

In our Time Programme 11
The Brain

Melvyn Bragg : Hello,we'll be talking about the brain,and the latest work on that most fascinating of subjects which is also an incredible object.I'm joined by professor Susan Greenfield,whose the current director of the Royal Institution,the first woman to have held the post.She's also professor of pharmacology at Oxford University and professor of physics at Gresham college.She's written several books,including "The Human Brain: A Guided Tour",and professor Rama Chandran ,professor of neuroscience and psychology,and director of the brain perception laboratory at the University of California in San Diego and a professor at the Institute.His new book is called "Phantoms in the Brain: Human Nature and the Architecture of the Mind",the nobel winner,Francis Crick said of this book,"if your at all interested in how your brain works,then this is the book you must read".I'll begin by quoting from the preface if that book,quote " the famous saying,"may you live in interesting times",has a special meaning now for those of us who study the brain and human behaviour,on the one hand,despite 200 years of research,the most basic questions about the human mind,how do we recognise faces? Why do we cry? Why do we laugh? Why do we dream? And why do we enjoy music and art,remain unanswered,as does the really big question,what is consciousness.On the other hand the advent of novel experimental approaches and imaging techniques is sure to transform our understanding of the human brain"

Looking at it one way,Susan,after 200 years,and all your work,why don't we know a few of these things?

Susan Greenfield : I think one of the problems is that we're getting a bit carried away with the techniques,and not really asking what we're going to use the techniques for,and I think I can give you three examples.One is imaging,where we can have windows onto the living human brain now,by exploiting the fact that that it's very greedy,and that will show you different parts of the brain lighting up whilst someone's doing something,but if you think about it,all that will show you is what areas of the brain light up when someone's doing something,that doesn't tell you how they're working together,or why they're lighting up like that,it just shows you that they are.

I think another technique that people are a little bit over infatuated with is that of molecular biology,where people now think they can isolate the gene for motherhood,or the gene for gayness,or the gene for criminality, and again whilst it's true that genes are very important determining the availability of certain chemical in your brain,those chemicals are like bricks or parts of bricks out of houses,they're not the whole story,and it's how they're organised and how they all work together that's very important and again I think that's often ignored.

Finally,I think I think another technique that's seduced people is that of neuronal nets,that's to say artificial silicon systems,where people think they can build a conscious robot or that they can....by building an artificial device understand how the brain works,and again I think the problem there is that they're putting a premium of learning and memory and not on the real feel,the real emotion of being a person.

So I think all these techniques while they're helping us understand little bits,they're not actually addressing the central issue as Rama said,of consciousness and of subjectivity,and that marvellous sensation that you have a "private inner world" in there.

Melvyn Bragg : Nevertheless,there's a lot there,ordinary things about how we behave,and why we laugh,why we cry.....that he's saying we don't know about,after 2 centuries of increasingly intensive research,and we know this is the decade of the brain.....

Susan Greenfield : Sure.

Melvyn Bragg :and whatever it is and so on,so how near are we to knowing things like that?

Susan Greenfield : I think we're nearer to knowing how things correlate,how different phenomena and processes in the brain,match up with states of mind.For example you could give someone Prozac,or morphine, or LSD and you could see certain configurations and chemicals change in the brain and you could match that up with a change in how happy someone felt.That doesn't tell you however,why it is that an increase in this chemical, let's say Serotonin,stops you being depressed.Or if you give someone Parkinson's disease,a chemical that allows their brain to make more Dopamine,why that Dopamine is needed for movement,it doesn't tell you those things.So I think we are very near to looking at correlations,that's to say how things match up,but we're are still completely bereft,completely ignorant about how to establish causality,how one thing causes the other.

Melvyn Bragg : Professor Rama Chandran,having laid your quotation on you,which is never a polite thing to do at

this time in the morning,how do you regard research into the brain at the moment? Do you think.....?

Rama Chandran : Well I agree with Susan,for example,about the imaging techniques,it's an interesting observation that for the longest time,you know psychologists and behavioural scientists took great pride in being functionless,in other words were not really interested in exactly where in the brain these things were occurring,you want an understanding of *how* it takes place,and yet when the imaging techniques have arrived, they take this tremendous voyeuristic delight in looking at exactly what's happening where.So there's a sort of a backlash from the early days of functionalism,as Susan was saying that's not enough,we want to know exactly how it works,not merely where each function is taking place,but it's a good beginning.

The second point I want to make is if you compare the history of ideas say in biology,which is about the same history as.....you know the same duration as psychology,you find many of the basic questions have been answered.Why do offsprings of goats look like goats and not like pigs? The problem of hereditary.How do cells divide? How do we reproduce? The DNA,you know the structure of the DNA molecule and so on and so forth. All the basic questions have been answered,or many of them have been answered,but in psychology if you ask the equivalent question,such as,why do people laugh? Why do they cry? Why do we dance,you know,why does everybody when there's a rhythmic sound feel like moving your body up and down? You know,it's a very basic question,and nobody has any idea why we do it,and all these basic questions have not been answered,but that 's not a pessimistic view,because I think the picture is changing very rapidly.

Melvyn Bragg : But your way to go at this dancer,you've described your method as "tinkering about",which is very charming,and then you proceed to tinker to great effect in your book.Nevertheless,you've chosen the word deliberately to give,I suspect,you tell me if I'm wrong,an impression of wandering around rather speculatively, not aimlessly,but with your imagination open and your scalpel firmly in your back pocket.Why did you use that word "tinkering" so emphatically?

Rama Chandran : Well simply because I think that every science goes through these obvious stages.There's an early stage,where you're just roaming the landscape,and looking for interesting phenomena to investigate,much as Faraday was doing with bits of wire and magnets and moving them,there's no overarching theory guiding his research,he was just driven by curiosity,but of course he learnt a great deal by this "tinkering",and then that set the stage for,you know,Maxwell's equations and all of that,and what I'm arguing in the book is that neuroscience is really in the Faraday stage,the tinkering stage,the laying the basic groundwork,discovering phenomena stage, not the stage of lofty theoretical speculation.

Melvyn Bragg : Susan?

Susan Greenfield : I think one of the exci...I don't want to sound too pessimistic here,because I think we're at a very exciting time for brain research.I think one of the problems has been up until now,that the psychologists have been operating in what they used to call "the conceptual nervous system",irritatingly abbreviated to CNS which of course stands for central nervous system,as well! They used to work with these boxes and arrows instead of real brain circuits,and up until very recently,they were completely divorced from the so-called "bottom up" neuroscientists,the sort of work that I do,where you work on a cell to cell basis,where you look at the chemicals that are squirted out from one brain cell to another,and I think we might start now,to see an increasing dialogue between the so-called cellular people,the bottom up people,with the people,that before used to just draw boxes and arrows,and if we can do that,I think we are going to make a very important stride, because it means we can actually route these very sophisticated concepts like laughter in the real physiology of the brain,rather than with boxes and arrows,saying "comparator" and "filter" and so on,which is how they used to be expressed.

Melvyn Bragg : Except the complication of the brain seems to be so incredible,staggering facts and figures pour out of your book more combinations than there are elementary particles in the universe,and so on and so forth,that it does seem.....I mean the needle in a haystack seems to be a fairly straightforward assignment, compared with what you're doing..But can I just come back to this tinkering? In what specific area your book is called "Phantoms in the Brain",and you've done an enormous amount of work on the phenomena of "phantom limbs",can you explain why you think that is interesting with regard to studying the brain?

Rama Chandran : Well,very briefly I mean here is a striking clinical observation,known since antiquity really, but at least for 100 years these patients have been studied systematically.An arm is amputated and the patient vividly

feels the presence of the missing arm, we call this a "phantom arm". The question is why does this happen? Well one of the.....

Melvyn Bragg : If they use their fingers, and they can feel pain in the arm that doesn't exist, and so on....

Rama Chandran :and so on. Of course he's aware of the fact that he doesn't have an arm, but it's a very vivid sensory illusion, the presence of the arm, and why does this happen? One of the things we've found was, if you simply touch this person's face, the patient's face, with a Q-tip, a cotton bud, he will experience sensations as emerging from his missing fingers, from his phantom fingers. What is this telling you about the brain? I think quite a lot. It turns out there's a complete map of the surface of the body, on the opposite side of the brain. So the left side of the body, for example, is mapped on top the right side of the brain. It's a systematic point-to-point map, and turns out that on this map, the hand representation is right next to the face representation on the map. So when the arm is amputated the hand is gone, the patch of cortex of brain that ordinarily receives signals from the hand is not getting any messages. What then seems to happen is that the input from the face, the sensory input invades the territory corresponding to the hand. So when you touch the face the message is going to the wrong part of the brain, it's going to the hand area, fooling the person into thinking that the fingers are being touched. So it's a very simple clinical demonstration with a cotton bud, but it's telling you that there's been this massive reorganisation of maps in the brain, often in an astonishingly short period.

Melvyn Bragg : So what does that massive reorganisation of maps in the brain tell you about the brain?

Rama Chandran : Well one of the things that it's telling you is the picture of the brain that you get from text books where there are all these fixed connections in the adult brain, must clearly be wrong. It's a much more dynamic pattern, and in fact one of the things that every medical student is taught is that neural connections are laid down in the foetus, and that you can't change these connections in the adult brain, but in fact that's not true. What you're seeing here is massive reorganisation.

Melvyn Bragg : One of the things, of course, that comes with a phantom limb is terrific pain. Now pain interests you Susan, you've written about this as being something you can learn from, and you can teach about the brain, again it's a very simple question, why is pain useful as an instrument of investigation here?

Susan Greenfield : As Rama says himself in his book, "Pain is in your head, pain is not out there in the real world", we know that if people have pain at different times through the day, they'll perceive, for example at lunch time less than at other times, if you're anticipating pain then it's perceived as more. So we know there's a very subjective element to pain. I've also heard reports that patients on morphine will sometimes say they still feel the pain, but it doesn't matter any more, there's no significance any more. Now this is, for my mind absolutely fascinating because I think this is a very interesting way in to understanding consciousness.

I think we should look at the ways in which a drug, for example, can make something not matter, and if we knew how that worked, with the connections between brain cells then we might actually have a handle on looking at the subjective, the issue that often scientists tend to forget, which fascinates philosophers, and I think is the baby out with the bath water if you ignore it, and that's the whole point about consciousness is that it's subjective.

Melvyn Bragg : But that is a key point in this particular area of science isn't it, Rama? Because the subjective has been the enemy of science for a very long time, and yet the subjective is part of this investigation?

Rama Chandran : Absolutely, and studying these patients who have damaged parts of the brain, and getting..... allows you to actually get to these very deep subjective questions. What I would like to do is link two of the ideas that we just mentioned, pain and laughter and humour, which seem completely unrelated, but I saw a patient in India not long ago, who has a condition called for pain, which simply means that if you poke her with a needle, a normal person would say "ouch!" and withdraw the hand. What she did instead, was every time I poke her with a needle, she'd start giggling incessantly, and couldn't stop laughing, so I asked her "why are you laughing?" and she said, "Well, it's very odd doctor, because I feel the pain, but I don't experience the agony". So this suggests pain is actually multi-layered, as Susan was just saying, and in fact with this patient what happened was there was damage to what's called the "insular cortex", which receives pain signals and transmits the signals to the emotional centres in the brain, including the Cingula, where you experience the agony. So you first experience the sensation, and then you experience the agony, and it's two different places in the brain. Now if these are disconnected by the damage, you get

this paradox where the patient experiences the pain but not the agony, and starts laughing because it's the only way she can kind of make sense of it.

Melvyn Bragg : Does this take us to Freud ? Sorry you wanted to say something?

Susan Greenfield : Yes, I've also been fascinated by the connection, the seeming paradoxical connection between laughter and joy, and actual pain, although I think I come to it a different way than Rama does, and that's with the onset of anaesthesia. When you give someone anaesthetic, first of all you go through a so-called analgesic phase, where you don't feel pain, and then in olden times before anaesthetics became as efficient as they are today, in the old days people actually used to go to parties called ether-frolics, or they, at fairs, take nitrous oxide for the euphoria it produced. Now, I'm fascinated therefore, that on the way to becoming unconscious, to losing your consciousness, you go from not feeling pain, from things not mattering, to feeling euphoria, and then of course, into this dream-like state that people seem to crave when they take morphine, and I'm just wondering, therefore whether there is a relationship between certain brain-states where you feel happy, or more alert, and then where you don't feel pain. For example, you know that schizophrenic people have a higher threshold for pain, that's to say they feel pain less than non-schizophrenic people. My own view is that this is connected with a chemical in our brain called Dopamine, which will change the configurations of their brain, so I think it's fascinating to explore from the two angles we've just said. I don't know who's right or wrong or if they go together, but certainly paradoxically these two things could come together.

Melvyn Bragg : Well what is interesting, at this moment about brain research, it seems to me, is that it switches from one level of entry to another, you're talking chemically at one stage, you're talking psychologically at another stage, you're talking about imaging at another stage, can I just come to Freud, if I may? Because this almost spans the century doesn't it? The beginning of the century let us say, there he had his great map, and then he became, towards the end of the century massively discredited, and yet both of you who, without being silly about it are leading neuroscientists, have gone, if I may say, back to Freud, and you have reservations Rama, but you say "undoubtedly he was a genius, and this is what he did", and why is he important to you now as a neuroscientist? Then I'll turn to Susan.

Rama Chandran : Well, a couple of things, first of all, I think that Freud's.....the general idea that your behaviour is governed by a very large number of processes of which you are largely unconscious, it turns out is right on the mark, and these are the very processes that we are studying when we are studying these patients.

Melvyn Bragg : So his 90% unconsciousness is right on the mark?

Rama Chandran : I wouldn't give it a percent, but something like that. But he also was addressing the key questions like laughter or sexuality, which interests everybody. The trouble is he was so much ahead of his time, and at that time they simply didn't have the techniques or even the conceptual tools to answer these questions, so the theoretical scaffolding he created was very nebulous, but the questions he raised are still perfectly valid and important.

Melvyn Bragg : I remember talking to Oliver Sacks when he said that "what Freud had done was the equivalent of Darwin's haul being brought back from the Galapagos", it was the precise equivalent, would you go along with that?

Rama Chandran : Oh, absolutely! Yeah, I think he had tremendous insight into human nature, and asked the right questions, but he didn't have the sophisticated.....

Melvyn Bragg : But in terms of pain that we were discussing what about his theory of denial?

Rama Chandran : Well I'm very interested in this, mainly because again, because of the patients I see, there is one group of patients who have stroke damage occurring to the right hemisphere, and they're completely paralysed on the left side of the body, and the majority of these patients complain that they're paralysed as they should, but there's a tiny fraction, about 5% of these patients who look at their paralysed arm and flatly deny that it's paralysed. They'll say "this arm is fine doctor", even though they're mentally quite lucid, and alert and they can see perfectly clearly that the arm is not moving. So what I tried to argue in the books is that by looking at these floridly exaggerated examples of denial that you see in these patients, this might give you an experimental handle on understanding some of the more common types of denial that we all engage in.

Melvyn Bragg : This is an aspect of Freud isn't it Susan that he takes exceptional cases? And Rama takes exceptional cases in his book. Now you like to....scientists like to deal in big numbers and big averages and big statistics don't they?

Susan Greenfield : But we also deal in caricatures.

Melvyn Bragg : Yes.

Susan Greenfield : In that you always, in an experiment, have to take a caricature situation something that is abnormally large or abnormally small. So whenever you do an experiment you wouldn't try and simulate what's called a physiological situation, because you want to have a very clear and unambiguous result, so you start off with something that is florid, that is extreme, but it's not to say that it's qualitatively different, it's quantitatively different, that's to say, it's not some bizarre extra thing that some poor person has bolted onto their head that no one else has. Quite often one can look at such cases and see them as extreme or florid examples of real life.

Melvyn Bragg : Do you see Freud as helping you in your work some way toward a unified theory which is lacking of the brain at the moment, it's completely lacking, isn't it? So do you see him as pointing, as a signpost in that direction?

Susan Greenfield : Yes, one of the reasons I'm a huge fan of Freud, contrary to many people nowadays is that I applaud anyone, *anyone*, who has a theory of how the brain might work, even if it's wrong, if they are generating, as Popper would say "falsifiable hypotheses", I applaud them, because at the moment I think a big problem with many contemporary neuroscientists is that they can't see the wood for the trees, they're i-dotting and t-crossing, and focusing on one small phenomenon or process, one tiny fact about the brain, rather than seeing how those facts relate to each other, or putting it into a great framework. I think what brain research lacks at the moment is we haven't got enough theory, we have too many facts and not enough theory, and I think that Freud did a great service by providing a theory. Now, of course with the hindsight of being 100 years on, in our hi-tech world of course we can jeer and jibe and mock and so on at some of the things, but on the whole, I think what he was trying to do, what he was trying to approach, the fact that he was talking about emotions, which scares a lot of neuroscientists off, and subjectivity and laughter, is something that really he should get enormous credit for, and myself....why he's helped me, is this paradox of emotion versus reason, and I myself am now evolving a theory of emotion that is not the same as his, but is certainly grounded in this idea of "how do these two things seem to relate together?", this logic, this rationale, versus the spontaneous, the road-rage, the crime-passionale.

Melvyn Bragg : Rama?

Rama Chandran : Well, I was going to say, one of Freud's failings....I'm also a fan of Freud, by the way, but one of his failings was he never did any systematic experiments on all these phenomena that he was talking about, and the advantage with studying the patients of the kind that I investigate, for example, a patient named Esmerelda I was just telling you about, who denied that her left arm was paralysed, you can ask a very simple question: How deep is the denial? In other words is it just a facade? Is she putting on a show? Pretending, if you like or malingering, or is she really and truly convinced that she's not paralysed, and you can actually do experiments to probe the depth of the denial, experiments that Freud only dreamed of, but never actually conducted, and this is the tremendous advantage of studying these patients, because you can actually do experiments on them.

Melvyn Bragg : Isn't there a huge divide between the Freudian going into emotions, discussing that, and something you say, the materialist view, which you say Rama, in your book again, "it seems somehow..." , I'm quoting, "...disconcerting to be told that life, all your hopes, triumphs and aspirations simply arise from the activity of neurones in your brain, but far from being humiliating this idea is enobling", I think you go on and so on, but isn't there some difficulty that people have in equating laughter, tears, love, passion, with a lot of neurones buzzing round, looking for other neurones to mate up with?

Rama Chandran : Well, they're not incompatible descriptions, I mean they're actually tri.....if you explain something in terms of its component parts, interacting your not explaining it away, in fact you're providing a solid foundation. In other words if I said "I'm in love with somebody, I'm giving her a rose", and you say "well here is this

cascade of chemicals that's producing this", it doesn't mean well love doesn't exist any more, it's just a different level of description, in fact it enriches your conception of love and your understanding of love, and you say "well it's not some abstract idea any more, in fact there's a solid foundation". So far from dispelling the idea of love, it should in fact enrich your idea of love, and make it even more real, in some sense!

Melvyn Bragg : Susan?

Susan Greenfield : I think also it helps us because the more we can understand about these things, the more we can combat the scourges of society like why people get depressed, why people take drugs, why they go bungee jumping, which incidentally has always fascinated me.

I think the more insight we can get into the human mind, the more we are going to be able to help people, so it's not so much that in our vanity, we wish that we were beamed in from planet Zog or something, it's much more that if we can have insight, then we can, as Rama says, appreciate things more. If you know why you like Claret, or why the taste is nice to you is because of the composition of the particular wine, then that helps you understand and select in the future, so you can enhance your joy in taking Claret. It's a bit like that with....

Melvyn Bragg : But how near is brain research to explaining things that matter still to millions and millions of people on the planet, and has mattered for centuries, and civilisation, let's take one thing, the religious impulse, the belief in belief, is brain research at the moment getting anywhere near that, explaining that, Susan Greenfield?

Susan Greenfield : No, but what I find interesting, is the link there, because I think we are very much creatures that want to be more than the material, and just as you might find it spooky that we can boil down to material things like brain cells, so most of us like to think that we can appreciate the world in a none material way, that we crave and need and enjoy and celebrate things other than the physical objects around us, and I think that's a very interesting insight into the human condition. As far as I know, certainly not in Britain, I can't see the medical research council giving anyone any money at the moment, and this pile of state of affairs we are for the neuroscience of religion.

But I do find it very interesting that we do have, rather like children do, and rather like when we are dreaming, a way within our brain of imbuing the outside world, or certain things that happen in the outside world with a significance that is not validated by their particular properties. We can give things an added significance or an added symbolism than they might deserve just in psycho-physical terms.

Melvyn Bragg : You take your materialism and the fact that neurones are responsible for everything, you actually take back or you take it across to Eastern mysticism, don't you?

Rama Chandran : Yes, to the extent that you know, the distinction between the self and the idea that you are a soul that is aloof from the rest of the universe and engaging in this lofty inspection of the events around you has always been considered to be an illusion in Eastern mysticism, especially in Hindu philosophy, and it's a great irony to me that you know, you do all this research on the brain, and essentially you are learning the same thing, except that you're learning exactly how the illusion comes about, and the illusion of self, and the illusion that you are inspecting the world, and so on and so forth. But there is a certain similarity here which I find tantalising.

Melvyn Bragg : Consciousness is a subject that has been discussed again and again. You talk about it not as a philosophical, logical, or conceptual issue, but rather as an empirical problem, what do you mean by that?

Rama Chandran : Well, what I mean is it could very well be that the word "consciousness" is a bit like the word "happiness", or the word "love", or even the word "life", in other words they are actually many different things, and you are lumping it all together into one word, for conversation, you know?

And once you dissect the different components, it might be possible to map each of those components to specific neural structures, and enrich your understanding of what consciousness is. So for example we know that when you say "happiness", it involves joy, it involves comfort, it might involve several obvious components that go into it, likewise consciousness involves self-consciousness, being aware of yourself, just awareness of something, awareness of pain, and there are umpteen.... a body image, the fact that you are embodied, the fact that you are passionate, you have emotions, and each of these you might be able to explain, but there's no final climactic solution, in much the same way that you know, DNA was the solution for the problem of hereditary, there may be no equivalent solution for the problem of consciousness.

Melvyn Bragg : Stuart Sutherland said that it's impossible to specify what it is, what it does, why it's evolved, he said "nothing worth reading has been written on it", which seems a bit hard, Susan what do you feel about consciousness, and where we are with dealing with it now, today?

Susan Greenfield : Well, I certainly feel that if you have an attitude like that, imagine if Christopher Columbus had someone like that on board, they'd have never got passed Lisbon harbour, (Mel laughs) and I find that rather sad, especially from a scientist to have such a negative attitude. I go along with Rama that consciousness means many things to many people, and the fact that we can't define it, I think is because it is bigger than everything else. Normally we define something by referring to a higher set, so you define love as an emotion, a table as a piece of furniture, Father Xmas as a mythical creature, consciousness as a and then that's where some people say, a property of the brain, but that makes it very banal, and I think, because it encompasses everything else, including the universe, we can't refer it to a higher set, so rather than fret because I'm a philosopher..... I'm not a philosopher, rather than fret about those things, I'd rather get on and try and see how it's generated by the real brain, I agree it's not so much, a problem, it's the ultimate challenge, it's not a simple, single problems that could be solved by one experiment, but I think it's a very exciting challenge.

Melvyn Bragg : Susan thinks of consciousness as a continuum from what I read of your work, you don't agree with that do you?

Rama Chandran : Well, what I would argue is that just as we know, obviously there was a time when people said you know a "panpsychist" , you know, people used to think everything was conscious, we now know that it's the brain that is conscious, the liver is not conscious, the heart probably is not conscious, but it's in the brain. You can narrow the scope of this further, and say it's not the entire brain, but certain parts are critically involved, and it maybe that certain functions, and certain circuitry is more relevant to conscious experience than other functions, and we know for example there are patients who engage in very elaborate actions, without having any conscious awareness of what they're doing. So it's not merely the elaborateness of what's going on that guarantees the emergence of consciousness. For this reason, I think it is only certain types of function that are associated with consciousness, it's not a graded thing.

Melvyn Bragg : Final word from Susan Greenfield.

Susan Greenfield : Well, I think that it must be looked at holistically , although some, like in any orchestra, some instruments might have more important parts than others. The other big, big issue I think are the chemicals and until people look at the chemical basis for why people are happy and sad, and relate that to consciousness, if they carry on with their silicon circuits, just looking at learning and memory, then I think that's the wrong path.

Melvyn Bragg : There you go, thanks Susan Greenfield, and congratulations on winning the Michael Faraday medal , and Professor Rama Chandran, whose book is called "Phantoms in the Brain: Human Nature and the Architecture of the Mind". Next week my guests will be two Historians, Linda Holly and Katherine Hall and we'll be discussing the legacy of empire through the 20th century, and thank you for listening.