



# Human Genetics and the Image of God

Graeme Finlay

## Overview

Dr Graeme Finlay delivered the lecture "Human Genetics and the Image of God" on 7th November 2006 at Queen's Lecture Theatre, Emmanuel College, Cambridge. A transcript of the lecture can be view at:

<http://www.st-edmunds.cam.ac.uk/faraday/CIS/Finlay/>

The lecture was followed by questions from the audience and later a dinner/discussion at St Edmunds College. A transcript of the discussion follows. It was chaired by Dr Denis Alexander (Babraham Institute) with introductory remarks from Prof. Brian Heap, Research Associate, Capability and Sustainability Centre, St Edmund' s College, Cambridge. The other contributors are described at the end of the discussion.

## Templeton Foundation Post-dinner Discussion

### Graeme Finlay – 7<sup>th</sup> November 2006

**Denis Alexander:** We usually invite someone who's been to the lecture to start with a few thoughts and responses to what was said and after that we'll throw it open to the floor, where anyone can chip in. Then we'll come back to Graeme to see what his response might be. So we try not to make this just a question-and answer-session to the lecturer, but rather to have a round-table discussion in which we hope everyone will feel free to contribute. The great thing is to remember you can revise your comments later, which is a very useful thing. Brian Heap has very kindly agreed to start us off this evening with a few comments.

**Brian Heap:** Thank you, Graeme, for a very stimulating lecture and also for all that you've contributed over the last few days since you arrived from New Zealand. You have worked very hard since you arrived but your visit has been very stimulating and we appreciate all you have done.

When your paper appeared in *Science and Christian Belief*, (Vol 15 [2003]) it reminded me of the epic event when Alfred Wallace sent his paper from distant New Zealand to Charles Darwin. It was a remarkable stimulus to subsequent events. Tonight, I am sure your lecture will have made many people think again about Christian belief and the implications of the evolution of humankind.

You drew our attention to retroviruses that have been incorporated into the human genome and how they can be traced to tell us much more about the descent of humankind. You described how the evidence provides 'incontrovertible evidence' about the descent of humankind. However, those who hold a creationist belief and people who support the idea of 'intelligent design' might well say that the presence of such retroviruses says more about susceptibility to incorporation of them in certain areas of the genome ('hot spots') than about descent.

I find a paradox here on that point. John Searle recently spoke to the London meeting of 'Christians in Science' about the biblical description of humans being made in the image of God. He reviewed the idea that humans are the crown of God's creation, that we are made for relationships in love, and that we have responsibilities to multiply and care for the world in which we live through an attitude of stewardship. Yet, as you said, it has been discovered that this crown of creation has parasitic material even in its genome. It also has a remarkable dependency on lower organisms that live in symbiosis and inhabit our alimentary canal in particular. Would you like to comment on the invasion of this image of God by viruses, some of which may be inert, and by dynamic organisms.

**Denis Alexander:** Before we let Graeme have a go at that I think it would be good – since we have homed right in on the science (I know not everyone round the table is a biologist by any means, although we've got plenty of biologists here) – to ask if there are any other comments, particularly on that, before we let Graeme respond?

**Derek Burke:** I'd like to raise just one point, which is something that Graeme hinted at but didn't draw out explicitly, about the times ago when these various splits in the trees occurred. Now some people round this table will already know them and Graeme, you will I'm sure know them, but some other people won't know them, and they are important because they give a feeling for the longevity of the evolutionary process, and they make impossible the idea of recent creation, if that was still to be seriously entertained, and they give a sense of perspective of the whole longevity of the timescale of evolution. I know that by making certain assumptions you can actually assign time points for when these splits came, so maybe at a later point this evening, you could just say a word about that.

**Nicole Maturen:** Just a word about the New York Times article today which I also read this morning. I think that in fact there wasn't any fossil evidence for a virus, that what they did was reconstruct from the human genome a uniquely human retrovirus and some HERV not found in any other primate, so it was an attempt somehow to get a glimpse into our own ancestry, something that was found only in our genomes and not in primate genomes. What they did effectively was reconstruct, based on endogenous retroviruses, what would likely be the ancestral retrovirus that was able to invade our genome.

**Harvey McMahon:** This comes back again to incontrovertible evidence.

We still don't actually understand how one jumps from one species to another. I always have difficulties in trying to see how individual mutations can actually lead to species progression. I study proteins and how proteins are organised into biological pathways. There is a strange observation that protein pathways frequently seem to 'know' their endpoint, and progression seems to be driven by this endpoint. It is almost as if evolution should know the endpoint. We observe that pathways, which perhaps involve 20-30 different proteins, often have their energy input at the end. I wonder whether we can't actually see this in genome evolution in terms of how all mutations come together; is it because there's an endpoint that's trying to be achieved, and does that shed any light on how evolution took place? You see, the protein composition and organisation of a cell determines what type of cell it is and what it does, while DNA is simply the cookbook full of recipes that can make different biomolecules, but it is proteins that determine which recipes are used and it is proteins that determine if the end product is good. Thus when we talk about evolution we need to keep our minds firmly on how protein pathways can evolve functionalities.

**Denis Alexander:** Spoken like a true molecular scientist! I think now we should let Graeme have a chance to reply to some of these big questions.

**Graeme Finlay:** I'll do my best. I feel that there are many people here who are more qualified than I am to address some of these issues, so please chip in and don't feel hesitant about putting me right if you hear me saying the wrong thing.

First of all about Professor Heap's concern – do these retroviruses and other inserts just look that way because they have a tendency to go into certain places? The short answer is no,

because when people infect cells with retroviruses experimentally and then look at the insertion sites, they find an enormous number of new insertion sites which can't be predicted *a priori*. Depending on the multiplicity of infection a vast number of different sites can be occupied by an incoming retrovirus.

Looking at other parasites such as the Alu elements and the LINE-1 elements, fantastic work has been done by the Batzer group, who have looked at hundreds or thousands of elements which are human-specific and then looked in the corresponding sites in the DNA of other primates to see if there are independent insertions of elements in those other primates. In no case have independent insertions in a range of other primates been found in the particular sites occupied by human-specific classes of LINE-1 elements (of which five hundred have been investigated), and Alus (of which 2,500 have been investigated). So I think that establishes experimentally that although there are preferences where these things insert, nevertheless there's an enormous range. The third answer to Professor Heap's concern is that every time an insert goes into DNA, it makes more DNA and so it creates a further substrate for new insertions, because you often find one insertion in an old one, one retrovirus in another one, or one LINE-1 element with another one inserting into it, and so the potential target pool in DNA continues to expand even as it accumulates inserts. Does that address that issue? I think experimentally you can't limit the insertions to a small number of preferred sites.

**Brian Heap:** I think it's valuable just to have rehearsed that because, as Denis has said, these things are now recorded and they are put on the website, so thank you for that response.

**Denis Alexander:** Speciation – a small detail?

**Graeme Finlay:** I think there are two things we can say. Firstly, that speciation won't occur with any one of these innumerable genetic changes. I think it's essential to consider human origins as a continuum. Having said that though, I think if there are particular genetic events that cause speciation, it's likely to be chromosomal and we differ from the other great apes by a particular chromosomal fusion by which our chromosome 2 was produced and that arises as a telomeric or end-to-end fusion of two other chromosomes, which are separate in all the other great apes. It's a sort of event like that, a chromosomal event, which causes reproductive isolation.

**Harvey McMahon:** So you're suggesting that we could convert ourselves back into an ape by reconstituting that chromosome?

**Graeme Finlay:** By reconstituting that chromosome? Other major chromosomal rearrangements have accumulated since but that's the big one, but there are now numerous inversions and other genetic events – (**Derek Burke:** Can we date that, Graeme?) – I think it can be dated but I'm not sure what the time is. Estimates of timescales in human evolution are (from Goodman, 1999, *Am J Hum Genet* **64**, 31):

<u>Common Ancestor with</u>	<u>Million Years Ago</u>
chimps	5
great apes	14
apes	18
Old World primates	25
New World primates	40
primates	63

Having said that, we in this table differ from each other in inversions, duplications and other genetic events by one-tenth as much as all of us differ from chimps, so there's an enormous amount of genetic variability which has accumulated in us since speciation occurred. It's a fascinating story.

**Denis Alexander:** I think it's time we gave the theologians here a chance to give their views on this evening's theme on human genetics in the image of God. We've got one or two, maybe more theologians around the table. I don't think you approach the idea of the image of God obliquely and I wondered if one or two theologians would like to have a go at just telling us what that means, actually. It's quite a simple question but it would be useful to have some theological input and then we can start trying to come back to the science and the theology, because after all this is a discussion about science and religion.

Do any of our theologians here want to reflect on the image of God? What does that mean? Can someone define it for us?

**Lisa Goddard:** I'll jump in because I'm writing that section at the moment. The image of God in the near Eastern context meant kingship. The image of the god was always the king. That kind of relates to the verbs that were used of the dominion which were used at the rule of the kings. Within that it was a human kingship which was to relate to Eloheme, the king, with creation so it assumes a lot of ideas of rationality and reasons. It has a long tradition but that is its near eastern meaning. I don't know if that's helpful.

**Hilary Marlow:** We haven't really had a chance to talk about it but I also am involved in this. The thing 'image of god' has become a sort of a stock phrase, if you like, that theologians churn out – what does it mean to be human – and it's worth flagging up that actually it's been the subject of intense and convoluted discussion over centuries. All the Christian traditions have debated it and come to different conclusions, so it's kind of a very complex thing and what Lisa said about the ancient near eastern context, which I agree with, is actually not always reflected in what the theological traditions do with it. Actually theology has made a lot more of it than the biblical text makes of it. This phrase only occurs in a couple of chapters of Genesis, so it's become a sort of a cipher for what we mean by what is human and I suppose my concern is that we read back into it what we want, because we want to establish something. Perhaps that's something I could ask you, Graeme. We want to establish something that actually makes us who we are: this need for identity being more than the sum of our genes and so on. You did this in your lecture and I found the way you did it very compelling. My concern is that in theology, if I can label myself with that name, we read back into the phrase what we want rather than actually starting as a biblical theologian. I want to ask what does the Bible say about it and what can we then say or not say, and also what else does the biblical text say about what makes us human, because there's an awful lot more than image of God in there. I don't know if you've got any other thoughts.

**Gerald Bray:** I would like to say something. I think that what you brought out very well is the relationality which it seems to me is very fundamental and goes right back to the Old Testament meaning because the kingship idea, the kingship of Adam, is a reflection of the kingship of God. Of course it can only be understood in relation to that so there is a relationality there. I think that from what Hilary was saying about the tradition, a lot of the tradition has been vitiated by misunderstanding, quite frankly, because people thought that the image and likeness were two different things and created all sorts of funny ideas on that basis.

Also I think the image of God is actually more widespread in the Bible than just in Genesis because if you include the New Testament as part of the Bible, you find that it's there in I Corinthians, it's in James and so on, and the interesting thing is most people think that the theological tradition has said that the image of God has been either lost or corrupted, or something like that, whereas the Bible never says that. You're not to kill someone (in Genesis 9) because they are created in the image of God; you're not to slander them (in James) because they're created in the likeness of God. I think the Bible itself is very clear on this and it's the playing around since which has caused a lot of problems, again based on lexical misunderstanding of what's going on. But this relational thing is vitally important and I think we see that he brought that out very well, this business about *ubuntu* in Africa, a person is not a person .. ("*I am what I am because of who we all are*"; alternatively, a person becomes a person through persons). Surely fundamentally this is what it is, that there's something about

us which is divine and not purely material. Defining what that is is very difficult but that it's there, it seems to me, is basic because we have a relationship with God which no other creature has. I bring this up as I find it hard to understand, but ask yourself this question. If you had a choice between being bitten by a dog or being bitten by me, which of these would you choose? Now a rationalist would choose to be bitten by me because they wouldn't suffer nearly as much in purely logical, physical terms. But of course everyone reacts to this question because they know that being bitten by a dog is somehow normal, whereas being bitten by me is a problem. You say that, well, why is it a problem, and then we get into, you know .... I get the image of God this way.

**Denis Alexander:** If the image of God is tied up with relationality, I think one has to raise the question of those humans who, for sad and unfortunate reasons, are unable to engage in relationships for maybe genetic reasons which you raised, and obviously those things touch on suffering, but just to throw that in as a sort of simple thing at the end there. Do you want to reflect on the image of God – how do you understand the image of God?

**Graeme Finlay:** Well, I tremble speaking in the presence of these theologians but can I give what is my understanding, such as it is. I get excited by it anyhow. When we struggle about what the Bible means by 'the image of God', we find the Image of God is Christ and that is given very clearly in the New Testament. So when we look at Christ, we see God in human form. That means the rest of us are in a sense a shadow, we are partial images, we are provisional images, we are tentative images, and so whatever part of the spectrum we are on, from mental deficiency to Einstein, from primitive man to whatever may be in the future, from conception or whatever, to old age, whatever we are, we are to be compared with the normative image, which is Christ. We are all relative images but Christ is the normative image.

**Brian Heap:** I find a paradox here on that point. Some of us attended a meeting in London on Saturday when John Searle talked about the image of God in his first paper. If I could just remind you he spoke about the image of God that we are created, we are made by God; we are the crown of his creation and we're more than our biology; we are created as two sexes, male and female; we are made for relationships, relationships in love; and we're given responsibilities to multiply and to take stewardship. Those of us who have been Christians for some time, we have known this for a long time and these are some of the basic features of what we understand about being made in the image of God.

Yet, I couldn't help being struck by what you were saying this evening about the extent to which there is parasitic material in our genome which is necessary for human expression and it hadn't struck me before that, if we're made in the image of God as the biblical teaching indicates, it is rather extraordinary that we're depending on parasites.

**Bob White:** It's no more extraordinary than the fact that we depend upon the whole of creation to live, don't we? We wouldn't be here if it wasn't for the rest of God's creation, we couldn't live in a vacuum.

**Graeme Finlay:** Or perhaps we're made of the ashes of dead stars.

**Bob White:** Well exactly so, and we need to eat other organisms to live so we need death to live, so in that sense we depend on all sorts of other organisms. The parasites happen to be inside us not outside us, but it's no different in kind, is it?

**Bill Broadhurst:** I think we may be in danger here of using "parasite" as a pejorative term. All animals possess mitochondria, while plants also have chloroplasts. Since we can't survive without them, it would be better to think of such organelles as symbionts, invaders that we have become adapted to.

**Nicole Maturen:** It might be related to how we think about perfection versus wholeness because sometimes we think the image of God and we think "perfect" and I suppose we could say Christ is the perfect image of God, but we ourselves hope to be whole images of God or, at least, whole in our creation and not broken. If we talk about the image of God being tarnished

or fallen, we find that objectionable; what we want to be is whole but not necessarily perfect. I find it helpful sometimes to think about perfection versus imperfection and wholeness versus brokenness and what is God really striving for in us, what are we striving for now, versus us at some later date when he has redeemed everything.

We should probably think about “wholeness” instead of “perfection”, so “whole” we can be composed of parasites or even all these bacteria that are part of our body and that can be beautiful, and perhaps it doesn’t have to be perfect in a kind of pure or sterile sense.

**Kevin Dutton:** Graeme, as a psychologist I feel far more comfortable in asking questions on the second half of your talk rather than the first half, which was equally fascinating. But I just want to touch on something which Denis had raised a few minutes ago which got me going during your talk and it was the part of your talk in which you were mentioning the importance of language, of words, in making us more fully human. I was thinking about people who are born deaf, dumb and blind. Is there any implication there that these people aren’t fully human? That’s one question.

Another question is you were talking about species, human beings become persons, but there’s a certain extent I think, and I’m certainly no biologist, in which all animals need to interact with members of their species in order to learn the skills of being that particular animal; so what makes us so different?

**Graeme Finlay:** It seems strange me answering a psychologist when I’m sure he knows far more about this than I do.

Deaf, dumb and blind: the classical example is Helen Keller who had a most marvellous humanity but I guess the fear is for those people who are truly insulated from love and from communication. They do indeed share our humanity; and it does not in any way minimise their preciousness or their sacredness before God - but in practical terms they are marginalised because they cannot communicate. I am certainly not an expert on this. I think it’s easier to look at feral children as an example, if there are in fact authentic examples, to see the pattern as John McCrone I think suggested, that those who cannot learn language cannot learn self-consciousness. They still share our humanity in a deep and wonderful way but they aren’t socialised and it appears they cannot be.

The other question is about animals, and we talked about rats and marmosets. There was a very touching little article in *Nature* magazine a few years ago about elephants and how Africa is filling with very angry young elephants because their herd has been disrupted by poaching and culling. My answer to that is, if this is true with mammals we consider to be simpler, then how much more true is it of human beings with their particularly well-defined and essential cognitive and relational abilities.

**Denis Alexander:** I think we would like to bring in people who haven’t spoken yet.

**Alasdair Coles:** First of all, may I thank you for your talk. But at the same time can I sound a note of caution about the interpretation of the neurological data you presented, particularly around the interaction of brain development and experience. I would not buy the interpretation that you drew from those two CT brain images – that such variation in brain size can be attributed to the sensorial richness of the developmental environment. Possibly in rats, with very drastic environmental deprivation, you can see changes in the thickness of the cortical ribbon, but the explanation for the changes you illustrated is much more likely to be due to poor nutrition. What is much more relevant to your argument is plastic change within the cortex contingent upon experience. That is what the taxi driver MRI shows, because functional MRI by definition isn’t showing structural changes, it’s showing changes in conductivity. So I’m just injecting a note of caution.

To change the subject, I wonder if there are people here who can help me because my memory doesn’t give me all the details on this, but Fox P2 is an interesting gene in the evolution of humanity and speech and the apparatus for pharyngeal expression or articulation. The

argument has been made that in this one gene, or at least in the cascade of genes which it controls, you can inject into the evolution of animal to man, firstly the pharyngeal apparatus which then allows language, which in turn allows self-consciousness. I don't know if anyone here can comment with more authority on this interesting story. Do you have any views on that?

**Graeme Finlay:** It's a while since I read a paper on it, but I'm sure everyone probably read it. Those who read it know that there are two amino acid changes in Foxp2 and Paavo and his group interpreted that as representing a selective pressure on this protein which is necessary for the fine control necessary for speech, but I can't comment beyond that.

**Alasdair Coles:** Would you concede that that might be the catastrophic change, as it were, in the genome that leads to the expression of humanity?

**Graeme Finlay:** I could just quote from Carroll who published a very thoughtful review on human evolution a few years ago and he made the point that we still have a weakness to talk about genes for this or genes for that and he believes that to say that there might be genes for bipedality or genes for faciocranial construction or genes for speech is a huge oversimplification. He said it's very unlikely that there is any particular gene controlling structural parts of our biology and that they will arise as the result of an interaction of a huge number of genetic changes. I think it's very simplistic to think that any single change will be able to account for the genetic changes. Having said that, there's a fascinating case of the MyH18 gene which controls the muscle in our cheeks which in human beings *only* is mutant, which means that we've all got very weak cheek muscles compared with all the other great apes. It's been suggested that the weakening of our cheek muscles allowed the remodelling of craniofacial bone structure which allows us to put our brain on top of our eyes. So that's a very interesting paper but I haven't quite seen the consequences of that, or what's flown from that.

But thank you for the point about Perry's paper – I can only refer you to Perry's paper and I'm not an expert in the area. But even so connectivity and formation of dendrites is still a physical change.

**Denis Alexander:** I think the idea of the "hopeful monster" has always hovered behind discussions of speciation historically, hasn't it? It constantly needs to be put down, that actually speciation is not an automatic thing. There are certain key changes that suddenly change the whole population but it's an inbreeding population that gets isolated and generates a new distinctive genotype, which leads to a new distinctive phenotype, and then it's a gradual process of emergence – I think that's a correct way of reading it. I don't know if our speciation experts will agree with my definition. I think this is why people jump on these Foxp2 genes as if somehow this is the trigger. I don't think there is a trigger, there are just different genotypes and Foxp2 is one of a hundred probably, whatever it is that we need to be human species, 100, or whatever it is we need to be human.

**Harvey McMahon:** But it's clearly very difficult for us to understand how we develop new characteristics involving the coordinated changes in so many different things all at once. Just by saying gene duplication and accumulations of mutations gives rise to new pathways seems a very simplistic concept, because ultimately expressing a different characteristic involves the coordination of many different pathways working together.

**Nick Holmes:** If I could just amplify something that Jane? said, I think it would be a mistake to think that there was only one route to speciation. There must be many ways in which species become distinct and sometimes they'll be quite dramatic. Probably in the majority of cases they'll be gradual but we shouldn't imagine that there's only one way in which species can be distinct.

**Gerald Bray:** What do you think about this theory I have been reading recently. People are saying you can go back not that long, maybe three and a half, four thousand years, something like that, so that everybody is interrelated – you find a common ancestor of the entire human race in fairly recent times. You mentioned Archbishop Ussher earlier and I wondered does this

rehabilitate him in a way, you know that somehow or other humanity did have some kind of start in the biblical Adamic period. What does anybody think about that?

**Graeme Finlay:** No, I think if you're speaking genetically -

**Gerald Bray:** Not genetically, but something else. There's something behind this, I don't know what and that's why I'm asking you as to what it is. If to get a common ancestor to every human being that now exists you only have to go back four thousand years, you don't think that's true?

**Graeme Finlay:** It's between one and two hundred thousand.

**Gerald Bray:** It's just that this has been floating around recently and I wondered what that's all about.

**Denis Alexander:** You may be thinking possibly of mitochondrial DNA and the idea of a sort of Eve. The mitochondrial DNA is inherited from the mother and therefore if you do a "back of the envelope" calculation, you have to go back to the fact that our mitochondrial DNA is inherited from one woman in one place and that simply means that the mitochondrial DNA, which is less than .1% of our genome, is inherited from a single female individual somewhere, which is around 120 or 150 thousand or thereabout. That doesn't mean to say, though, that all of that DNA comes from a certain individual. It's mitochondrial DNA.

**Gerald Bray:** It's just that you often hear people loosely talk about six or seven degrees of relationship and that we're all interconnected somehow.

**Bob White:** I would like to suggest that Bishop Usher might be rehabilitated if you consider Adam and Eve to be Neolithic farmers and if you think of that time about ten thousand years ago as the start of humanity in biblical terms. So the timescales fit quite well with Bishop Ussher's calculations. And since most of the Bible is about the history of humankind, there's only that little short period of 14,000 million years prior to humankind appearing which is covered in the first chapters of Genesis. Actually, Bishop Ussher did good work. I think the genealogies through the Bible do give roughly the same time period as historic and archaeological evidence for the existence of humankind in the sense of settled communities of people living off farming and animal husbandry, which is what the Bible is talking about in Genesis I.

**Derek Burke:** I have just read an interesting book (*Blood of the Isles*, Bantam Press, 2006 ISBN 0593056523) by Bryan Sykes, a professor at Oxford, who has used DNA sequencing to trace genetic relationships between peoples from all over the world - I'm sure Graeme knows about this. In addition to tracing the maternal relationships from the mitochondria, he uses a section of the Y chromosome to trace paternal relationships and has deduced from that that most of western society comes from three or four points of origin which he can date. So here again DNA sequences can be used to discover origins. He has also run a business where people get their DNA characterised so they know to which family of man or woman they belong; there is apparently a great longing in us not only to trace our relatives back into the 18<sup>th</sup> century, but to trace them back several tens of thousands of years. It's a little bit of biochemistry enterprise that's made good!

**Denis Alexander:** A lot of the Y chromosomes come from Ghengis Khan apparently, so if you have one from Ghengis Khan you can be proud.

I know that some of you haven't yet had a chance to perhaps to contribute or to raise different points and I think to the extent that we can bring the science and religion together in the same discussion, that's most helpful in the sense that we have limited time. If there are others who haven't yet had a chance to chip in and have some other reflections or points you would like to bring in ...

**Chris Gaston:** I was just going to say I am certainly not a theologian – it's a whole big area – but I wonder if there's another issue in the development of humanness and what makes us human in the sort of development of conscience and awareness of things not being right. Perhaps that ties in a little bit with the question I think you were asked about whether the God-

given relationships were any better than human relationships. Is there something special about human relationships to God?

**Denis Alexander:** When did conscience arise?

**Graeme Finlay:** Conscience. You would have to ask our socio-biological colleagues if you want a mechanistic answer. I guess socio-biology explains behaviours but as a Christian I would say it cannot explain right and wrong.

**Denis Alexander:** Would it be fair to say that all animal species express socialisation of various kinds? Humans are socialised in a sense in very parallel ways as you said in the way humans are socialised, but to hold a concept in your head long enough to think about its consequences: if I do A, B will follow; if I do C, D will follow etc. I think that's probably a unique characteristic, isn't it? Or do you think that animals do have that characteristic of degree? Can animals weigh up? Are their frontal lobes big enough to weigh up consequences sufficiently that they would be morally responsible? In a sense, that's the issue, isn't it?

**Graeme Finlay:** There's a fascinating table on things that make us human by Varki and Altheide in a recent issue of *Genome Research* and they had a whole page of things which are unique about humans: awareness of the past and awareness of the future is certainly one of them according to that table.

**Lisa Goddard:** There's a recent article in *Nature* about gorillas being able to forward plan.

**Kevin Dutton:** Can I also chip in there on that point, just to get in before my wife does! On that issue of conscience, it's important to remember that there are human beings with a psychopathic personality disorder in whom conscience does not exist, so there are people who do not have a conscience and who are still human. It's not an absolute.

**Elaine Fox:** There's a huge amount of work now showing that animals, through their emotional centres in brains, are exquisitely good at remembering contingencies of reward and punishment. Clearly there is a difference between humans and animals in terms of complexity, but actually it did strike me in a lot of things you were talking about that animals are very good at detecting value in that sense, in terms of the whole contingencies, which includes the future: for example, even rats are extremely good at predicting the future in terms of reward and punishment. Now clearly there's a difference between humans and rats but I wasn't sure whether the relational issue is necessarily the point at which we really differ, because it seems that these processes do go on within other species.

**Alasdair Coles:** On a point of information, would you say that animals display theory of mind which would be a far more pertinent asset to the relationship?

**Elaine Fox:** Chimpanzees do, and I think there's a lot of evidence to show that many primates do display theory of mind. I think probably non-primates don't, but certainly chimpanzees and other apes do show that.

**Denis Alexander:** Let me just put that point in a nutshell and then I will come back to you. In a sense what we're saying is that actually, as you look at animal evolution and you look at human evolution, we see a continuum: we see an emergence of consciousness, we see an emergence of conscience, we see an emergence of free will if you like. In the glimmerings of all of that, even in the primates, if we had the common ancestors of us and chimps, if Neanderthals were alive, then these issues would be more pressing, wouldn't they, because we would have populations genetically much closer to us and so then see those continuities perhaps much more clearly, so are we really saying that there is actually a lot of continuity going on there? So the image of God isn't just looking at those endogenous characteristics biologically and genetically, which I think is what you meant, but ends up as a theological question actually as to what does God deem. If we believe in God then what does he deem, as it were, the beings with whom he has a relationship. Is that where you come from or do you want to put it in a different way? I'm just trying to provoke comment here.

**Graeme Finlay:** Yes, I'm sure there are a great many features which animals show. I think there was a highly publicised incidence where recently where gorillas showed tool use which hadn't been suspected before in gorillas. (**Elaine Fox:** A lot of bird species as well)

**Graeme Finlay:** Yes, that's right. There is great intelligence in crows and in dolphins, so it's not only in primates either but I guess it's the suite of characters. Again coming back to Varki and Altheide, who like to think and talk about it in terms of human condition as being that entire suite of characters which make us distinct, which are both genetic and cultural. So we need to think of both genetic and cultural transmission and how they form us as the people we are.

**Denis Alexander:** Are our theologians happy with that side of things?

**Hilary Marlow:** I just want to throw something in that may or not be interesting. In my work in the Old Testament text there's a lot of grey area over to what extent it is only humankind that has the capacity to respond to God and there are a number of texts that kind of use the language of response for the rest of the creative world, and so that poses to me questions about relationality and so on. Given that actually perhaps we can only understand our own relationships from a sort of anthropocentric point of view and we don't know what bats think, we have no answer to that so perhaps we can't answer theologically either. I will just throw that in as something that turns round my mind perpetually. I don't know if any else has any thoughts on that.

**Bill Broadhurst:** Could I ask you a question about the flip side of the idea that we are human because other humans treat us as being human. One of the ethical consequences of this might work as follows: if I decide not to treat you as being human any more, does that mean that you become just an animal and can I therefore justify killing you if I think you are annoying? I think this is one way that conflicts can play themselves out in the world: we find ways of defining other people as not being quite as human as we are.

**Denis Alexander:** Especially when you want to go to war.

**Graeme Finlay:** : I think Stanley Hauerwas would say that the definition of humanity is how we treat those who are perhaps different from us.

**Bill Broadhurst:** So, rather than the care we receive from others, it's the care that we are prepared to give to others that define us as human beings."

**Graeme Finlay:** I think this is a very interesting thing. If our humanity comes from the range of people around us, then our humanity comes from the weak, the sick, the different; and if we get rid of them, if we abort them, if we euthanise them, if we get rid of them for any reason, then it's our humanity which is suffering. We end up with a restricted and truncated humanity if we get rid of those or if we deny those or if we reject those that are different from us.

I think that's a terribly strong argument against euthanasia. One trembles in the face of great suffering – one can't be dogmatic about great suffering – but across the board to get rid of those who are said to be a burden in society through euthanasia I think impinges upon the humanity of all of us, because our humanity is formed by those around us.

**Harvey McMahon:** If random mutations and jumping around within genomes still occurs over the next million years, what's going to happen to our ability to express the image of God? As we see already we are becoming more selfish, so this will become more imprinted in our genes and is it possible that eventually we won't be able to express the image of God? What are your thoughts about that?

**Graeme Finlay:** Well, I'm a bit of a spoilsport, I'm afraid, because my answer to that is that cultural evolution is occurring far, far faster than ever biological evolution and if in fact our humanity is so tenuous as to depend upon the love that we pass on from generation to generation, one wonders whether in a society of strangers we could lose it, we could become less and less human, as we fail to show love and care to those around us.

**Harvey McMahon:** Do you see man though as unique or could another organism evolve the ability to express the image of God?

**Graeme Finlay:** Yes I do. The Bible does give man that particular position. Whatever else the image of God means it means that here, of all the biological creatures, is one particular creature with whom God deals. Now I know that Professor Dawkins says that we just happen to be one terminal twig on the great tree of evolution and we shouldn't give ourselves such airs as to imagine there is anything special about us - but that's a faith position, of course. But as a Christian, as one informed by the story of the Bible, we must accept that we have a special calling and a responsibility. That calling and responsibility does not entail a privilege to abuse what we don't like but, to be God's representatives on this earth. For example, I think one of the implications of what the image of God means that we have this incredible responsibility to care for creation, to care for other creatures.

**Denis Alexander:** I think that's a very good last word, actually, thank you. That was a great summary of all you've said this evening so I think we're going to draw stumps at this point and we ought to thank Graeme very much, we've worked him very hard, and he's got another talk to give tomorrow so bring people all this way, work 'em hard, that's what we say. Thank you very much indeed, Graeme.

## Who's Who

**Dr Graeme Finlay** was a member of the Auckland Cancer Society Research Laboratory for 20 years, involved in anticancer drug development. He has taught scientific pathology over the last 6 years. He has a BTh degree from the Open University of South Africa.

**Dr Denis Alexander**, Director of the Faraday Institute and Fellow of St. Edmund's College, cancer and immunology research, The Babraham Institute; Editor of the journal *Science & Christian Belief*; author of *Rebuilding the Matrix* (2001, Lion).

**Rev Dr Gerald Bray** is research professor of divinity at Beeson Divinity School, Samford University, Birmingham, Alabama and director of research for the Latimer Trust here in Cambridge. He edits the journal 'Churchman'.

**Dr. Bill Broadhurst**, Assistant Director of Research at the Department of Biochemistry and Fellow of Emmanuel College; nuclear magnetic resonance; structural biology of proteins; natural product biosynthesis.

**Prof Derek Burke**, Honorary Fellow of St Edmund's, a former Vice-Chancellor of the University of East Anglia, a former Chairman of the Advisory Committee on Novel Foods and Processes, a former Specialist Adviser to the House of Commons Science and Technology Committee and a member of the Societal Issues Panel of the EPSRC.

**Dr. Geoff Butcher**, immunology researcher and member of the executive committee, The Babraham Institute; Chair of the Babraham ethical review committee overseeing animal experimentation.

**Dr. Alasdair Coles**, University lecturer in neuroimmunology; consultant neurologist, Addenbrooke's Hospital; and C.o.E ordinand. Co-Editor of *Advances in Clinical Neuroscience and Rehabilitation*.

**Justin Cross** trained in Cambridge, UK and Toronto, Canada before being appointed Consultant Neuroradiologist at Addenbrooke's Hospital, Cambridge. Clinical and research interests include the imaging of brain tumours and vascular disease. He is a supervisor in neuroanatomy at Peterhouse, Cambridge and is on the Editorial Board of the *British Journal of Neurosurgery* and *British Journal of Radiology*.

**Kevin Dutton** is a psychologist with an interest in the fields of conflict resolution and social influence. He is a research associate at the Faraday Institute and is the co-editor of *Why the Science and Religion Dialogue Matters: Voices from the International Society for Science and Religion* (published Oct, 2006, JTF Press.)

**Prof Elaine Fox**, Director of the Affective Science Laboratory at the University of Essex, and Visiting Scientist at the MRC Cognition & Brain Sciences Unit, Cambridge; cognitive and neural correlates of anxiety disorders; emotion; attention. Associate editor of *Emotion*.

**Dr Christine Gaston**, general practitioner principal in Cambridge for 10 years, with an interest in palliative care

**Dr Lisa Goddard** is reading for a second doctorate at the Centre of Religion and the Biosciences, Chester University, supported by a Gladstone Fellowship.

**Prof Sir Brian Heap CBE FRS**, Research Associate, Capability and Sustainability Centre, St Edmund's College, biological scientist, ed *Philosophical Transactions of the Royal Society series B*.

**Dr Nick Holmes**, University Lecturer, Dept of Pathology; research in immunology and immunogenetics.

**Prof Paul Luzio FMedSci**, Master of St Edmund's College; Professor of Molecular Membrane Biology, Department of Clinical Biochemistry and Director of the Cambridge Institute for Medical Research (CIMR); cell biology, protein localisation and function in cells; molecular mechanisms of disease.

**Dr Harvey McMahon**, Group Leader in the Neurobiology Division at MRC LMB; research in the molecular mechanisms of endocytosis.

**Hilary Marlow** Research Associate at the Faraday Institute and member of Queens' College; Divinity Faculty research student - interrelationship between God, humanity and nature in the Old Testament; nature, status and role of humanity; religious motivations for environmental concern.

**Nicole Maturen**, Ph.D. candidate; Dept. of Botany, The Natural History Museum, London and Dept. of Ecology and Evolutionary Biology, The University of Michigan, Ann Arbor; evolution of development, floral evolution.

**Prof Bob White FRS**, Associate Director of the Faraday Institute and Fellow of St. Edmund's College; Professor of Geophysics, Dept of Earth Sciences; volcanoes, earthquakes, climate change and other catastrophes; co-author of *Beyond Belief – Science, Faith and Ethical Challenges* (Lion, 2004).