease it undermines the very fabric of our spiritual lives. Even that very basic personal relationship of love and obedience to our Creator which scripture teaches us, is embodied in our mortality.

The capacity for personal relatedness is part of what in the past has been called the societal nature of the divine image. Some of the leading theologians of the last century such as Brunner and Barth both emphasised that the image of God is not the possession of an isolated individual but of the person in community (Ferguson, 1988). Barth developed the idea in a christocentric manner. More recently Colin Gunton (1997) has been explicit that 'to be a person is to be made in the image of God, it is in our relatedness to others that our being human consists'. David Fergusson (1998: 14) extends this idea of relationship: 'The function of the human being is to exercise God's rule over the non-human creation... The image of God is to be understood not substantively in terms of the possession of an immortal soul, but relationally in terms of the role that human beings play before God and before the rest of creation.'

But we cannot leave it there. After reviewing the evidence from the Psalms concerning what it means to be a human being and comparing this with the book of Hebrews, Patrick Miller (2004) wrote that

The writer to the Hebrews hears in the Psalms the word that whatever we say about the human reality must take into account the face of Jesus Christ... [But] the Hebrews writer says the critical words 'But we do see Jesus'. We do see Jesus, who for a little while was made lower than the angels, crowned with glory and honour because of the suffering of his death, so that by the grace of God he might taste death for everyone (Hebrews 2:9)... Whatever therefore is to be said about the human cannot be confined to general statements about humanity apart from God. It cannot be said apart from the discovery that in Jesus Christ we see who we are and we also see God for us. And what he said about the human cannot be said as a general statement that assumes that what we see now is all there is to see. The answer to the question about who we are is finally eschatological, where tears are no longer part of the human reality, where joy is the order of eternity, and where our transience disappears in the disappearance of death. We cannot see that yet. But we do see Jesus. That will have to do. I think it is enough.

And for us it is certainly so.

Conclusions

The evidence from biology and evolutionary psychology that we are apes, genetically (and closely) related to chimpanzees is overwhelming. But that is only part of the story: we believe also that we are individuals made by grace in God's image for fellowship with Him and that we have 'fallen' from that relationship through disobedience. We can know this only by faith, in a similar way as we believe that God, in Christ, has reconciled humankind to Himself and that 'to those who put their trust in Him, He gives the right to become children of God'. These beliefs complement the scientific understanding of humanity and in no way contradict or qualify our understanding of ourselves as biological organisms (Jeeves, 2002). We can respond to the Holy Spirit because we are in God's image. Knowing our biological origins and limits does not affect our spiritual capabilities one jot. God declared that His creation (including humankind) was 'very good' despite all the hangovers from our ancestry (e.g. insufficient support for our abdominal organs as a result of changing from quadrupedalism to bipedalism; the route of the recurrent laryngeal nerve extended through the acquisition of a neck; the congenital persistence of branchial clefts) and awareness that our knowledge is incomplete. Westermann (1987: 11) comments, 'The goodness of creation is based solely on God's authority; what it is good for, such as it is, only God knows. But because it is good in God's sight, joy in God's creation (as it is expressed in the praise of creation in the Psalms) is set free in human beings'. Commenting on Genesis 1:31, Wenham (1987: 38) concludes similarly: God's judgment

brings out the conformity of creation to the divine will. The waters will remain separate from the earth, the light from the darkness. The sun will rule the day and the moon and the stars the night. The plants will bear seed and the animals be fruitful and multiply. In so fulfilling the divine purpose, 'the heavens declare the glory of God and the firmament shows his handiwork' (Ps. 19: 1).

History is littered with examples of attempts to force together preconceived assumptions of biology or religion, or alternatively claims that they are utterly incompatible (see for example Rendle-Short, 1981; Bowler, 2001). For some, the Bible story is rejected as incompatible with science; for such, the Fall has been rationalised as an 'upward' fall so that it is interpreted as an entry into an awareness of God, rather than the rupture of relationships described in Genesis 3. Such endeavours are unnecessary. Our thesis is that the proper way is to examine *all* evidence rigorously and then follow the advice of Francis Bacon in the *Advancement of Learning* (1605) (quoted at the beginning of the *Origin of Species*):

Let no-one out of a weak conceit of sobriety think or maintain that they can search too far or be too well studied in the book of God's words or in the book of God's works; rather let all endeavour an endless progress or proficience in both.

Malcolm Jeeves is Emeritus Professor of Psychology at the University of St

Andrews; R.J. (Sam) Berry is Emeritus Professor of Genetics at University College London.

References

- Abbie, A.A. (1958) 'Timing in human evolution', *Proceedings of the Linnean Society of New South Wales*, 83: 197-213.
- Alexander, R.D. (1987) *The Biology of Moral Systems*, New York: Aldine.
- Anderson, R. S. (1998) 'On being human: the spiritual saga of a creaturely soul', In *Whatever Happened to the Soul?* 175-194. Brown, W.S., Murphy, N. & Malony, H.N. (ed.). Minneapolis, MN: Fortress Press.
- Arnold, K. & Zuberbühler, K. (2006) 'Semantic combinations in primate calls', *Nature* 441: 303.
- Ashton, J.F. (ed.) (1999) *In Six Days. Why 50 Scientists Choose to Believe in Creation*, Sydney: New Holland Publishers.
- Augustine of Hippo (394) [1982] *The Literal Meaning of Genesis*, translated by Taylor, J.H. Mahwah, NJ: Paulist Press.
- Avise, J.C. (1994) *Molecular Markers, Natural History and Evolution*, New York: Chapman & Hall.
- Avise, J.C. (1998) *The Genetic Gods: Evolution and Belief in Human Affairs*, Cambridge, MA: Harvard University Press.
- Ayala, F.J. (1974) Introduction, In *Studies in the Philosophy of Biology*: vii-xvi. Ayala, F.J. & Dobzhansky, T. (eds.), London: Macmillan.
- Ayala, F.J. (1998) 'Human nature: one evolutionist's view', In *Whatever Happened to the Soul?* 31-48, Brown, W.S., Murphy, N. & Malony, H.N. (eds.), Minneapolis, MN: Fortress Press.
- Bakewell, M.A., Shi, P. & Zhang, J. (2007) 'More genes underwent positive selection in chimpanzee evolution than in human evolution', *Proceedings of the National Academy of Sciences, USA* 104:7489-7494.
- Barclay, O.R. (2006) 'Design in nature', *Science & Christian Belief* 18: 49-61.
- Barr, J. (1993) *Biblical Faith and Natural Theology*, Oxford: Clarendon Press.
- Barth, K. (1960) *Church Dogmatics*, volume 3 (2), translated by Bromiley, G.W., Edinburgh: T&T Clark.
- Begley, S. (2004) *Train Your Mind To Change Your Brain*, New York: Ballantine Books.
- Begley, S. (2007) 'How Thinking Can Change Your Brain', *Wall Street Journal*, 19 June.
- Berry, R.J. (1986) 'What to believe about miracles', *Nature* 322: 321-322.
- Berry, R.J. (1999) 'This cursed earth. Is "the Fall" credible?', *Science & Christian Belief* 11: 29-49, 165-167.
- Berry, R.J. (2006) 'Natural selection could not have done it all', In *Human Nature*: 65-83. Jeeves, M.A. (ed.), Edinburgh: Royal Society of Edinburgh.
- Bishop, D.V.M. (2002) 'Putting language genes into perspective', *Trends in Genetics* 18: 57-59.
- Blocher, H. (1984) *In the Beginning*, Leicester: IVP.
- Boffelli, D., McAuliffe, J., Ovcharenko, D., Lewis, K.D., Ovarchenko, I., Pachter, L. & Rubin, E.R. (2003) 'Phylogenetic shadowing of primate sequences to fine functional regions of the human genome', *Science* 299: 1391-1394.
- Boomsma, D.I., de Geus, E.J. van Baal, G.C. & Koopmans, J.R. (1999) 'A religious upbringing reduces the influence of genetic factors on disinhibition: evidence for the interaction between genotype and environment in personality', *Twin Research* 2: 115-125.
- Booth, D. (2007) 'Biological and cultural inheritance of the image of God and of original sin', Lecture at the CiS/ASA Conference, Edinburgh.
- Bouzouggar, A., Barton, N., Vanhaeren, M., d'Errico, F., Collcutt, S., Higham, T., Hodge, E., Parfitt, S., Rhodes, E., Schwenninger, J.-L., Stringer, C., Turner, E., Ward, S., Moutmir, A. & Stambouli, A. (2007) '82,000-year-old shell beads from North Africa and implication for the origins of modern human behavior', *Proceedings of the National Academy of Sciences, U.S.A.* 104: 9964-9969.
- Bowler, P.J. (2001) *Reconciling Science and Religion*, Chicago: Chicago University Press.
- Boyd, R. & Silk, J.B. (2006) *How Humans Evolved*, 4th edition. New York: Norton.
- Britten, R.J. (2002) 'Divergence between samples of chimpanzee and human DNA sequences is 5%, counting indels', *Proceedings of the National Academy of Sciences of the USA*, 99: 13633-13635.
- Brooks, A.S. (2007) 'What is a human? Archaeological perspectives on the origins of humanness', In *What Is Our Real Knowledge About the Human Being?* 21-35 M.S.Sorondo, (ed.) Pontificia Academia Scientiarum, Scripta Varia 109, Vatican City.

- Brown, P., Sutikna, T., Morwood, M.J., Soejono, R.P., Jatmiko, Wayhu Saptomo, E. & Awe Due, R. (2004) 'A new small-bodied hominin from the Late Pleistocene of Flores, Indonesia', *Nature* 431: 1055-1061.
- Brown, W.S. (1998) 'Cognitive contributions to soul', In *Whatever happened to the Soul?* 99-125.
- Brown, W.S., Murphy, N. & Malony, N.H. (eds.), Minneapolis, MN: Fortress Press.
- Brown, W.S. (2004) 'Neurobiological embodiment of spirituality and soul', In *From Cells to Souls – and Beyond*: 58-76. Jeeves, M.A. (ed.), Grand Rapids, MI: Eerdmans.
- Brown, W.S., Murphy, N. & Malony, H.N. (eds.), (1998) *Whatever Happened to the Soul?* Minneapolis, MN: Fortress Press.
- Brunner, H.G., Nelen, M., Breakefield, X.O., Ropers, H.H. & van Oost, B.A. (1993) 'Abnormal behavior associated with a point mutation in the structural gene for monoamine oxidase A', *Science* 262: 578-580.
- Buckland, W. (1837) *Geology and Mineralogy Considered with relation to Natural Theology*, London: William Pickering.
- Bunn, H.T. & Kroll, E.M. (1986) 'Systematic butchery by Plio/Pleistocene hominids at Olduvai Gorge, Tanzania', *Current Anthropology* 27: 431-452.
- Burns, J.M. & Swerdlow, R.H. (2003) 'Right orbitofrontal tumor with pedophilia symptom and constructional apraxia sign', *Archives of Neurology* 60: 437-440.
- Bustamante, C.D., Fledel-Alon, A., Williamson, S., Nielsen, R., Huicz, M.T., Glanowski, S., Tanenbaum, D.M., White, T.J., Sninsky, J.J., Hernandez, R.D., Civello, D., Adams, M.D., Cargill, M. & Clark, A.G. (2005) 'Natural selection on protein-coding genes in the human genome', *Nature* 437: 1153-1157.
- Byrne, R.W. (2006) 'Evolutionary psychology and socio-biology. Prospects and dangers', In *Human Nature*: 84-105. Jeeves, M.A. (ed.), Edinburgh: Royal Society of Edinburgh.
- Byrne, R.W. & Whiten, A. (1988) *Machiavellian Intelligence, Social Expertise and the Evolution of Intellect in Monkeys, Apes and Humans*, Oxford: Clarendon Press.
- Cann, R.L., Stoneking, M., & Wilson, A.C. (1987) 'Mitochondrial DNA and human evolution', *Nature* 325: 31-36.
- Carroll, S.B. (2003) 'Genetics and the making of *Homo sapiens*', *Nature* 422: 849-857.
- Caspi, A., Sugden, K., Moffitt, T.E., Taylor, A., Craig, I.W., Harrington, H., McClay, J., Mill, J., Martin, J., Braithwaite, A. & Poulton, R. (2003) 'Influence of life stress on depression: moderation by a polymorphism in the 5-HTT gene', *Science* 301: 386-389.
- Cavalli-Sforza, C. & Bodmer, W.F. (1971) *The Genetics of Human Populations*, San Francisco, CA: W.H. Freeman.
- Cheng, Z., Ventura, M., She, X., Khaitvich, P., Graves, T., Oseogawa, K., Church, D., DeJong, P., Wilson, R.K., Pääbo, S., Rocchi, M. & Eichler, E.E. (2005) 'A genome-wide comparison of recent chimpanzee and human segmental duplications', *Nature* 437: 88-93.
- Church of England Doctrine Commission (2003) *Being Human: Power, Money, Sex and Time*, London: Church House Publishing.
- Cohen, A.S., Stone, J.R., Beuning, K.R.M., Park, L.E., Reinthal, P.N., Dettman, D., Scholz, C.A., Johnson, T.C., King, J.W., Talbot, M.R., Brown, E.T. & Ivory, S.J. (2007) 'Ecological consequences of early Late Pleistocene megadroughts in tropical Africa', *Proceedings of the National Academy of Sciences of the USA* 104: 16422-16427.
- Clayton, P. & Schloss, J. (eds.) (2004) *Evolution and Ethics*, Grand Rapids, MI: Eerdmans.
- Cloninger, C.R. (2000) 'Biology of personality dimensions', *Current Opinion in Psychiatry* 13: 611-616.
- Cloninger, C.R. (2002) 'The discovery of susceptibility genes for mental disorders', *Proceedings of the National Academy of Science of USA* 99: 13365-13367.
- Colwell, J.E. (1988) 'Anthropology', In *New Dictionary of Theology*: 28-30. Ferguson, S.B & Wright, D.F., Leicester: IVP.
- Conway Morris, S. (2003) *Life's Solution. Inevitable Humans in a Lonely Universe*, Cambridge: Cambridge University Press.
- Conway Morris, S. (2006) 'Darwin's compass: how evolution discovers the song of creation', *Science & Christian Belief* 18: 5-22.
- Cooper, J.W. (1989) *Body, Soul and Life Everlasting*, Grand Rapids, MI: Eerdmans.
- Crick, F.H.C. (1994) *The Astonishing Hypothesis*, New York: Simon & Schuster.
- Cullmann, O. (1958) *Immortality of the Soul or Resurrection of the Dead? The Witness of the New Testament*, London: Epworth.

- Cupitt, D. (1984) *The Sea of Faith*, London: BBC.
- Damasio, A. (1994) *Descartes Error*, New York: Putnam.
- Darwin, C.R. (1871) *The Descent of Man*, London: John Murray.
- Davies, G. (2004) 'Spiritual awareness, personality and illness', In *From Cells to Souls – and Beyond*: 123-145. Jeeves, M.A. (ed.), Grand Rapids, MI: Eerdmans.
- Dawkins, R. (2003) *The Devil's Chaplain*, London: Weidenfeld & Nicolson.
- Dawson, J.W. (1873) *The Story of the Earth and Man*, New York: Harper.
- Day, A.J. (1998) 'Adam, anthropology and the Genesis record – taking Genesis seriously in the light of contemporary science', *Science & Christian Belief* 10: 115-143.
- De Beer, G.R. (1930) *Embryos and Evolution*, Oxford: Oxford University Press.
- Dembksi, W.A., & Ruse, M. (eds.) (2004) *Debating Design. From Darwin to DNA*, Cambridge: Cambridge University Press.
- Dennett, D.C. (2006) *Breaking the Spell: Religion as a Natural Phenomenon*, New York: Viking.
- De Waal, F. (1996) *Good Natured. The Origin of Right and Wrong in Humans and Other Animals*, Cambridge, MA: Harvard University Press.
- De Waal, F. (1997) *Bonobo: the Forgotten Ape*, Berkeley, CA: University of California Press.
- De Waal, F. (2006) *Primates and Philosophers. How Morality Evolved*, Princeton, NJ: Princeton University Press.
- Diamond, J.M. (1991) *The Rise and Fall of the Third Chimpanzee*, London: Radius.
- Diamond, J.M. (1997) *Guns, Germs and Steel*, London: Jonathan Cape.
- Diamond, J. & Bellwood, P. (2000) 'Farmers and their languages: the first expansions', *Science* 300: 597-603.
- Doye, J., Golby, I., Line, C., Lloyd, S., Shellard, P. & Tricker, D. (1995) 'Contemporary perspectives on chance, providence and free will', *Science & Christian Belief* 7: 117-139.
- Dunbar, R. (2004) *The Human Story*, London: Faber & Faber.
- Dunn, J. (1988) *Word Biblical Commentary 38A. Romans 1-8*, Dallas, TX: Word.
- Dyson, F. (2005) 'Complementarity', In *Spiritual Information*: 52-55. Harper, C.L. (ed), Conshohocken, PA: Templeton Foundation Press.
- Eaves, L. (2004) 'Genetic and social influences on religion and values', In *From Cells to Souls – and Beyond*: 102-122. Jeeves, M.A. (ed.), Grand Rapids, MI: Eerdmans.
- Ebstein, R.P., Benjamin, J. & Belmaker, R.H. (2000) *Current Opinion in Psychiatry* 13: 617-622.
- Eccles, J.C. (1989) *Evolution of the Brain. Creation of the Self*, London: Routledge.
- Ehrlich, P. (2000) *Human Natures. Genes, Cultures and the Human Project*, Washington, DC: Island Press.
- Enard, W., Przeworski, M., Fisher, S.E., Lai, C.S.L., Wiebe, V., Kitano, T., Monaco, A.P. & Pääbo, S. (2002) 'Molecular evolution of FOXP2, a gene involved in speech and language', *Nature* 418: 869-872.
- Ettlinger, G. (1984) 'Humans, apes and monkeys: the changing neuropsychological viewpoint', *Neuropsychologia* 22: 685-696.
- Faraone, S.V., Doyle, A.E., Mick, E. & Biederman, J. (2001) 'Meta-analysis of the association between the 7-repeat allele of the dopamine D(4) receptor gene and attention deficit hyperactivity disorder', *American Journal of Psychiatry* 158: 1052-1057.
- Ferguson, S.B. (1988) 'Image of God', In *New Dictionary of Theology*: 328-329. Ferguson, S.B. & Wright, D.F. (eds.), Leicester: IVP.
- Ferguson, S.B. & Wright, D.F. (eds.) *New Dictionary of Theology*, Leicester: IVP.
- Fergusson, D.A.S. (1998) *The Cosmos and the Creator*, London: SPCK.
- Finlay, G. (2003) 'Homo divinus: the ape that bears God's image', *Science & Christian Belief* 15: 17-40.
- Finlayson, C. (2005) 'Biogeography and evolution of the genus *Homo*', *Trends in Ecology and Evolution* 20: 457-463.
- Fisher, C.L. (2005) 'Animals, humans and X-men: human uniqueness and the meaning of personhood', *Theology and Science* 3: 291-314.
- Fukuyama, F. (2002) *Our Posthuman Future*, London: Profile Books.
- Furlong, R.F. & Holland, P.W.H. (1992) 'Polyploidy in vertebrate ancestry: Ohno and beyond', *Biological Journal of the Linnean Society* 82: 425-430.
- Garrigan, D. & Hammer, M.F. (2006) 'Reconstructing human origins in the genomic era', *Nature Genetics* 7: 669-680.
- Gehring, W.J. (2002) 'The genetic control of eye development and its implications for the evolution

- of the various eye-types', *International Journal of Developmental Biology* 46: 65-73.
- Gintis, H., Bowles, S., Boyd, R. & Fehr, E. (2003) 'Explaining altruistic behaviour in humans', *Evolution and Human Behavior* 24: 153-172.
- Gomes, G. (2002) 'The interpretation of Libet's results on the timing of conscious events. A commentary', *Consciousness and Cognition* 11: 221-230.
- Gómez, J.C. (2004) *Apes, Monkeys, Children and the Growth of Mind*, Cambridge, MA: Harvard University Press.
- Gosse, P.H. (1857) *Omphalos*, London: Van Voorst.
- Gould, S.J. (1981) *The Mismeasure of Man*, New York: W.W. Norton.
- Gould, S.J. (1999) *Rocks of Ages*, New York: Ballantine.
- Grayson, D.K. (1983) *The Establishment of Human Antiquity*, New York: Academic.
- Green, J.B. (1998) "Bodies – that is human lives" a re-examination of human nature in the Bible', In *Whatever Happened to the Soul?* 149-173, Brown, W.S., Murphy, N. & Malony, H.N. (eds.), Minneapolis, MN: Fortress Press.
- Green, J.B. (1999) 'Scripture and the human person', *Science & Christian Belief* 11: 51-64.
- Green, J.B. (2002) 'Eschatology and the nature of humans: a reconsideration of pertinent biblical evidence', *Science and Christian Belief* 14: 33-50.
- Green, J.B. (2004) 'What does it mean to be human?', In *From Cells to Souls – and Beyond*: 179-198. Jeeves, M.A. (ed.), Grand Rapids, MI: Eerdmans.
- Green, J.B. (2008) 'Humanity – created, restored, embodied', In *On Being Fully Human*: Chapter 13. Jeeves, M.A. (ed.), Grand Rapids, MI: Eerdmans.
- Greene, J. (2003) 'Balfour v. Huxley on evolutionary naturalism: a 21st century perspective', *Science & Christian Belief* 15: 41-63.
- Gunton, C. (1997) *The Promise of Trinitarian Theology*, Edinburgh: T&T Clark.
- Haldane, J.B.S. (1927) *Possible Worlds*, London: Chatto & Windus.
- Haldane, J.B.S. (1932) *The Causes of Evolution*, London: Longmans Green.
- Hamer, D. (2004) *The God Gene: How Faith Is Hardwired into Our Genes*, New York: Doubleday.
- Hamilton, W.D. (1964) 'The genetic evolution of social behaviour', *Journal of Theoretical Biology* 7: 1-52.
- Hampshire, S. (2004) *Spinoza and Spinozism*, Oxford: Oxford University Press.
- Haight, J.F. (2006) *Is Nature Enough?*, Cambridge: Cambridge University Press.
- Hauser, M.D., Chomsky, N. & Fitch, W.T. (2002), 'The faculty of language: what is it, who has it, and how did it evolve?' *Science* 298: 1569-1579.
- Hinde, R.A. (1987) 'Animal-human comparisons', In *The Oxford Companion to the Mind*: 25-27. Gregory, R.L. (ed.), Oxford: Oxford University Press.
- Hitchens, C. (2007) *God Is Not Great*, New York: Hachette.
- Hobson, J.A. (2004) 'Neuroscience and the soul. The dualism of John Carew Eccles', *Cerebrum* 6: 61-70.
- Hodge, C. (1874) *What is Darwinism?*, New York: Scribner, Armstrong.
- Holland, P.W.H., Holland, L.Z., Williams, N.A. & Holland, N.D. (1992) 'An amphioxus homeobox gene: gene sequence conservation, spatial expression during development and insight into vertebrate evolution', *Development* 116: 653-61.
- Home, H.H. (1774) *Sketches of the History of Man*, 4 vols. Edinburgh.
- Humphreys, C.J. (2003) *The Miracles of Exodus*, London: Continuum.
- Huxley, J.S. (1957) *Religion without Revelation*, revised edition, London: George Allen & Unwin.
- Huxley, T.H. (1863) *Evidence as to Man's Place in Nature*, London: Williams & Norgate.
- Huxley, T.H. (1893) *Evolution and Ethics*, London: Macmillan.
- Ijdo, J.W., Baldini, A., Ward, D.C. et al. (1991) 'Origin of human chromosome 2: an ancestral telomere-telomere fusion', *Proceedings of the National Academy of Science of the USA* 88: 9051.
- Jacobs, P.A. (1975) 'The load due to chromosome abnormalities in man', In *The Role of Natural Selection in Human Evolution*: 337-352, Salzano, F.M. (ed.), Amsterdam: North-Holland.
- James, W. (1902) *The Varieties of Religious Experience*, London: Longmans, Green.
- Jeeves, M.A. (1998) 'Brain, mind and behavior', In *Whatever Happened to the Soul?* 73-98, Brown, W.S., Murphy, N. & Malony, H.N. (eds.), Minneapolis, MN: Fortress Press.
- Jeeves, M.A. (2002) 'Changing portraits of human nature', *Science & Christian Belief* 14: 3-32.
- Jeeves, M.A. (2003) 'Human nature without a soul?' *European Review* 12: 45-64.
- Jeeves, M.A. (2004) 'How free is free?' *Science & Christian Belief* 16: 101-122.
- Jeeves, M.A. (2005) 'Neuroscience, evolutionary psychology and the image of God', *Perspectives on*

- Science and Christian Faith* 57: 1-17.
- Jeeves, M.A. (ed.) (2006) *Human Nature*, Edinburgh: Royal Society of Edinburgh.
- Jeeves, M.A. & Berry, R.J. (1998) *Science, Life and Christian Belief*, Leicester: Apollos.
- Jobling, M.A., Hurles, M.E. & Tyler-Smith (2004) *Human Evolutionary Genetics*, New York: Garland Science.
- Johnson, P. E. (1991) *Darwin on Trial*, Downers Grove, IL: IVP.
- Joseph, J. (2001) 'Is crime in the genes? A critical review of twin and adoption studies of criminality and antisocial behavior', *Journal of Mind and Behavior* 22: 179-218.
- Kanwisher, N. & Yovel, G. (2006) 'The fusiform face area: a cortical region specialised for the perception of faces', *Philosophical Transactions of the Royal Society of London B* (in press).
- Karmiloff-Smith, A. (2002) 'Elementary, my dear Watson, the clue is in the genes... Or is it?', *The Psychologist* 15: 608-611.
- Kendler, K.S., Thornton, L.M., Gilman, S.E. & Kessler, R.C. (2000) 'Sexual orientation in a U.S. national sample of twin and nontwin sibling pairs', *American Journal of Psychiatry*, 157: 1843-1846.
- Kidner, D. (1967) *Genesis*, London: Tyndale.
- Kim, J. (1994) 'The myth of nonreductive materialism', In *The Mind-Body Problem*: 242-260. Warren, R. & Szubka, T. (eds.), Oxford: Basil Blackwell.
- Koenig, M., Young, L., Adolphs, R., Tranel, D., Cushman, F., Hauser, M. & Damasio, A. (2007) 'Damage to the prefrontal cortex increases utilitarian moral judgements', *Nature* 446: 908-911.
- La Peyrère, I. de (1655) *Men Before Adam, or a Discourse upon the twelfth, Thirteenth and Fourteenth Verses of the Fifth Chapter of the Epistle of the Apostle Paul to the Romans, by Which Are Provd That Men Were Created Before Adam*, London.
- Laslett, P. (ed.) *The Physical Basis of Mind*, London: Macmillan.
- Lee, P.A. & Kerrigan, J.A. (2004) 'Effect of prenatal androgens on gender development', *Current Opinion in Endocrinology & Diabetes* 11: 9-12.
- Leonard, W.R. & Robertson, M.A. (1997) 'Comparative primate energetics and hominid evolution', *American Journal of Physical Anthropology* 102: 265-281.
- LeVay, S. (1991) 'A difference in hypothalamic structure between heterosexual and homosexual men', *Science* 253: 1034-1037.
- Lewis, C.L.E. & Knell, S.J. (eds.) (2001) *The Age of the Earth: from 4004 BC to AD 2002*, London: Geological Society Special Publication No. 190.
- Li, W-H. & Saunders, M.A. (2005) 'The chimpanzee and us', *Nature* 437: 50-51.
- Libet, B. (1973) 'Electrical stimulation of cortex in human subjects and conscious memory aspects', In *Handbook of Sensory Physiology*: 743-790. Iggo, A. (ed.), Berlin: Springer-Verlag.
- Livingstone, D.N. (1992) *The Preadamite Theory and the Marriage of Science and Religion*, Philadelphia: American Philosophical Society.
- Loewe, L. & Scherer, S. (1997) 'Mitochondrial Eve: the plot thickens', *Trends in Ecology and Evolution* 12: 422-423.
- Lordkipanidze, D., Vekua, A., Ferring, R., Rightmire, G.P., Agusti, J., Kiladze, G., Mouskhelishvii, A., Nioradze, M., Ponce de Léon, M.S., Tappen, M. & Zollikofer, C.P.E. (2005) 'Anthropology: the earliest toothless hominin skull', *Nature* 434: 717-718.
- Lowenstein, L.F. (2003) 'The genetic aspects of criminality', *Journal of Human Behavior in the Social Environment* 8: 63-78.
- Lucas, E. (2001) *Can We Believe in Genesis Today?* Leicester: IVP.
- Lyell, J.C. (1863) *The Geological Evidences of the Antiquity of Man with remarks on theories of the origin of species by variation*, London: Murray.
- McBrearty, S. & Brooks, A.S. (2000) 'The revolution that wasn't: a new interpretation of the origin of modern human behaviour', *Journal of Human Evolution* 39: 453-563.
- MacDonald, H.D. (1981) *The Christian View of Man*, London: Marshall, Morgan and Scott.
- MacDougall, D. (1907) 'The soul: hypothesis concerning soul substance together with experimental evidence of the existence of such substance', *American Medicine* 12:240-243.
- McGrath, A. (2005) *Dawkins' God*, Oxford: Blackwell.
- MacKay, D.M. (1991) *Behind the Eye*, Oxford: Blackwell.
- MacKay, D.M. & MacKay, V. (1992) 'From cell biology to behaviour and conscious experience', *Fundamentals of Medical Cell Biology* 6: 247-262.
- Maguire, E.A., Gadian, D.G., Johnsrude, I.S., Good, C.D., Ashburner, J., Frackopwiak, R.S.J. & Frith, C. (2000) 'Navigation-related structural changes in the hippocampi of taxi drivers', *Pro-*

- ceedings of the National Academy of Sciences, USA* 97: 4398-4403.
- Maringer, J. (1960) *The Gods of Prehistoric Man*, London: Weidenfeld & Nicolson.
- Marsden, G. (2003) *Jonathan Edwards*, New Haven, CN: Yale University Press.
- Matthews, K., Dalley, J.W., Matthews, C., Tung Hu Tsai, and Robbins, T.W. (2001) 'Periodic maternal separation of neonatal rats produces region and gender-specific effects on biogenic amine content in post-mortem adult brain', *Synapse* 40: 1-10. 2001.
- Medstrand, P., van de Lagemaat, L.N., Dunn, C.A., Landry, J-R., Svenback, D. & Mager, D.L. (2005) 'Impact of transposable elements on the evolution of mammalian gene regulation', *Cytogenetic & Genome Research* 110: 342-352.
- Middleton, J.R. (2005) *The Liberating Image. The imago Dei in Genesis 1*, Grand Rapids, MI: Brazos Press.
- Miller, P.D. (2004), 'What is a human being? The anthropology of scripture', In *What About the Soul?* 63-73, Green, J.B. (ed). Nashville, TN: Abingdon Press.
- Milton, K. (1999) 'A hypothesis to explain the role of meat-eating in human evolution' *Evolutionary Anthropology* 8: 11-21.
- Mithen, S. (1996) *The Prehistory of the Mind: a Search for the Origin of Art, Science and Religion*, London: Thames & Hudson.
- Mithen, S. (2006) 'Ethnobiology and the evolution of the human mind', *Journal of the Royal Anthropological Institute* (N.S.) 12: S45-S61.
- Moll, J., Krueger, F., Zahn, R., Pardiini, M., Oliveira-Souza, R. de & Grafman, J. (2006) 'Human fronto-limbic networks guide decisions about charitable donation', *Proceedings of the National Academy of Sciences of the US* 103: 15623-15628.
- Moltmann, J. (2001) 'God's kenosis in the creation and consummation of the world', In *The Work of Love*: 137-151. Polkinghorne, J.C. (ed.), London: SPCK.
- Moore, A. (1889) 'The Christian doctrine of God', In *Lux Mundi*: 57-109. Gore, C. (ed.), London: John Murray.
- Morris, L. (1988) *The Epistle to the Romans*, Grand Rapids, MI: Eerdmans.
- Moule, C.F.D. (1964). *Man and Nature in the New Testament*, London: Athlone Press.
- Murphy, N. (1999) 'Supervenience and the downward efficiency of the mental: a nonphysicalist account of human action', In *Neuroscience and the Person*: 147-164. Russell, R.J., Murphy, N., Meyering, T.C. & Arbib, M.A. (eds.), Vatican: Vatican Observatory.
- Murphy, N. & Brown, W.S. (2007) *Did My Neurons Make Me Do It?*, Oxford: Oxford University Press.
- Mustanski, B.S., DuPree, M.G., Nievergelt, C.M., Bocklandt, S., Schork, N.J. & Hamer, D.H. (2005) 'A genomewide scan of male sexual orientation', *Human Genetics* 116: 272-278.
- Myers, D.G. (1998) *Psychology*, 5th edition, New York: Worth.
- Nelson, G.B. (2003) "'Men before Adam": American debates over the unity and antiquity of humanity', In *When Science and Christianity Meet*: 161-181, Lindberg, D.C. & Numbers, R.L. (eds.), Chicago: University of Chicago Press.
- Newman, J.H. (1873) *The Idea of a University*, London: Longmans, Green.
- Nilsson, D-E. & Pelger, S. (1994) 'A pessimistic estimate of the time required for an eye to evolve', *Proceedings of the Royal Society of London*, B, 256: 53-58.
- Noll, M.A. & Livingstone, D. (2003) 'Charles Hodge and B.B. Warfield on science, the Bible, evolution and Darwinism', In *Perspectives on an Evolving Creation*: 61-71, Miller, K.B. (ed.), Grand Rapids, MI: Eerdmans.
- Noss, J.B. (1964) *Man's Religions*, 3rd edition, New York: Macmillan.
- Nott, J. & Gliddon, G. (1854) *Types of Mankind*, Philadelphia.
- Nuffield Council on Bioethics (2002) *Genetics and Human Behaviour. The Ethical Context*, London: Nuffield Council on Bioethics.
- O'Brien, S.J., Menotti-Raymond, M., Murphy, W.J., Nash, W.G., Wienberg, J., Stanyon, R., Copeland, N.G., Jenkins, N.A., Wornack, J.E. & Graves, J.A.M. (1999) 'The promise of comparative genomics in mammals', *Science* 286: 458-481.
- Palmer, S.L. (2005) 'Christian life and theories of human nature', In *In Search of the Soul*: 189-215. Green, J.B. & Palmer, S.L. (eds.), Downers Grove, IL: IVP.
- Paquette, V., Lévesque, J., Mensour, B., Leroux, J-M., Beaudoin, G., Bourgouin, P. & Beaugregard, M. (2003) "'Change the mind and you change the brain": cognitive-behavioral therapy on the neural cognates of spider phobia', *NeuroImage* 18: 401-409.
- Passingham, R. (1982) *The Human Primate*, Oxford: Oxford University Press.
- Peters, T. & Hewlett, M. (2003), *Evolution from Creation to New Creation*, Nashville, TN: Abing-

- don Press.
- Pinker, S. (1999) *Words and Rules. The Ingredients of Language*, London: Weidenfeld & Nicolson.
- Pinker, S. (2002) *The Blank Slate. The Modern Denial of Human Nature*, London: Allen Lane.
- Plantinga, A. (1990) *The Twin Pillars of Christian Scholarship*, Grand Rapids, MI: Calvin College.
- Plotnik, J.M., De Waal, F.B.M. & Reiss, D. (2006) 'Self-recognition in an Asian elephant' *Proceedings of the National Academy of Sciences of the US* 103: 17053-17057.
- Polyani, M. (1969) *Knowing and Believing*, London: Routledge and Kegan Paul.
- Polkinghorne, J.C. (1986) *One World*, London: SPCK.
- Polkinghorne, J.C. (1994) *Science and Christian Belief*, London: SPCK.
- Pollard, K.S., Salama, S.R., Lambert, N., Lambot, M-A., Coppens, S., Pederson, J.S., Katzman, S., King, B., Onodera, C., Siepel, A., Kern, A.D., Dehay, C., Igel, H., Ares, M., Vanderhaegen, P. & Haussler, D. (2006) 'An RNA gene expressed during cortical development evolved rapidly in humans', *Nature* 443: 167-172.
- Pope John Paul II (1966) 'Message to the Pontifical Academy of Sciences, 22 October 1966'.
- Popper, K.R. & Eccles, J.C. (1977) *The Self and Its Brain – an Argument for Interactionism*, Berlin: Springer International.
- Povinelli, D.J., Bering, M. & Giambrone, S. (2000) 'Towards a science of other minds: escaping the argument by analogy', *Cognitive Science* 24: 531.
- Povinelli, D.J. & Vonk, J. (2003) 'Chimpanzee minds: suspiciously human?' *Trends in Cognitive Science* 7: 157-160.
- Premack, D. & Woodruff, G. (1978) 'Does the chimpanzee have a mind?', *Behavioural and Brain Sciences* 4: 515-526.
- Reichenbach, B. (1974) 'Life after death: possible or impossible?' *Christian Scholar's Review* 3: 232-244.
- Rendle-Short, J. (1981) *Man: Ape or Image. The Christian's Dilemma*, Sunnybank, Queensland: Creation Science Publishing.
- Rich, T.H., Hopson, J.A., Musser, A.M., Flannery, T.F. & Vickers-Rich, P. (2005) 'Independent origins of middle era bones in monotremes and therians', *Science* 307: 910-914.
- Robertson, I. (1999) *Mind Sculpture*, New York: Bantam Press.
- Robinson, W.H. (1925) 'Hebrew psychology', In *The People and the Book*: 366, Peake, A.S. (ed.), New York: Oxford University Press.
- Rokas, A. & Holland, P.W.H. (2000) 'Rare genomic changes as a tool for phylogenetics', *Trends in Ecology & Evolution* 15: 454-459.
- Rosenzweig, M.R., Krech, D. & Bennett, E.L. (1958) 'Brain chemistry and adaptive behavior', In *Biological and Biochemical Bases of Behavior*: 367-400, Harlow, H.H. & Woolsey, C.N. (eds.), Madison, WI: University of Wisconsin Press.
- Russell, R.J. (2003) 'Special providence and gene mutation; a new defense of theistic evolution', In *Perspectives on an Evolving Creation*: 335-369. Miller, K.B. (ed.), Grand Rapids, MI: Eerdmans.
- Rutter, M. (2005) *Genes and Behaviour. Nature-Nurture Interplay Explained*, Oxford: Blackwell.
- Saitou, N. (2005) 'Evolution of hominoids and the search for a genetic basis for creating humanness', *Comparative Genomics and Molecular Evolution* 108: 16-21.
- Savage-Rumbagh, E.S., Shanker, S.G. & T.J. Taylor (1998) *Apes, Language and the Human Mind*, New York: Oxford University Press.
- Schumacher, J., Hoffmann, P., Schmä, Schulte-Köne, G. & Nöthen. M.M. (2007) 'Genetics of dyslexia: the evolving landscape', *Journal of Medical Genetics* 44: 289-297.
- Sebat, J. (2007) 'Major changes in our DNA lead to major changes in our thinking', *Nature Genetics Supplement* 39: S3-S5.
- Shanks, N. (2004) *God, the Devil and Darwin*, New York: Oxford University Press.
- Shoshani, J., Groves C.P., Simons E.L. & Gunnell G.F. (1996) 'Primate phylogeny: Morphological vs molecular results', *Molecular Phylogenetics and Evolution* 5:102-154.
- Shu, W., Cho, J.Y., Jiang, Y., Zhang, M., Weisz, D., Elder, G.A., Schmeidler, J., De Gasperi, R., Gama Sosa, M.A., Ravidou, D., Santucci, A.C., Perl, D., Morrisey, E. & Buxbaum, J.D. (2005) 'Altered ultrasonic vocalization in mice with a disruption in the *Foxp2* gene', *Proceedings of the National Academy of Sciences of the USA* 102: 9643-9648.
- Simons, E.L. (1992) 'Fossil history of primates', In *Cambridge Encyclopaedia of Human Evolution*: 199-208. Jones, J.S., Martin, R.D. & Pilbeam, D. (eds.), Cambridge: Cambridge University Press.
- Singer, P. (1981) *The Expanding Circle. Ethics and Sociobiology*, Oxford: Clarendon Press.
- Smith, B.H. (1990) 'The cost of a large brain', *Behavioural and Brain Sciences* 13: 365-366.

- Soskice, J. (2008) 'Imago Dei' In *On Being Fully Human*: Chapter 14. Jeeves, M.A. (ed.), Grand Rapids, MI: Eerdmans.
- Spencer, H. (1893) *The Principles of Ethics*, London: Williams & Norgate.
- Spoor, F., Leakey, M.G., Gathogo, P.N., Brown, F.H., Antón, S.C., McDougall, I., Kiarie, C., Manthi, F.K. & Leakey, L.N. (2007) 'Implications of new early Homo fossils from Ileret, east of Lake Turkana, Kenya', *Nature* 448: 688-691.
- Stone, L.G. (2004) 'The soul: possession, part or person?', In *What About the Soul?* 47-61, Green, J.B. (ed.), Nashville, TN: Abingdon Press.
- Stott, J.R.W. (1972) *Understanding the Bible*, London: Scripture Union.
- Stott, J.R.W. (1994) *The Message of Romans*, Leicester: IVP.
- Stringer, C. (2002) 'Modern human origins – progress and prospects', *Philosophical Transactions of the Royal Society of London*, B 357: 563-579.
- Swinburne, R. (1996) *Is There a God?*, Oxford: Oxford University Press.
- Sykes, B. (2001) *Seven Daughters of Eve*, London: Bantam Press.
- Tancredi, L.R. (2005) *Hardwired Behavior: What Neuroscience Reveals About Morality*, Cambridge: Cambridge University Press.
- Teilhard de Chardin, P. (1959) *The Phenomenon of Man*, London: Collins.
- Thorpe, W.H. (1961) *Biology, Psychology and Belief*, Cambridge: Cambridge University Press.
- Thorpe, W.H. (1974) *Animal Nature and Human Nature*, London: Methuen.
- Thwaites, A. (2002) *Glimpses of the Wonderful The Life of Philip Henry Gosse*, London: Faber.
- Tomarev, S.I. & Piatigorsky, J. (1996) 'Lens crystallins of invertebrates', *European Journal of Biochemistry* 235: 449-465.
- Tomasello, M. (2000) 'Primate cognition – introduction to the issue', *Cognitive Science* 24: 357.
- Tomasello, M., Call, J. & Hare, B. (2003) 'Chimpanzees understand psychological states – the question is which ones and to what extent', *Trends in Cognitive Science* 7: 153-156.
- Torrance, A. (2004) 'Developments in neuroscience and human freedom: some theological and philosophical questions', *Science & Christian Belief* 16: 123-137.
- Trivers, R.L. (1971) 'The evolution of reciprocal altruism', *Quarterly Review of Biology* 46: 35-57.
- Van Assche, F.A., Holemans, K. & Aerts, L. (2005) 'Long-term implications of an abnormal intrauterine environment', *Current Opinion in Endocrinology & Diabetes* 12: 171-173.
- Van Huyssten, J.W. (2006) *Alone in the World? Human Uniqueness in Science and Theology*, Grand Rapids, MI: Eerdmans.
- Waddington, C.H. (1960) *The Ethical Animal*, London: George Allen & Unwin.
- Weaver, G. (2004) 'Embodied spirituality: experiences of identity and spiritual suffering among people with Alzheimer's Dementia', In *From Cells to Souls – and Beyond*: 77-101, Jeeves, M.A. (ed.), Grand Rapids, MI: Eerdmans.
- Wenham, G. (1987) *Genesis 1-15*, Word Bible Commentary, volume 1, Waco, TX: Word.
- Westermann, C. (1964) *The Genesis Accounts of Creation*, translated by Wagner, N.E. Philadelphia, PA: Fortress.
- Westermann, C. (1984) *Genesis 1-11*, translated by Scullion, J.J. London: SPCK.
- Westermann, C. (1987) *Genesis*, translated by Green, D.E. Grand Rapids, MI: Eerdmans.
- Whitcomb, J.C. & Morris, H.M. (1861) *The Genesis Flood*, Grand Rapids, MI: Baker Book House.
- Whiten, A. & Byrne, R. (1997) *Machiavellian Intelligence II. Extensions and Evaluations*, Cambridge: Cambridge University Press.
- Wilson, D.S. (2003) *Darwin's Cathedral*, Chicago: Chicago University Press.
- Wilson, E.O. (1975) *Sociobiology*, Cambridge, MA: Harvard University Press.
- Wilson, E.O. (1978) *On Human Nature*, Cambridge, MA: Harvard University Press.
- Wilson, E.O. (1998) *Consilience: the Unity of Knowledge*, New York: Knopf.
- Wolpert, L. (2006) *Six Impossible Things Before Breakfast. The Evolutionary Origins of Belief*, London: Faber & Faber.
- Wrangham, R.W., Holland Jones, J., Pilbeam, D. & Conklin, N. (1999) 'The raw and the stolen', *Current Anthropology* 40: 567-594.
- Wray, A. (1998) 'Protolanguage as a holistic system for social interaction', *Language & Communication* 18: 47-67.
- Wright, C.J.H. (2004) *Old Testament Ethics for the People of God*, Leicester: IVP.
- Wright, N.T. (1999) *New Heavens, New Earth. The Biblical Picture of the Christian Hope*, Cambridge: Grove Biblical Series, B11.
- Zeman, A. (2002) *Consciousness: a User's Guide*, News Haven, CN: Yale University Press.