Origins of Purpose

**Melanie Challenger**

I'm delighted to be joined today by neuroscientist Kevin Mitchell. Kevin is Associate Professor of developmental neurobiology and genetics at Trinity College Dublin. Aside from his research, he communicates neuroscience to publics, and blogs at wiringthebrain.com. He’s the author of the book Innate, how the wiring of our brains shapes who we are, and Free Agents, How Evolution created the power to choose.

**Melanie Challenger**

So Kevin, thank you very much for joining me today.

**Kevin Mitchell** 01:36

It's my pleasure.

**Melanie Challenger**

I'm going to start with your recent book *Innate.* What sorts of questions emerged, because I'm very interested in what we're going to talk about a little bit later today in terms of agency, where in your book *Innate*, those sorts of questions and ideas started seeding themselves in that process?

**Kevin Mitchell**

Yeah, great. So innate was really about how our psychological traits come to be the way they are. So what makes us each the way we are, and of course, we all have different personality traits and cognitive abilities, and all sorts of patterns of behaviour that are characteristic to us. And of course, there's an age-old question of whether it's nature versus nurture. And really, you know, my starting point was the behavioural genetics field, which had demonstrated very clearly that there was a genetic component to a lot of our traits, but I wanted to go a little bit further than that, and dig into it and say, Okay, well what's the nature of that? How is it that differences in our genes can lead to differences in the way our minds work? And really to initially sort of took a step back from that to ask, well, what is it that defines humans in general, what defines human nature versus nature of other species. And really, it comes down to the way our brains developed. So our genome, written in human DNA generally, is a program to make a human brain, and that necessarily entails all of the typical aspects that define us. You know, behaviourally, psychologically, intellectually as human beings. So if that's true, and I think that's hopefully uncontroversial, then the corollary of that is, that program must vary between people in the same way as the program to build a human body varies between people, and we see variation in our faces and how tall we are, and the length of our limbs and all sorts of other physical things, we should expect to see variation in the genetic program that specifies our brains.

**Kevin Mitchell**

And and the interesting thing is that when you look at the actual outcome of the sort of gene hunting that's gone on in the behavioural genetics field, so they really moved on from just showing that these traits are heritable, that part of the variation is genetic in origin, to actually finding some of the genetic variants that contribute to these traits. And when they do that, overwhelmingly the genes that are implicated are involved in neural development. So really, it suggests that the differences in our psychology reflect how our brains develop. And as opposed to reflecting something like it, a difference in the metabolism or some particular neurotransmitter in our brain right now, it really is a story, the relationship between the genotype and what we call the phenotype, the expression of our traits, has to be realised through the processes of development, and the genetics is telling us that that's true. But there's another sort of outcome of that, which is that, so typically when we think about nature versus nurture these days, we sort of think of genes versus environment, you know, those are now our proxies, for nature and nurture. The idea generally then would be if something is only partly genetic, then the rest of the variation must be environmental in origin, it must be something to do with our upbringing, or our experiences, and so on. And people have looked really hard for any sort of systematic factors in the environment that might correlate with different personality traits, without really coming up with anything. But that equation of genes and environment leaves out a really important source of variation, which is development itself. Because the genome doesn't encode a final outcome, it's not a blueprint, it's not a static thing. It's, more like a, a recipe or a code that gets read out by the cells as the embryo is developing. And that's a really noisy process at a molecular level, it just doesn't happen exactly the same way every time you do it.

**Kevin Mitchell**

You know, I like to say you can't bake the same cake twice, it doesn't matter how good your recipe is. So there's a lot of randomness that's just inherent in the processes of development, you can start with the exact same genome, as we see in identical twins, for example, and you don't end up with the exact same outcome. And we see that in their physical structure, we see it in the physical structure of their brain and the way that it works. And we see it in their psychology as well. So collectively what that means is that actually, even though our traits are only partly genetic, they may be much more innate than that indicates, because we really are born a certain way, with these psychological predispositions, that are partly due to genetic variation, partly due just to the particular outcome of that run of development, if you will. And so it's a picture that says, Okay, we don't come hardwired, but we definitely come pre-wired, it’s not a blank slate, we really are sort of wired a certain way. And that I don't want to, you know, suggest that those things control our behaviour on a moment to moment basis, but they do inform the way our behaviour emerges over our lifetimes. So again, you still have to maintain a kind of a trajectory view or process view of how those innate predispositions influence our behaviour, as an ongoing process, over time. That often sort of gets amplified by the way that we choose our environments, by the way that because we're wired a certain way we respond to our experiences, and so on.

**Kevin Mitchell**

So that was the general thesis that the developmental lens there lets us understand how our traits can be partly genetic, and gives a better a better view, I think, than the blueprint metaphor, which is really I think, kind of misleading. And in terms of how that led on to, you know, thinking about agency, it led in a couple of ways. But one of the most obvious ones is that when I talk about these things people often ask then afterwards, okay, well, if I'm wired a certain way, and I didn't choose that, it's nothing to do with me. It's just the way my brain developed, then, am I really in control of my actions? I mean, I can do what I want, but I can't choose what I want, necessarily, if I'm tuned, you know, some certain way. So. it got me interested in the question of freewill, which is normally framed, obviously, around human beings, but once you start sort of scratching the surface of that, or at least once I did it, it quickly leads to a much, much deeper question, which is not just how could a human be in control of their actions at any given moment? But how could anything act? How could any thing in the universe do something? Like most things in the universe don't do anything, and we have the certain class of things, living organisms that do things, they're capable of action. And they're not just acted upon by things in the world, by causes outside them, they become causes in their own right, or at least that's how it seems. And so I became interested in trying to ground a discussion of freewill in a much more basal sense of understanding how agency could exist at all. And really, the approach that I'm taking to try and tease that out is the approach that nature took. It's an evolutionary one. Starting with, you know the origin of life, what is it? What does it even mean, really, to be a living thing? And actually, although it's often overlooked, and it's not really foregrounded very much, I think being an agent is probably the most salient characteristic of living things that separates them from the rest of everything else in the universe.

**Melanie Challenger**

That was a fantastic scene setting for us in terms of how your work has been developing over the last few years. What *Innate* is achieving as a book is trying to show us how we go from a sort of base nature, human nature, if you like, to multiple variable human natures. And you talked about how crucial development is here in operationalizing the genome, if you like, the sort of basic ingredients of the genome, but when you're talking about development, can you clarify for people who maybe are coming to your work without sort of, you know, a deep knowledge of it? What are the key stages of development? What, what do they look like? Yeah. And how does that elide into the sort of neuroplasticity that's talked about a lot, you know, as the later stage in how variation emerges in mind and action and behaviour?

**Kevin Mitchell**

So when I was talking about development there., I'm mainly talking about neural development of the embryo and the foetus. And so how the nervous system gets actually made. And so when you have obviously you know, you start life as a single cell, a fertilised egg, and as that develops it, the cells start to differentiate from each other. So as the embryo, you get a ball of cells that gets several 1000 cells, but you're already within that have some differentiation, have a kind of an axis, you know, a front and a back a top and a top and a bottom kind of thing. And so the embryo has within it, a self-organising capacity and that's built into the genome. So as the cells divide, so you get some sort of asymmetries between them, that get entrenched, and that ultimately become through all this sort of feedback mechanisms define the pattern of the embryo itself. And then they set aside different tissues, you know, muscles, skin, the nervous system. And then of course, within the nervous system, you have to pattern different elements of it. So you need a forebrain, midbrain, hindbrain, spinal cord, and so on. And of course, at finer and finer detail as you go into that, and it's an extraordinarily complex set of processes that have to happen. So you need to make 1000s and 1000s of different types of neurons. There's not just nerve cells, there's 1000s of different types, all at different jobs to do, they're really specialized, they have to be laid out in exactly the right way again, you get this, sometimes there's a sort of artist's impression of what's going on inside the brain. And it looks just like a kind of a randomly laid out sponge, which is absolutely the opposite. It's incredibly exquisitely structured, in terms of the way different cell types are laid out, and how they connect to each other, which is really key. So the nervous system works as a set of circuits, those circuits require the right cells to become connected to each other, in the same way, as if you were designing a circuit board, you'd have to connect up the elements in the right way for it to get it to do the right things. So different circuits in the brain are specialised for different kinds of computations or cognitive operations. And so for all of that to happen, the instructions in the genome have to be read out and played out through billions and billions of just mindless biochemical algorithms, you know, you just make the proteins and, and the way the genome is set up, they interact with each other in a certain way. And you just reliably get this outcome. I mean, it's almost miraculous, but it isn't, really the instructions, if you will, are there in the genome, and they're read out by the material, starting with the material in the fertilised egg itself, the proteins that are out there, already in there.

**Kevin Mitchell**

So through those through those mechanisms, you will end up with a human brain, you know, and if, for example, I managed to clone myself, and my clone developed, then they would end up with a brain that's very similar to mine, but not identical, because of this extra variation that happens. So through all those mechanisms, and the variation that happens, you will end up with a variation in things like the size of different parts of the brain, the number of different types of neurons in different places, the number of nerve connections in different circuits and so on. And then, underlying that, there's also lots of variation in the biochemical parameters, because neurons are not just electrical components, they're cells and the cells will actually do a lot of computation just with their proteins and stuff. So we have tons of variation in basically the way the brain is wired, both structurally and functionally. And that will manifest in ways that I have to say, we don't really understand well, but will manifest in differences in the sort of global functioning of the brain that you can measure with neurophysiology or neuroimaging. And thereby affect our psychological traits by affecting sort of the tuning, maybe of some particular neural circuits that mediate, not personality traits, like extraversion, or things like that, but much more basal behavioural control functions, like, reward, how sensitive are you to reward? How sensitive are you to threats? How risk averse are you? How willing are you to wait for a reward, or how impulsive are you? So those kinds of things are parameters within the brain, where we can see them working in, even in animals, you know, you can look in mice, and you can actually not just see them working, you can tweak them. So you can make the mouse be more impulsive or make it respond more to reword or make it be more confident of some information before it makes a decision.

**Kevin Mitchell**

So all of those things will also vary between people in which is interesting, because I think that's, first of all, that that idea can connect these psychological constructs that we use, like extraversion, or conscientiousness, or neuroticism, which are just a superficial descriptors of patterns of behaviour. I think that idea can connect them to what might be varying within the brain. And I mean, that's a bit speculative. But the idea that really patterns of behaviour reflect differences in or biases in decision making. And the parameters of decision making are the kinds of things I was just talking about reward sensitivity, risk sensitivity, and so on. That kind of variation may result in a profile of personality traits between people. But then this gets on to this question of plasticity, because of course, development doesn't end at birth. And what happens in neural development is you have this initial stage where the program in the genome is read out through these processes of development in the embryo to make the structure of the brain, but then, almost immediately, the nerves start firing, so they start talking to each other. And that process allows the conductivity of the brain to refine itself. First of all, it just, even in the womb, the brain is already trying to refine those circuits. But then after birth, it does that in response to experience. And of course, that's what we call learning. And as everybody knows, infants are the most amazing learners around. They're just soaking up information. And their brain is basically remodelling itself all the time. And that continues right up till early 20s, actually, a lot of remodelling is still going on. So what can happen in terms of the relationship between our traits and those processes of plasticity is rather than thinking, you know, that experience can override our innate predispositions, I actually think the opposite happens. And there's a lot of evidence for this, that it amplifies those predispositions. And the reason is that our experiences don't just happen to us, at least after a certain age, we become agents of choosing our own experiences, and we construct our own environments by choice, more and more throughout our lives. And what that means is that, if for example, you have someone who's say socially anxious, as that maybe they're tuned that way to begin with. And then they don't enjoy interacting with people as much or they don't do it as much because they're anxious about it, and then they don't get as practiced at it, and so on. And so, you know, their peers might progress faster than them in in terms of their social cognition and skills. And then that becomes a sort of a vicious circle.

**Melanie Challenger**

Yeah, it's interesting. We think about humans as occupying a kind of cognitive niche, and you're sort of describing the way that we self-select them for a personal niche if you like later on.

**Kevin Mitchell** 19:54

Absolutely, we absolutely construct our own niche based on what we like and what we're good at, and, and that those processes of plasticity, then reinforce things because when things are rewarding to you, and you know, you and I could have exactly the same experience, but the way that you're attuned is different from me. So you might find it really rewarding. And your brain would actually then that plasticity is actually gated, it doesn't happen all the time, we don't remember everything, we don't change our brain in response to everything that happens to us, we're really selective actually, or our brains are. So you know, if you have two people, one of whom is really responding emotionally to something, the other one who's quite sort of indifferent to it, then the first person, their brain's going to change in a way that reinforces that and so over time, what you get is that our habits emerge, and our character becomes more sort of developed, and maybe crystallised in certain ways. And of course, when we talk about the way people are, most of what we observe is actually their habitual behaviour. And it's really that that is what we're talking about, when we're talking about their behaviour. So the idea, you know, that we have these personality predispositions, I think is right. But I don't think that, like I said, that it's those things that control our behaviour on a moment to moment basis. Rather, they inform the way our habits and character have emerged over our lifetime. And then all of that picture, that whole trajectory then informs the decisions that we make on a moment to moment basis.

**Melanie Challenger**

One of the things that I really liked about *Innate* is that I think you manage a very sophisticated balance between variation and determinism. So we get, we have been plagued even, frankly, at a high level, because we're always in the process as thinkers and researchers of each generation of just steadily trying to move things along and work out what was wrong in the past and tweak things and get a clearer picture of what we're trying to explain about biology or behaviour and so forth. There is a lot of reductive talk isn't there, either or dichotomous all the time. And it is a nuanced picture that allows us to be reasonable about accepting what elements are bound in the flesh, if you like, and just how labile it is, how much variation is also possible. But even that is not a simplistic picture either. I really admire that aspect of what you were doing there. But I would say, or I would ask you rather, nonetheless, anything right, that's kind of baked in, from the beginning, that starts to stray into, as you were saying earlier, that seems to trespass on our freewill or just worries at the edges of our idea of who we are, and what we're able, what control we're able to have over our lives, is always a little bit controversial isn't it? And how free do you feel as a researcher to be able to just cut out the noise of people's concerns and just pursue your intellectual line of inquiry? Do you feel free and able to do that?

**Kevin Mitchell**

Yeah I do. I mean, first of all, thanks very much for your kind comments about the book. That is, I guess the line I was trying to walk, is to give a more nuanced picture that isn't, because the debates get really polarised, and people tend to react to what they think the other side is saying. And then they kind of reject it and then they move a little further away. And then that just ping pongs across the two sides get further and further apart. And that just has never been very satisfying because it simply is the case that we are born with some psychological predispositions. But it also is the case that that doesn't mean that we're fixed in stone and there's interesting science there to understand, and it has important implications for understanding the nature of the human condition, but also it has societal implications in terms of the way we make decisions about things like education, for example.

**Kevin Mitchell**

So, but anyway, to answer your second question, I haven't felt in any way kind of hamstrung or restricted from discussing these things. Well, let me say, I took some pains I suppose, in writing the book to try and be very clear, not just in what I was saying, but to make it clear what I wasn't saying, because sometimes, people can say, oh, you know, so what you're really saying is such and such? And I would say, Well, no I didn't say that. I said really precisely what I meant. But actually, that's not enough. You sometimes have to precisely lay out what it doesn't mean. So I did take some effort to do that. I haven’t felt stymied at all. In fact, I've had lots of interesting discussions about it, but the one area where it's maybe more controversial, would be in the question of sex differences. And there's a whole, again, there's a really, really polarised debate out there. And I think there's a nuanced, I wouldn't even say, a middle ground, it's an interactive ground. There's an interplay between these real sex differences that we do see and behaviour and of course, societal influences and so on, that, to me, it's just much more intellectually satisfying, because it doesn't deny the reality of either of those factors. And it tries to tease out the way that they interact with each other.

**Melanie Challenger**

Absolutely, and I was talking to Frans De Waal and he's actually taking on sex as the topic for his next book. So it'd be interesting to see how he sort of traverses that ground, but I certainly think we are in desperate need of some acceptance, that there are sex differences. That manifesting characteristics, that are not simply coming from the external environment, or even our ideas about what sex is, you know. But there is just so much shifting and shiggling around, isn't there, because, you know, hormonal profiles, apart from anything else, shift all the way through the month, let alone the year and how it results in different secondary characteristics. So it's just not simplistic is it?

**Kevin Mitchell**

Yeah and so we should try to frame it in a way that isn't simplistic, I think. And the one danger in that I did feel and was conscious of, in writing about some of this stuff, is that it can get hijacked by people who are quite sort of deterministic about genetic influences and biological influences. And there has been a resurgence in recent times of this sort of pseudo- science around race, which I think is again, I took pains to explain why the picture that I was describing does not support the idea that there are those kinds of group differences between huge continental populations, in psychological traits that have any kind of genetic origin to them. So, yes, there are tricky bits. But I think there are also really important societal conversations to be had about this stuff. And there are ethical implications, for example, I mean I mentioned education earlier, but you know, they're ones a little closer to the science, like screening embryos by genomic testing, for example, a kind of a eugenics which obviously right now is done for disease risk, for example, but which could we now have the technology to do it for markers of the sort of scores for things like intelligence or personality traits, and there are some companies out there that are proposing to do that. So, if we don't engage with the genetics of intelligence, because we're afraid that, it sounds not egalitarian, to say that some people are more intelligent than others, then we're doing a disservice, I think, and it allows all of this other stuff to happen in a vacuum, when in fact there is a really good scientific understanding there. But it has to be couched in careful terms and in societal terms, so that you don't infer things that just aren't right from it. So from the fact that some people have greater IQ than others, it doesn't mean for example, that some people should get the best education and other people there's no point. Exactly the opposite, I think is the inference that I would draw?

**Melanie Challenger**

Nor is it prediction of the good an individual will do, with the intelligence that they have.

**Kevin Mitchell**

Absolutely

**Melanie Challenger**

I mean, this is the problem, isn't it, that we were talking about development, and one thing that is clear is that things like maternal stress are going to have an impact. And instead of focusing on the naught to three years, for instance, and ensuring that the nurturing environment is positive both within the family and within the wider societies as possible, instead, you will always get people who will want to engineer how you get a better brain out of, I mean this is sadly, that often follows instead of the higher ground, if you like.

**Kevin Mitchell**

Well, it's funny, because you can go from pre implantation genomic screening, to Baby Mozart, and high stim toys and all those kinds of things. And to me a lot of that is nonsense, in a way, but this is a societal social position, it's not a scientific one. But my social position would be that we should invest in education for everybody as much as we can and not worry too much about the individual differences or where they are, where they come from, and indeed set up a system where everybody can flourish and reach their potential.

**Melanie Challenger**

Absolutely, and value the variation that there is in society absolutely equally on people's own terms, because we don't want everyone being or wanting or seeing things in this kind of very narrow way. Because that's always the trouble with value assumptions, of course, that they are very dangerous when they become too narrow. Let's move on to even more controversial territory.

Let's go back to this free will. So, how we start looking at the story of agency, because that's sort of where your work is moving at the moment isn't it? And that involves, as you were saying, in the opening notes, that involves looking at, how did we go from nonliving matter to an entity? And along that way, when does purpose emerge? When does meaning emerge, when do the reasons emerge? So can you sketch a little bit of that in for us?

**Kevin Mitchell**

Sure. So I mean, it's really fascinating once you dig into it, and there's a really good picture actually emerging of how life actually evolved. So how we went from sort of prebiotic chemistry to biology and Nick Lane actually has written some really interesting stuff about this. I read his recent book called *The vital question,* and he sketches a still somewhat speculative kind of scenario where life would have emerged in a very particular environment of hydrothermal vents at the bottom of the ocean. And the reason is, if we think about life, and think about what it actually is, on earth, at least life is chemistry. And it's chemistry in motion. It's chemical reactions, right? It's, we think about a cell. As you know, you could think of it as a bag of chemicals, a bag of molecules, but it's a bag of chemical reactions that are sustaining themselves. So you know, you have A makes B and B makes C and C makes D and D makes A, in the most simplistic kind of an idea that you have a kind of a network of chemical reactions that are through their interactions, sustaining the entire system. And what may have happened in these early hydrothermal vents, for that system to sustain itself like that, it needs a source of what's called free energy. So it needs energy that can be used to do work, because it takes work to keep something organised, because the second law of thermodynamics basically says that things should fall apart, complicated stuff, ordered things take some energy to make that way and they take energy to keep that way. So what may have happened in these hydrothermal vents that was a source of a gradient of protons or hydrogen ions that could have powered some early organic chemistry that was happening just in the rocks, sort of in the porous bits of the rocks, tiny little compartments that would have concentrated these chemicals there and allowed some of them to these eactions to progress enough that you've got complicated macromolecules like peptides, so you know the forerunners of proteins. Nucleic acids like RNA and DNA, and fatty acids like lipids, and so on.

**Kevin Mitchell**

This is really a big jump, but once you got all of those things together, you could get some chemical reactions within that that kind of feed off each other. And once they have a source of energy and raw materials, they could keep themselves going. And at some point, they might have become enclosed within a little fatty bubble, a lipid bubble, the forerunner of a cell membrane. And once that happened, you got something really interesting, because now you have something that has an inside and an outside, it has a barrier between it and the rest of the world. And again, if it's sustaining itself, well, I mean effectively, what happens is there's a very simple mathematical kind of truism at work here, which is things that have the tendency to persist, because they're there, they have the right set of relations with each other, will persist. And things that don't, won't. So that's basically natural selection in a nutshell, and it can operate on very simple thing, it doesn't have to operate on organisms, the principle applies to anything. So it could have applied to the sort of early pre-living bubbles of biochemistry. And at some point, you could get the RNA and the DNA within there to act as not just a component of the chemical reactions, but kind of as a store of information about the configuration of the cell, the way the cells should be configured. Because the DNA codes for the proteins, the way the proteins work, will catalyse the chemical reactions. And you know, how quickly each protein works, you know, its kinetics, will determine the whole flux of all the biochemistry. I hope this is making sense.

**Kevin Mitchell**

It's a long-winded way of arriving at a point where you have the first cellular living organisms where within them, they're living because they have some biochemistry, kind of an internal cellular economy, that they just keep running and they import energy and raw materials in order to keep it running and they export waste materials. But also crucially, there's this template, there's this informational template there. It sort of maintains the equilibrium of this economy and ensures that you're making the right amounts of all the proteins to keep everything going right. And once you have that, the other thing that you can do with a template like that is you can copy it. And when you copy it, then it can recapitulate, it can regenerate that biochemistry in another cell. And then you're off to the races. Because then you can have basically lineages of cells that are dividing, they're copying their genetic material. They're using that to reinstate, there's this dynamic profile of biochemistry within them, which basically is life. I mean, we have to think of life not as a substance or a property, but a process. It's ongoing. And that continuity and persistence is what defines it as life in one extra sense, in that it persists, not by being super stable like a rock, it persists by being really dynamic. And by doing work to keep itself in that organisation.

**Melanie Challenger**

So if we have purpose here, if you like, as persistence, and if we act in order to persist, or at least the first things that we might call action are in service to persistence. Are you seeing an agent as emerging at the moment that you can act to enable persistence? Or are you seeing that sort of being, do we need to have some sort of sensory element in here to be able to act in a more meaningful way?

**Kevin Mitchell**

That's really interesting. First of all, I'm not so keen on trying to draw a sharp distinction of when we had no agency and then we suddenly had agency, I don't think it's an all or none characteristic. I think it can be graded. And some things have more agency than others. And in fact, that's the story of evolution, the story of our evolution, at least as human beings, the lineage that leads to us is an increase in agency all the time. So these first cells that I just described, would be sitting there and they would be doing thermodynamic work to keep themselves sustained basically in that dynamic state, but they wouldn't yet be acting on the world right, they wouldn't be causal things happening in the world, they would have some causal insulation from the world. So because their barrier, that external cell membrane is a chemical barrier, it's a physical barrier, but it's also a causal barrier, a lot of things out in the world can't affect things inside the cell, because it's keeping itself out of equilibrium with the rest of its surroundings. So, that is it gives it some, at least some autonomy. And I think you can start to get agency when you can imagine, so you've got the cells sitting there. And they might develop some mechanisms whereby they could reconfigure their internal biochemistry, if, for example, some food source changes in the environment. So you know, bacteria do this all the time, or if there's oxygen or no oxygen, they can reconfigure their internal biochemistry to keep themselves going, but in a different regime. So that's acting, in a sense, but it's still internal. And I think we get to external acting, when you get things that for want of a better word, realise through natural selection, that actually one way to deal with a changing environment is to move. And then once you get things that are capable of movement that will then you have a question of where should they go and then you get sensors that are for example, detecting food molecules in the environment, and that are allowing something simple, like a bacterium to move towards a food source.

**Kevin Mitchell**

So that becomes real agency then I think, it's really doing that. And it's doing that because it wants to get to the food source. And I know, I'm anthropomorphizing, but at some point, you mentioned earlier, the idea of purpose, it really does have a purpose, natural selection, puts that purpose into it to persist just as much iif I made a robot whose job was to persist it, it would have a purpose, I put it there, well, natural selection puts it in there. And once you have that purpose, then what's interesting is that you start to see things that were never there in the universe before like meaning and value. Because for something to mean something or have value to something, it has to be relative to some goal. Nothing matters to a rock but things matter to a bacterium. And so through the action of natural selection, it's a good thing, if a bacterium evolves in such a way that it can sense food, and it couples that sensing to a motor behaviour that makes it go towards that food source. So there's no meaning in the food source or in the signal, the meaning only comes through this circular interaction with natural selection that happens over generations really. And the value that it becomes a good thing, in a normative sense relative to the goal of the organism, it becomes a good thing to go there. And it becomes also a good thing to avoid going somewhere where there's toxic things, or there's something that's going to eat you so, you get a really interesting kind of causation there, which is about information that has some relevance for the organism, relative to its goals. And I think that's a fairly decent definition of meaning, which in the scientific discourse, I think meaning has a kind of a connotation that's a bit mystical and nebulous, but really, I mean what I just said, some information, that's relative to the goals of an organism that has some value to it, that's a fairly decent concept at least have a meaning.

**Kevin Mitchell**

So once you can ground those kinds of concepts in really simple organisms with simple behaviour, then I think we can build on the idea that you know, that ultimately leads to the kind of agency or even freewill that you see in human beings, by elaborating on those basic mechanisms by just making them a bit more sophisticated. So rather than, say, a bacterium automatically moving towards a food source, it might be able to integrate, that there's also a threat in that sense, same area, and that shouldn't go there. So, you know, you can integrate multiple signals. And organisms, of course can learn such that, one bacterium that has recently had one experience might go towards the food source, but another one might not because it's in a different state because it had a different experience. And then you're approaching something where you say, Okay, well, it's not a mere machine, it's doing something that warrants being called cognition. Even its simple biochemistry. But it's kind of figuring things out inside itself. And it's acting in a more sophisticated way, not just a reflexive way, that is just, you know, the stimulus is not just a trigger it's instead, it's information that's internalised and operated upon, integrated with other information. So ultimately, the organism is deciding to do something or not. And there you get, that's real agency I think. Once the organism has a choice, then I think you're at something I would call agency,

**Melanie Challenger**

Kevin, I'm going to make a big leap here. I mean, there's so, so much to talk about, we could talk for hours and hours. But so I'm going to make a big and slightly facile leap. But how are we then thinking about multicellularity? And that big leap 1000s of years later on in evolution where we get the emergence of multicellular organisms that still have that kind of proto agent, that cellular proto agent and a kind of colony of proto agents then if you like, and how do you certainly as a neuroscientist, then start thinking about mind as a presumably sort of centralised mechanism for all of these multiple agents?

**Kevin Mitchell** 47:09

Well, those are great questions. And so once you generate multicellular organisms, then the organism has an interesting challenge in that it has to coordinate what the various cells are doing. There's various ways that really simple multicellular things do that. But really, the nervous system was invented for that. I mean, that is what nervous systems get you, we often think I think we have a kind of a holdover actually, from early days of, of artificial intelligence, of thinking that the purpose of the brain is to do logical computations. And you know, that sort of abstract thought that you can use to program, a chess program for example. But really, the nervous system is a control system, it's there to control what the organism does. And initially it's in really simple things like jellyfish, and so on, it's basically a network of nerves that coordinate the muscles, so that the organism can do this kind of squeezing rhythmic movement that allows it to move within the world, because it's coordinated its muscles in a certain way, as opposed to just randomly spasming in place, which would happen if you couldn't coordinate the activities of the different muscle cells. But of course, the nervous system is also good for processing sensory information, and then connecting that, integrating it, acting on it, and then using that to determine what the organism should do. And really the main thing that the nervous system does, and actually even that single cells do is try to infer what is out in the world. So they take a signal, something coming from the outside, I mean, even a bacterium does this, right? It takes a signal that maybe say, and it compares a sensor signal from the front end to the back end, to say, well, there's a greater signal of this fruit molecule at the front end than at the back end. And essentially, it makes a model of the world and the model is that there's more food out there in this direction in the world. And of course, we do the same thing with our nervous systems on a vastly more sophisticated level. Because we infer what's out in the world based on our vision and hearing and other smell and other senses.

**Kevin Mitchell**

So the idea, I guess through evolution, is that you elaborate these control systems, and each time you make it a bit more sophisticated, you grant the organism a bit more autonomy from the environment. It becomes a bit more insulated causally from what's going on and out in the world, and a bit more proactive, and in fact, even capable of planning over longer timescales. So basically, because we don't have much time left, that's the arc that I want to explore in the book that I'm writing at the moment, which is how you go from these really simple ideas. And once you have those clear in your mind, that elaborating them I think is much, much easier, as opposed to, you know, starting with human beings, the most sophisticated instantiation of this kind of agency that we know of, and trying to figure it all out there at once. You know, it's like if you wanted to understand aerodynamics, you wouldn't start with the space shuttle, it's just too complicated. But I think you can approach it in that way, and hopefully ground what it is that our nervous systems are for and what they let us do and how decision making actually works.

**Kevin Mitchell**

And I guess the final bit of that, the bit that really, I think can give us something that we could be happy calling freewill, would be the fact that human beings have, we don't just model what's out in the world, we have these extra levels of neural hierarchy Each of which is kind of looking at the level below it. And ultimately, we can model not just what's going on in the world, but we model the model. So we're looking at in a sense, our own model of what's out in the world, but we're also looking at things like our goals and desires and beliefs, those become objects of cognition, or metacognition. So it's not true to say that because I'm wired a certain way, I have no control over what I want to do, I can look at what I want to do, and I can introspect on that. And that ability actually does give me, as an agent, the opportunity to change that. And in fact, we do that all the time. We're constantly inspecting our own goals and the rationale and reasons. And we're constantly changing our own goals and our behaviour changes accordingly. So for me, the ultimate sort of level of freedom comes from that ability within our nervous systems and our minds, to introspect on the drivers of our own behaviour in a way that allows us to sometimes override them.

**Melanie Challenger**

Kevin’s work is thrilling to me, because I'm chasing down similar questions, although from quite a different perspective. I came to the question of agency because I was surprised at how often the agency of other species was ignored when thinking about ecosystems or environments. Kevin, as he explains, came to this subject from a refusal to accept that free will is just an illusion. As a neurobiologist, what he does for us is consider, bit by bit, from a very gradualist perspective, how we eventually arrive at humans and other animals that can choose what they do, and the underlying mechanisms that can help explain this. To me what is most remarkable about both living beings, organisms, and biology broadly is that everything’s so busy doing something. So why is this purposive aspect of biology and organisms so often treated with wariness or even ignored? Could it really be possible that this purposefulness is all just an illusion created by blind evolutionary force? That animals don’t really pursue goals but only appear to pursue the goals that evolution has placed there? Today we inherit several centuries worth of anxiety to avoid misunderstanding what is causing a phenomenon in nature. That is well-founded. Humans have a tendency to see reasons everywhere. We have fingers because we need to hold things. Giraffes have long necks to eat the leaves. But many evolutionary biologists argue that long necks are the consequences of long necked giraffes leaving more offspring in that particular environment. That can seem as if it’s saying the same thing, but it’s importantly different to some biologists. But that resistance to misunderstanding causes has also left us troubled by the dynamic, driven, sometimes unexpected ways that living beings act. That is why returning to the biology of agency can help us to see both how daunting and how exciting are these inquiries into the choices organisms make and how they make them. The more I explore the evidence and research, the more amazed I become, by the ability of life to organize into a tiger or hummingbird, or even a humble bacterium that can then act in the world in remarkable ways. And once you go deep into the neurobiology, like Kevin, it can start to look like the old question of the chicken and the egg. Did life or purpose come first?