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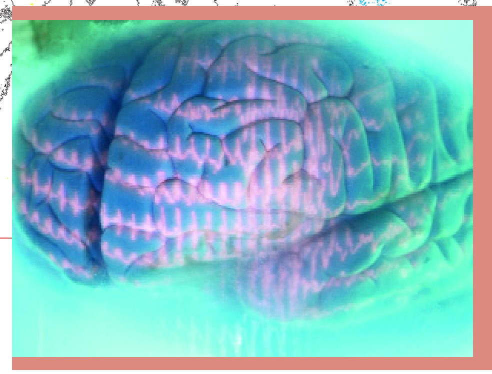

The Artful Brain

WHAT IS ART? When Picasso said, "Art is the lie that reveals the truth," what exactly did he mean? Neuroscientists have made remarkable headway in understanding the neural basis of psychological phenomena such as body image or visual perception. Given that art originates in the brain, can neuroscience also help us better understand the basis of art? V.S. Ramachandran, director of the Center for Brain and Cognition and professor of neurosciences and psychology at the University of California, San Diego, asks whether there are such things as artistic universals. That is, are there laws or principles that transcend cultural boundaries and styles? Ramachandran notes the enormous number of artistic styles across the world: Tibetan art, Classical Greek art, Renaissance art, Cubism, Expressionism, Impressionism, Indian art, pre-Columbian art, and so on. Despite this diversity, he speculates that artistic universals do exist and explains them from a neuroscientist's point of view.

Unleashing Human Potential

When patients suffer a stroke in the brain's left hemisphere and then can suddenly draw better than ever before, or when patients have seizures as a result of temporal lobe epilepsy and suddenly start writing poetry (which they had absolutely no interest in prior to their seizures), something very intriguing is happening in their brains. I would argue that these patients' innate creative potential has been suddenly unleashed—showing us that we all have tremendous potential, and far more than we realize. "Neuroaesthetics," the effort to uncover the neural basis of artistic and aesthetic experience, can help us understand that potential and, ideally, learn how to nurture and tap it.

Artistic Universals

Let me begin with a note of caution. When I speculate about "artistic universals" I am not denying the enormous role played by culture in art. Obviously culture plays a tremendous role—otherwise we wouldn't see different artistic styles—but it doesn't follow that art is completely idiosyncratic and arbitrary, or that there are no universal laws.

Let me put it somewhat differently. Let's assume that 90 percent of the variance we see in art is driven by cultural diversity or—more cynically—by just the auctioneer's hammer, and only 10 percent by universal laws that are common to all brains. The culturally driven 90 percent is what most people already study—it's called art history. As a scientist, I am interested in the 10 percent that is universal. The advantage that I and other scientists have today is that unlike philosophers, we can now test our conjectures by directly studying the brain empirically.

My suggested 10 universal laws of art, while speculative and arbitrary, offer a place to begin this discussion:

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

Space constraints permit me to discuss only the first two laws here.

Peak shift. I'll illustrate this law using a hypothetical example from rat behavioral psychology. Imagine you're training a rat to discriminate between a square and a rectangle, so every time it sees a particular rectangle you give it a piece of cheese, and when it sees a square you don't give it anything. Very soon it learns that the rectangle means food, and it starts liking the rectangle (although you're not supposed to say that if you're a behaviorist). That is, the rat consistently moves toward the rectangle because it prefers the rectangle to the square.

But now the amazing thing is that if you take a longer, skinnier rectangle and show it to the rat, it actually prefers that to the original rectangle that you used to teach it. The rat has learned a rule: rectangularity. And if you make the shape longer and skinnier, it's even more rectangular. So the rat thinks: "Wow! What a rectangle!" and it goes toward that rectangle.

What does this have to do with art? Well, let's think about caricature. Suppose you want to produce a caricature of Richard Nixon. You start with Nixon's face and you identify what's special about it, what makes him different from other people. What you're doing is taking the mathematical average of all male faces and subtracting that from Nixon's face. And you're left with the bulbous nose and the shaggy eyebrows. And then you amplify them and produce 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 does that have to do with the rest of art? What about abstract art? What about Picasso? What about Impressionism? What about Cubism? How can my ideas even begin to approach some of those artistic styles?

To answer this question, we need to look at ethology, especially the work of Niko Tinbergen at Oxford more than 50 years ago, when he was doing some elegant experiments on seagull chicks.

As soon as a gull chick hatches, it looks at its mother. The mother has a long yellow beak with a red spot on it. 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. Tinbergen asked himself: "How does the chick recognize its mother? Why doesn't it beg for food from a person who is passing by, or from 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.

Why does the chick confuse the scientist waving a beak for a mother seagull? The answer is that 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 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 think: "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 labor by just looking for that."

That's reasonable. 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 went berserk. They actually pecked at this long thing with the three red stripes more than they would at a real beak. They preferred it to a real beak, even though it didn't resemble a beak. It's as though he had stumbled on a superbeak, or what I call an ultrabeak.

We don't know exactly why this happens, but 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, the chicks 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 centers in the chick's brain, giving it a big jolt and saying: "Wow! What a super beak!" and the chick is absolutely mesmerized.

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

In other words, human artists, through trial and error, intuition, and 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 that you can test them experimentally. You can actually record from cells in the brain, in the fusiform gyrus, that fire when you show a subject a face. Now some of them will fire only in response to a particular view of a face. But higher up are neurons that respond to any view of a given face. 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 hyperactivated. Just as the long stick with the three red stripes hyperactivates the beak-detecting neurons in the chick's brain, this Cubist portrait of a monkey face will hyperactivate these face-detecting neurons in the monkey brain—and the monkey will say: "Wow! What a face." So what you have here is in fact a neural explanation for Picasso, for Cubism.

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So, to explain peak shift and the idea of ultranormal stimuli, we have borrowed insights from ethology, neurophysiology, and rat psychology to account for why people like nonrealistic art.

Isolation. My second universal law of art is the law of isolation or understatement.

You know that a simple outline doodle by Picasso or a nude by Rodin or Klimt can be much more evocative than a full-color photo of a woman. Similarly, the cartoonlike 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 neurons as possible? The way out of this paradox is to consider another visual phenomenon, called "attention." It's a well-known fact that you cannot have two overlapping patterns of neural activity simultaneously. Even though you have 100 billion nerve cells, you cannot have two overlapping patterns. In other words, there is a bottleneck of attention. You can allocate your attentional resources to only one thing at a time.

When you look at a pinup girl, for example, the main information about her sinuous soft contours is conveyed by her outline. Her skin tone or hair color, after all, is not much different from anyone else's. It's irrelevant to her beauty as a nude. So the realistic photo has all this irrelevant information cluttering the picture and distracting your attention away from where it's needed critically—to view 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 "supernude."

You can test this theory by doing brain-imaging experiments comparing neural responses to outline sketches and caricatures versus full-color 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 five-year-old autistic child, Nadia, had exceptional artistic skills. She was quite retarded mentally, and could barely talk, yet she could produce amazing drawings of horses and other animals. (See Figure 1.) 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 children or even normal adults.

Figure 1.

Horse Drawings

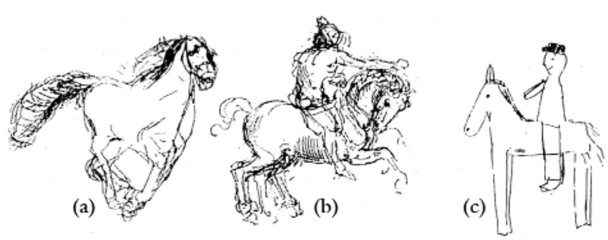

Figure 1 (a) A drawing of a horse by Nadia, the autistic savant, at age five. (b) A horse drawn by Leonardo da Vinci. (c) A horse drawn by a normal eight-year-old. Reprinted from *A Brief Tour of Human Consciousness* by V. S. Ramachandran, courtesy of Pi Press.

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

Perhaps many or even most of Nadia's brain modules were damaged because of her autism, but there was a spared island of cortical tissue in the right parietal. So her brain spontaneously allocated all her attentional resources to the one module that was still functioning, her right parietal. Now, it turns out that the right parietal is the part of the brain that's concerned with the sense of artistic proportion. We know this because when it's damaged by a stroke, for example, in adults, they lose their artistic sense. Conversely, since everything else was damaged in Nadia's brain, she allocated all her attention to this brain module, so she had a hyperfunctioning art module in her brain. Hence the beautiful renderings of horses and other animals. What most of us "normals" have to learn to do through years of training—ignoring irrelevant variables—she did effortlessly. Consistent with this idea, Nadia lost her artistic sense once she grew up and improved her language skills.

Conclusion

Do my suggested laws of neuroaesthetics encompass everything there is to know about art? Of course not; they barely scratch the surface. I hope, though, that they provide some hints about the general form of a future theory of art, and about how a neuroscientist might try to approach the problem.

The solution to the problem of aesthetics, I believe, lies in a more thorough understanding of the connections between the 30 visual centers in the brain and the emotional limbic structures (and the internal logic and evolutionary rationale that drives them). Once we have achieved a clear understanding of these connections, the insights they offer into the human brain will have a profound impact not just on the sciences but also on the humanities. Indeed, they may help us bridge the huge gulf that separates what C.P. Snow called the two cultures—science on the one hand, and arts, philosophy, and humanities on the other. We could be at the dawn of a new age in which specialization becomes old-fashioned and a 21st-century version of the Renaissance person is born.

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