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**Reith Lectures 2003: The Emerging Mind**

**Lecture 3: The Artful Brain**

In this lecture - which is the most speculative one in the series of five - I'd like to take up one of the most ancient questions in philosophy, psychology and anthropology, namely what is art? When Picasso said: "Art is the lie that reveals the truth" what exactly did he mean?

As we saw in my previous lectures neuroscientists have made some headway in understanding the neural basis of psychological phenomena like body image, how you construct your body image, or visual perception. But can the same be said of art - given that art obviously originates in the brain?

In particular what I'd like to do is raise the question: "Are there such things as artistic universals?"

Now let me add a note of caution before I begin. When I speak of artistic universals I am not denying the enormous role played by culture. Obviously culture plays a tremendous role, otherwise you wouldn't have different artistic styles - but it doesn't follow that art is completely idiosyncratic and arbitrary either or that there are no universal laws.

Let me put it somewhat differently. Let's assume that 90% of the variance you see in art is driven by cultural diversity or - more cynically - by just the auctioneer's hammer, and only 10% by universal laws that are common to all brains. The culturally driven 90% is what most people already study - it's called art history. As a scientist what I am interested in is the 10% that is universal - not in the endless variations imposed by cultures. The advantage that I and other scientists have today is that unlike we can now test our conjectures by directly studying the brain empirically. There's even a new name for this discipline. My colleague Semir Zeki calls it Neuro-aesthetics - just to annoy the philosophers.

I recently started reading about the history of ideas on art - especially Victorian reactions to Indian art - and it makes fascinating reading.

For example if you go to Southern India, you look at the famous Chola bronze of the goddess Parvati dating back to the 12th century. For Indian eyes, she is supposed to represent the very epitome of feminine sensuality, grace, poise, dignity, everything that's good about being a woman. And she's of course also very voluptuous



*The Goddess Parvati*

But the Victorian Englishmen who first encountered these sculptures were appalled by Parvati, partly because they were prudish, but partly also just because of just plain ignorance.

They complained that the breasts were way too big, the hips were too big and the waist was too narrow. It didn't look anything like a real woman - it wasn't realistic - it was primitive art. And they said the same thing about the voluptuous nymphs of Kajuraho - even about Rajastani and Mogul miniature paintings. They said look these paintings don't have perspective, they're all distorted.

They were judging Indian art using the standards of Western art - especially classical Greek art and Renaissance art where realism is strongly emphasized.

But obviously this is a fallacy. Anyone here today will tell you art has nothing to do with realism. It is not about creating a realistic replica of what's out there in the world.

I can take a five dollar camera, aim it at one of you here, take a photograph. It's very realistic but you wouldn't give me a penny for it. In fact art is about the exact opposite. It's about deliberate hyperbole, exaggeration, in fact even distortion in order to create pleasing effects in the brain.

But obviously that can't be the whole story. You can't just take an image and randomly distort it and call it art - although many people in La Jolla where I come from do precisely that. The distortion has to be lawful. The question then becomes: What kinds of distortion are effective? What are the laws?

So one day I was sitting in a temple in India when I was on a sabbatical and in a whimsical frame of mind I just jotted down what I think of as the universal laws of art, the ten laws of art which cut across cultural boundaries. Given our time limits, I'm

going to just tell you four or five of my ten laws - the rest are on the BBC Website, so you can go look it up.

**Professor Ramachandran's suggested 10  
universal laws of art:**

Peak shift  
Grouping  
Contrast  
Isolation  
Perception problem solving  
Symmetry  
Abhorrence of coincidence/generic viewpoint  
Repetition, rhythm and orderliness  
Balance  
Metaphor

The first law, I call peak shift and to illustrate this I'll use a hypothetical example from animal behaviour, from rat psychology.

Imagine you're training a rat to discriminate a square from a rectangle. So every time it sees a particular rectangle you give it a piece of cheese. When it sees a square you don't give it anything. Very soon it learns that the rectangle means food, it starts liking the rectangle - although you're not supposed to say that if you're a behaviourist. And it starts going towards the rectangle because it prefers the rectangle to the square.

But now the amazing thing is if you take a longer skinnier rectangle and show it to the rat, it actually prefers the longer skinnier rectangle to the original rectangle that you taught it. And you say: Well that's kind of stupid. Why does it prefer a longer skinnier rectangle rather than the one you originally showed it? Well it's not stupid at all because what the rat is learning is a rule - Rectangularity. And of course therefore if you make it longer and skinnier, it's even more rectangular. So it says: "Wow! What a rectangle!" and it goes towards that rectangle.

Now you say: Well, what's that got to do with art?

Well let's think about caricature. What do you do in a caricature? Supposing you want to produce a caricature of Maggie Thatcher or a caricature of Nixon, what do you do? You take Nixon's face and you say: What's special about his face? What makes him different from other people. So what you do is you take the mathematical average of all male faces and you subtract it from Nixon's face. And you get the big bulbous nose and the shaggy eyebrows. And then you amplify it. And then you get an image that looks even more like Nixon than Nixon himself. Now if you do it just right you get great portraiture, even a Rembrandt. But if you overdo it you get caricature, it looks comical. But it still looks even more like Nixon than the original Nixon. So you're behaving exactly like that rat.

But what's it got to do with the rest of art. Let's go back to the Chola bronze of Parvati. Let's talk about Indian art. Well the same principle applies. How does the artist convey the very epitome of feminine sensuality? What he does is simply take the average female form, subtract the average male form - you're going to get big breasts, big hips and a narrow waist. And then amplify it, amplify the difference. And you don't say: "My God, it's anatomically incorrect". You say: "Wow! What a sexy goddess!"

But that's not all there is to it because how do you bring in dignity, poise, grace?

Well what you do is something quite clever, what the Chola bronze artist does is something quite clever. There are some postures that are forbidden to a male. I can't stand like that even if I want to. But a woman can do it effortlessly. So what he does is he goes into an abstract space I call "posture space", and then subtracts the average male posture from the female and then exaggerates the feminine posture - and then you get elegant triple flexion - or tribhanga - pose, where the head is tilted one way, the body is tilted exactly the opposite way, and the hips again the other way. And again you don't say: "My God, that's anatomically inappropriate. Nobody can stand like that." You say: "My God! It's gorgeous. It's beautiful! It's a celestial goddess". So the image is extremely evocative and it's an example of the peak shift principle in Indian art.

OK, this is all about faces and caricatures and bodies and Chola bronzes. That seems quite reasonable, but what about the rest of art? What about abstract art? What about Picasso. What about semi-abstract art? What about impressionism, what about Cubism? Van Gogh? Monet? Henry Moore? How can my ideas even begin to approach some of those artistic styles?

To answer this question, you need to go and look at ethology, especially the work of Niko Tinbergen at Oxford more than fifty years ago. And he was doing some very elegant experiments on seagull chicks.

As soon as the herring-gull chick hatches, it looks at its mother. The mother has a long yellow beak with a red spot on it. And the chick starts pecking at the red spot, begging for food. The mother then regurgitates half-digested food into the chick's gaping mouth, the chick swallows the food and is happy. Then Tinbergen asked himself: "How does the chick know as soon as it's hatched who's mother? Why doesn't it beg for food from a person who is passing by or a pig?"

And he found that you don't need a mother.

You can take a dead seagull, pluck its beak away and wave the disembodied beak in front of the chick and the chick will beg just as much for food, pecking at this disembodied beak. And you say: "Well that's kind of stupid - why does the chick confuse the scientist waving a beak for a mother seagull?"

Well the answer again is it's not stupid at all. Actually if you think about it, the goal of vision is to do as little processing or computation as you need to do for the job on hand, in this case for recognizing mother. And through millions of years of evolution, the chick has acquired the wisdom that the only time it will see this long thing with a

red spot is when there's a mother attached to it. After all it is never going to see in nature a mutant pig with a beak or a malicious ethologist waving a beak in front of it. So it can take advantage of the statistical redundancy in nature and say: "Long yellow thing with a red spot IS mother. Let me forget about everything else and I'll simplify the processing and save a lot of computational labour by just looking for that."

That's fine. But what Tinbergen found next is that you don't need even a beak. He took a long yellow stick with three red stripes, which doesn't look anything like a beak - and that's important. And he waved it in front of the chicks and the chicks go berserk. They actually peck at this long thing with the three red stripes more than they would for a real beak. They prefer it to a real beak - even though it doesn't resemble a beak. It's as though he has stumbled on a superbeak or what I call an ultrabeak.

Why does this happen?

We don't know exactly why, but obviously there are neural circuits in the visual pathways of the chick's brain that are specialized for detecting beaks as soon as the chick hatches. They fire when seeing the beak. Perhaps because of the way they are wired up, they may actually respond more powerfully to the stick with the three stripes than to a real beak. Maybe the neurons' receptive field embodies a rule such as "The more red contour the better," and it's more effective in driving the neuron, even though the stick doesn't look like a beak to you and me - or maybe even to the chick. And a message from this beak-detecting neuron now goes to the emotional limbic centres in the chick's brain giving it a big jolt and saying: "Wow, what a super beak!" and the chick is absolutely mesmerized.

Well now what's this got to do with art, you're wondering?

Well this brings me to my punch line of about art. What I'm suggesting is if those seagulls had an art gallery, they would hang this long stick with the three red stripes on the wall, they would worship it, pay millions of dollars for it, call it a Picasso, but not understand why - why am I mesmerized by this damn thing even though it doesn't resemble anything? That's what all of you are doing when you are buying contemporary art. You are behaving exactly like those gull chicks.

In other words human artists through trial and error, through intuition, through genius have discovered the figural primitives of our perceptual grammar. They are tapping into these and creating for your brain the equivalent of the long stick with the three stripes for the chick's brain. And what you end up with is a Henry Moore or a Picasso.

The advantage of these ideas is you can test them experimentally. You can actually record from cells in the brain which sort of fire when you show it a face in the fusiform gyrus. Now some of them will fire only to a particular view of a face. But higher up you've got neurons which respond to any view of a given face. And I'm predicting that if you present a Cubist portrait of a monkey face - where you present two views of a monkey's face in the same place - that cell will be hyper-activated. Just as the long stick with the three red stripes hyper-activates the beak-detecting neurons in the chick's brain, this Cubist portrait of a monkey face will hyper-activate these face-detecting neurons in the monkey brain - and the monkey says: "Wow! What a face". So what you have here is in fact a neural explanation for Picasso, for Cubism.

I've told you about one law so far - peak shift and the idea of ultra-normal stimuli. We have borrowed insights from ethology, neurophysiology, rat psychology to account for why people like non-realistic art.

The second law is more familiar to all of you. It's called Grouping.

Many of you may have seen those famous puzzle pictures, like Richard Gregory's Dalmatian dog. You just see a bunch of splotches when you first look at it but you sense your visual brain trying to solve a perceptual problem, trying to make sense of this chaos. And then after a few seconds, or maybe actually several seconds - 30 or 40 seconds - suddenly everything clicks in place and you group all the correct fragments together, and lo and behold you see a Dalmatian dog.



*Richard Gregory's Dalmatian*

You can almost sense your brain groping for a solution to the perceptual riddle and as soon as you successfully group the correct fragments together to see the dog, what I suggest is a message gets sent from the visual centres of the brain to the limbic-emotional brain centres of the brain giving it a jolt and saying: "AHA, there is a dog" or "AHA, there is a face".

The Dalmatian dog example is very important because it reminds us that vision is an extraordinarily complex and sophisticated process. And even looking at a simple scene involves a complex hierarchy, a stage by stage processing. At each stage in the hierarchy of processing, when a partial solution is achieved - "Hey it looks a bit dog-like right here" - there is a reward signal "AHA", a partial "AHA", and a small bias is sent back to earlier stages to facilitate the further binding of the features of the dog. And through such progressive bootstrapping the final dog clicks in place to create the final big "AHA!" Vision has much more in common with problem solving - more like a twenty questions game - than we usually realize.

The grouping principle is widely used in both Indian and in Western art - and even in fashion design. For example you go to Harrods, and you pick out a scarf with red splotches on it. Then you often match it with a skirt which has got some red splotches on it. Now what's this all about? Is it just hype, is it just marketing? Or is it telling you something very deep about how the brain is organized? I'm going to argue it is telling you something very deep, something to do with the way the brain evolved.

Vision evolved mainly to discover objects and to defeat camouflage. You don't realize this when you look around you and you see clearly defined objects.

But imagine your primate ancestors scurrying up in the treetops trying to detect a lion seen behind fluttering green foliage. What you get inside the eyeball on the retina is just a bunch of yellow lion fragments obscured by all the leaves. But the brain says - so to speak - "What's the likelihood that all these different yellow fragments are exactly the same yellow simply by chance? Zero. They must all belong to one object, so let me link them together, glue them together. Oh my God, it's a lion - let me out of here!" And as soon as you glue them together, a signal gets sent to the limbic system saying: "AHA, there's something object-like, pay attention here".

So there's an arousal, and an attention which then titillates the limbic system, and you pay attention and you dodge the lion.

And such "AHAs" are created, I maintain, at every stage in the visual hierarchy as partial object-like entities are discovered that draw your interest and attention. What the artist tries to do is to generate as many of these "AHA" signals in as many visual areas as possible by more optimally exciting these areas with his paintings or sculptures than you could achieve with natural visual scenes or realistic images. Not a bad definition of art if you think about it.

That takes me to the third law - the law of perceptual problem solving or visual peekaboo. Now what do I mean by that? As anyone knows a nude seen behind a diaphanous veil is much more alluring and tantalizing than a full-colour Playboy photo or a Chippendale pinup - or a Page Three girl, is that what you call it? Why?

As I said our brains evolved in highly camouflaged environments. Imagine you are chasing your mate through dense fog. Then you want every stage in the process - every partial glimpse of her - to be pleasing enough to prompt further visual search - so you don't give up the search prematurely in frustration. In other words, the wiring of your visual centres to your emotional centres ensures that the very act of searching for the solution is pleasing, just as struggling with a jigsaw puzzle is pleasing long before the final "AHA". Once again it's about generating as many "AHAs" as possible in your brain.

The fourth law is the law of isolation or understatement. You all know that a simple outline doodle by Picasso or a nude by Rodin or Klimt can be much more evocative than a full colour photo of a woman. Similarly the cartoon-like outline drawings of bulls in the Lascaux Caves are much more powerful and evocative of the animal than a National Geographic photograph of a bull. Hence the famous aphorism in art: "Less is more".

But why should this be so? Isn't it the exact opposite of the first law, the idea of hyperbole, of trying to excite as many "AHAs" as possible? A pinup or a Page Three girl after all has much more information. It's going to excite many more areas in your brain, many more neurons, so why isn't it more beautiful?

The way out of this paradox is to consider another visual phenomenon, called Attention. It's a well-known fact that you can't have two overlapping patterns of neural activity simultaneously. Even though you've got one hundred billion nerve cells, you can't have two overlapping patterns. In other words, there is a bottleneck of attention. You can only allocate your attentional resources to one thing at a time.

Well when you look at a Page Three girl, the main information about her sinuous soft contours is conveyed by her outline. Her skin tone, hair colour after all is no different from anyone sitting here. It's irrelevant to her beauty as a nude. So in the realistic photo you have all this irrelevant information cluttering the picture and distracting your attention away from where it's needed critically - to her contours and outlines. By leaving all this out in a doodle or sketch the artist is saving your brain a lot of trouble. And this is especially true if the artist has also added some peak shifts to the outline to create an "ultra nude" or a "super nude".

What's the evidence for all this? Of course you can test it by doing brain imaging experiments comparing neural responses to outline sketches and caricatures versus full-colour photos. But there's also very striking neurological evidence from children with autism. Some of these children have what's called the savant syndrome. Even though they are retarded in many respects, they have one preserved island of extraordinary talent.

For example, a seven-year-old autistic child Nadia had exceptional artistic skills. She was quite retarded mentally, could barely talk, yet she could produce the most amazing drawings of horses and roosters and other animals. A horse drawn by Nadia would almost leap out at you from the canvas. Contrast this with the lifeless, two-dimensional, tadpole-like sketches drawn by most normal eight or nine-year-olds - or even normal adults.

So we have another paradox. How can this retarded child produce a drawing that is so incredibly beautiful? The answer, I maintain, is the principle of isolation.

In Nadia perhaps many or even most of her brain modules are damaged because of her autism, but there is a spared island of cortical tissue in the [right parietal](#). So her brain spontaneously allocates all her attentional resources to the one module that's still functioning, her right parietal. Now it turns out that the right parietal is the part of your brain that's concerned with your sense of artistic proportion. We know this because when it's damaged in stroke, for example, in an adult, you lose your artistic sense. You produce drawings that are often excessively detailed but lack the vital essence of the picture you're trying to depict. You lose your sense of artistic proportion. Conversely, since everything else is damaged in Nadia's brain she allocates all her attention to this brain module - so she has a hyper-functioning art module in her brain. Hence the beautiful renderings of horses and roosters.

Another example, equally striking. Dr Miller, University of California, has studied

patients who start developing rapidly progressing dementia in middle age, a form of dementia called the fronto-temporal dementia, affecting [frontal lobes](#) and [temporal lobes](#), but sparing the parietal lobe. And guess what happens. These patients suddenly start producing the most amazingly beautiful paintings and drawings - not all of them but some of them - even though they had never had any artistic talent before the onset of their dementia. Again, it's the isolation principle at work. With all other modules in the brain not working the patient develops a hyper-functioning right parietal. There are even reports from Alan Snyder in Australia that you can temporarily paralyze parts of the brain in normal volunteers - all of us less gifted people here. Imagine just zapping bits of your brain and unleashing hidden talents. If that happens, it will truly be a brave new world.

We don't have time to talk about all my other laws in detail. But I'll just mention the last law on my list - and in many ways the most important, yet the most elusive: Visual Metaphor. You all know what a metaphor is in literature as when you say it's the East and Juliet is the sun. But you can do the same thing in visual art - both in Western art and in Indian art. For example, when you look at the Chola bronze of the dancing Shiva or Nataraja with multiple arms you are not meant to take the multiple arms literally or call it a multi-armed monstrosity like the Victorian art critic, Sir George Birdwood, did. Funnily enough he didn't think that angels sprouting wings were monstrosities - although I can tell you as a medical man you can have multiple arms, but wings on scapulae are anatomically impossible!

The multiple arms are meant to symbolize multiple divine attributes of God and the ring of fire that Nataraja dances in - indeed his dance itself - is a metaphor of the dance of the Cosmos and of the cyclical nature of creation and destruction, an idea championed by the late Fred Hoyle. Most great works of art - be it Western or Indian - are pregnant with metaphor and have many layers of meaning.

Everyone knows that metaphors are important yet we have no idea why. Why not just say: "Juliet is radiant and warm" instead of saying: "Juliet is the sun"? What is the neural basis for metaphor? We don't know but I'll have a stab at this question next week in my Oxford lecture on synesthesia.

With that I conclude my lecture on Neuro-aesthetics. Have we understood the neural basis of art? Of course not. We have barely scratched the surface. But I hope the "laws of art" I've discussed might give you some hints about the general form of a future theory of art.

The solution to the problem of aesthetics, I believe, lies in a more thorough understanding of the connections between the 30 visual centres in your brain and the emotional limbic structures. And once we have achieved a clear understanding of these connections, we will be closer to bridging the huge gulf that separates C.P. Snow's two cultures - science on the one hand and Arts, philosophy and humanities on the other.

We could be at the dawning of a new age where specialisation becomes old-fashioned and a new 21st century version of the Renaissance man is born.