Scientific Life: My Word

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Doing science making art

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It is a challenge to balance doing both science and art, but I attempt both because each provides unique insight into perception and cognition, often to mutual benefit. The techniques I use in visual neuroscience (psychophysics, fMRI, microelectrode recording) are different from those I use in visual art (etching, watercolor and oil paint, glass and silk), but the process is always empirical, testing hypotheses driven by observation, trial and error, while striving to be creative.

Science has an apprentice system and its guilds establish the goal of publishing in peer-reviewed journals. My science interests dovetail two issues: the computations made by brain regions responsible for vision; and color, a model system for understanding how complex phenomena arise from neural networks [1]. In addition to doing science, I make art. The rules of making art are no longer well codified, but this, I argue, may represent a boon to scientists interested in perception and cognition.

When I started making art as a child, like many novices I made figurative, representational work. I became reasonably good at observational rendering because I did it obsessively. I was struck by the way artistic processes are often described by non-artists who think art comes about by a mystical, almost random act. In fact, the work of most artists is the result of deep deliberation and few accidents. Techniques are employed because they have predictable results: drawing with lines is useful in depicting object shape; painting a background green makes a red object stand out; portraits often capture precisely the line formed by closed lips because it provides a good cue to the sitter's identity. Deploying these strategies, the 'lie' of art according to Picasso [2], is what making art is all about. Some neuroscientists have started to mine art for insight into neural computations – line drawings interpreted in terms of the orientation selectivity of visual neurons [3]; color contrast effects in terms of double-opponent cells [4]; and portraiture in terms of face processing [5,6].

It is a curious feature of our perceptual cognitive apparatus that insight into the artists' strategies, whether gained through art or science, does not seem to diminish the power of the effects. In fact, the insight often enhances appreciation, much like knowledge of winemaking enriches the wine-tasting experience. On the one hand, this is not surprising: we all return to our favorite visual illusions even though we know what we will see in them and may even have some knowledge of how they play on the visual apparatus. On the other hand, it is often said that visual delight comes from the element of surprise. That we can derive pleasure from both the familiar and the unexpected suggests that any single reductionist theory of vision is probably incomplete. A similarly complex interplay is often at stake in celebrated works of art, which are usually recognizable yet afford a seemingly endless source of new discovery, inviting extended, repeated viewing.

Besides pleasure, art serves a useful function: looking at pictures can make apparent the computations that the brain must be solving, which can guide the experiments we run. Making pictures, rather than just looking at them, might be even more instructive, since the process of making not only requires time, providing time to think, but is also invested with a salience brought about by activating muscles. Motor salience is important: pulling the muscles in your face into a smiling position is far more effective in bringing about happiness than just thinking about smiling. The elusive yet powerful connection between cognition and movement is what artists call muscle memory. By the same token, I have found that in considering the brain's mechanisms of vision I have been inspired to take new approaches to making art. A few examples are given at the end of this essay.

Although work at the interface of neuroscience and art can be fruitful in uncovering the nuts and bolts of vision and in inspiring new art, my hunch is that it will be impossible to gain insight into aesthetics simply by assessing what tricks artists use to represent the world or by looking at patterns of brain activity generated when people look at 'beautiful' or 'ugly' pictures, for the simple reason that aesthetic judgments are mutable and shaped by cultural context. A red spot might pop out when surrounded by green, but whether this color combination is considered beautiful would seem to be dependent on the cultural baggage with which it is delivered. That aesthetic judgments are contingent on context should not come as a surprise to neuroscientists: almost every sensory phenomenon is characterized by a contextual relationship (as the red-on-green example illustrates). Making unqualified associations of brain activity and aesthetics may be not only naïve, but also detrimental to the integrity of science, and I think it misses the point of art. Against this backdrop, the nascent field of neuroesthetics is struggling to establish the terms by which it can be productive. Certainly, to be so it will be important for scientists, art historians, philosophers and artists to negotiate meaningful points of contact.

Picasso quipped that he could do a decent portrait of a good friend without looking at him. Making art, as Picasso showed, is a cognitive act that has an indirect relationship with seeing. The success of Picasso's portraits depended on hundreds of hours of careful observation, not while making

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art but in the course of life with his friends. From these hours, Picasso was able to extract a friend's 'essence', which he pinned down with marks that bore little resemblance to those one might expect from a photograph, but were remarkably more recognizable. Through his work, Picasso advanced the Modernist spirit that placed a premium on subjective experience. Picasso's portraits are celebrated even though few of us actually knew, or even saw, his subjects. How did Picasso's private cognitive work translate into pictures that had, and continue to have, a profound effect on us? The legacy of Picasso is evident in contemporary art, almost all of which is concerned with ideas, some entirely divorced from materials (conceptual art). Art today is freed from the constraints of the codified apprentice system of an earlier time. This would seem to provide an even richer data set for neuroscientist interested in brain mechanisms of cognition, as artists pursue the imperative of continuous innovation, constantly seeking new modes of expression, exploring the full range of cognitive space. Yet few neuroscientists have equipped themselves with the skills to understand contemporary art. Scientists are not alone: many people find contemporary art esoteric and impenetrable. Most of us gravitate instead to work that has an objective basis, which is why galleries in vacation hotspots show pictures that look like something, whereas major London galleries show sharks floating in formaldehyde. The penchant of the uninitiated for figurative work and the culturally literate for conceptual work underscores the challenges facing the field of neuroaesthetics.

Liberated from the professional requirements of many artists to make work that meets the public's expectations, I have enjoyed making a wide range of work using a wide range of media. Figure 1a shows a watercolor inspired by the brilliant foliage seen on a hike through the rolling hills of New Hampshire in the fall. An art critic looking at the work remarked that the picture was 'full of air', which I attributed to the vacant regions of paper left white. These white regions buffer against chromatic induction, so that the color of each mark as it appears in the final picture is similar to the color of the mark as it was made during the painting's development. The importance of the white unfinished spaces to color relationships was obvious to the widely recognized colorist Paul Cézanne. Yve-Alain Bois recounts an exchange between the artist and his dealer, Vollard, concerning the two small spots on the hands in a portrait that had not yet been covered with pigment. Cézanne said 'maybe tomorrow I will be able to find the exact tone to cover up those spots. Don't you see, Monsieur Vollard, that if I put something there by guesswork, I might have to paint the whole canvas over starting from that point?' Bois goes on to emphasize that another famous colorist, Henri Matisse, 'was well aware that the apparently "unfinished" quality of Cézanne's canvasses had an essential function in their construction' [7]. Tackling color is a case in which art history, art practice and neuroscience can mutually benefit [4].

Rarely do I make art to illustrate perceptual phenomena, but occasionally on reflection I become aware of the deployment of strategies (lies in Picasso's sense) that prompt me to think about the brain mechanisms underlying perception. Figure 1b shows an etching I made by painting a sugar-ink solution directly onto a copper plate at Tanglewood, Massachusetts. The piece explores the relationship between marks made to represent objects and marks made to communicate written words – hand writing. The artistic issues at stake here are not unlike those of the transformation of retinal signals into position-invariant object codes and the cognitive function of forming symbols.

Another example of my artwork tiptoes towards sculpture (Figure 2). In these 3D drawings, I define a set of conceptual rules on which I base the construction of a cube, which I make out of glass and silk. The approach is a nod to Sol Lewitt and minimalism, but came about from the echoes of computational neuroscience, which has characterized object identity as 'read out' from neuronal spikes [8]. Does a set of instructions describing how the spikes are read out adequately capture the representation of an

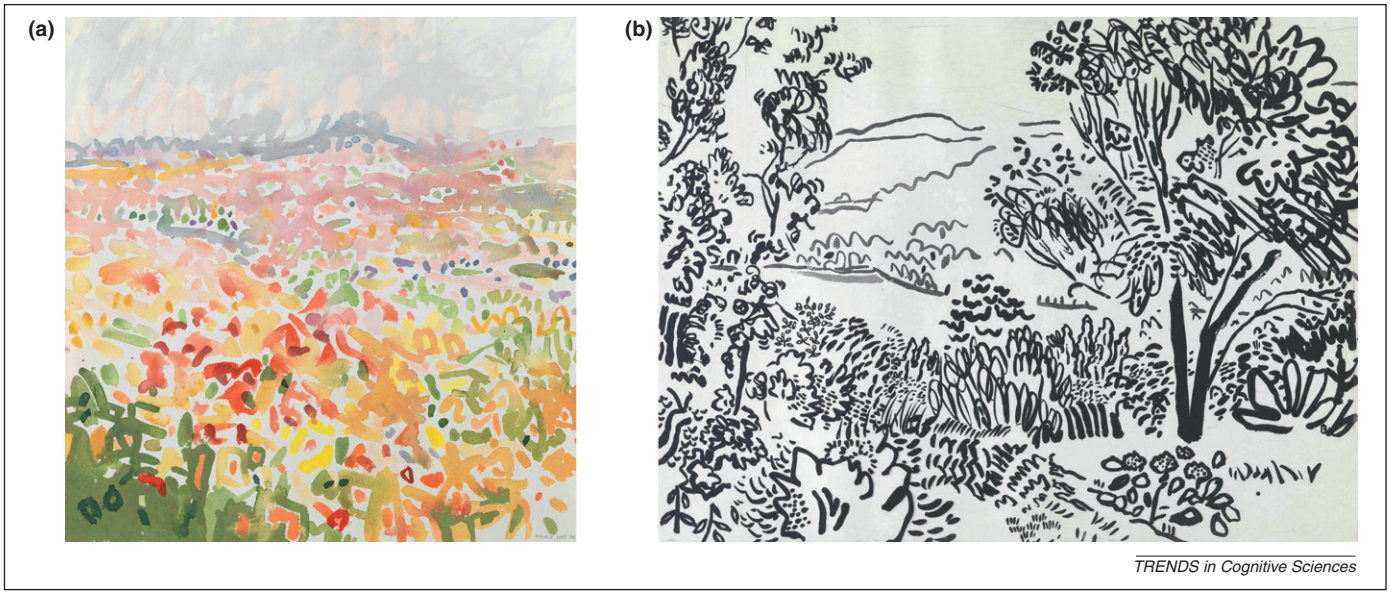

Figure 1. **(a)** New Hampshire hills, watercolor on paper, 2007. **(b)** A Rake's Progress IV (At Tanglewood, While They Had Dinner with Ellsworth Kelly), sugar-lift aquatint, 2007.

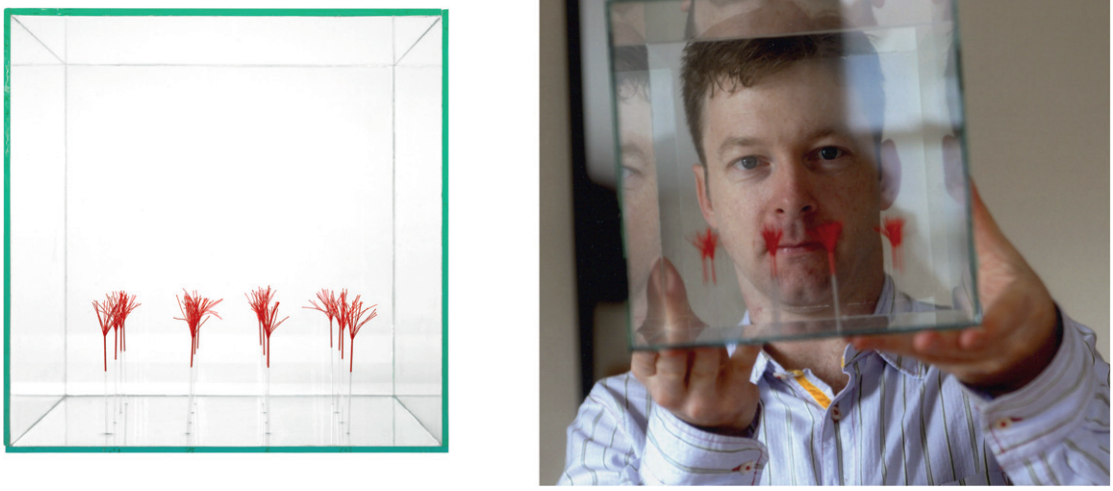

Figure 2. GB #5, four rows of four tufts of red silk, glass and silk, 2005–2012. Photo credits: (left) Stewart Clement; (right) Joanne Rathe (Boston Globe).

object? By analogy, what is the difference in impact in how we feel about or expect we will feel about something pictured in the mind's eye versus something physical, solid and real? Four rows of four tufts of red silk arranged in a grid and suspended by glass micropipettes. What does this look like? Thinking about smiling versus actually smiling. In this work, I am interested in the subtle and unavoidable variability that arises not just in the execution of an instruction ('noise' according to computational neuroscience) but also in the surprises that accompany the realization of something previously only visualized. This variability is the fingerprint of the handmade, and the surprise is a reminder that vision is only complete on experience. Unlike my science, which sets out to ask and answer questions, my art just seeks to raise questions. But I strive to be creative in both pursuits and to enrich the experience of seeing.

It is a joy attempting to do something original, in both art and science. And life can be rich partly because of the variety, a lesson I learned from my mentor David Hubel. Finding something new in art or science, writing about it, teaching, developing the manual creativity to make a woodblock, etching, or electrode: it's all great fun.

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