The Neuroscience of Art

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By casual juxtaposition the two fields of art and neuroscience seem to have little in common. Our culture characterizes art as imaginative, subjective, narrative, and often controversial, but very rarely scientific. In contrast, we portray science as logical, objective, factual, and integral to our understanding of nature, both of ourselves and the world around us. But the growing insight that some scientists have gained in recognizing the work of artists as co-investigators of reality have led them to conclude that while their approaches differ, artists and scientists strive toward a common goal in their quest for knowledge.

Under this joint endeavor, the relationship between artist and neuroscientist doesn't seem so hard to swallow. After all, the artist has historically been the prime investigator of visual perception. Although not always with reproducible experiments or verifiable results, they intuitively unlocked the secrets of the eye and the visual brain. Leonardo da Vinci used his knowledge of how the eye perceives form and depth through gradual changes in light to perfect his techniques of sfumato and chiaroscuro, centuries before psychologists and neuroscientists formulated theories of depth cues. In his 1871 lecture, Helmholtz articulated that "we must look upon artists as persons whose observation of sensuous impression is particularly vivid and accurate, and whose memory for these images is particularly true. That which long tradition has handed down to the men most gifted in this respect, and that which they have found by innumerable experiments in the most varied directions […] forms a series of important and significant facts, which the physiologist, who has here to learn from the artist, cannot afford to neglect" (qtd in Hyman 2008).

Artists have also embraced new knowledge about visual perception to work alongside the discoveries of scientists. Optical art of the 60s, better known as "Op Art," is perhaps one of the best examples of such cross-fertilization of ideas. Op art, so-called because of its focus on retinal effects, embraced new discoveries about how the retina processes contrast and color. Artists like Richard Anuszkewitz were even characterized as "scientific artists" in their highly methodical creation of artworks that scintillated the eye with its often jarring retinal effects. He concluded in his masters thesis that " 'through their studies, modern psychologists have presented to us ways of 'seeing' works of art more competently. They have shown to us how the eye organizes visual material according to definite psychological laws […] The relationship between artist and psychologist has proven a benefit for both' " (qtd. in Lunde 23). Artists like to break neurologic and perceptual rules, but in order to break rules, one must first understand them. Thus, it is fitting that artists take just as much interest in understanding visual perception as the neuroscientist, and have created in their canvases a repository of knowledge from their investigations.

In the past decade, neuroscientists have taken a newfound interest in exploring art's insights on visual perception. Semir Zeki, who pioneered the field of neuroaesthetics explains, "Because all art obeys the laws of the visual brain, it is not uncommon for art to reveal these laws to us, often surprising us with the visually unexpected. Paul Klee was right when he said, 'Art does not represent the visual world, it makes things visible'"(Zeki website).

In fact, Harvard psychologist Patrick Cavanagh has called artists "neuroscientists" in their understanding that "our visual brain uses a simpler, reduced physics to understand the world" (Cavanagh 2005). He argues that artists subsequently incorporate these shortcuts onto the canvas through physically impossible shadows, colors, reflections, and contour, which typically go unnoticed by the viewer. Furthermore, Harvard neurobiologist Margaret Livingstone has hypothesized that the ephemeral and mysterious nature of Mona Lisa's smile may in fact be attributed to the attention of our peripheral and central vision to different levels of resolution, with the former preferring coarse components, while the latter prefers fine details. Livingstone theorizes that since facial expressions are more easily identified from their coarse components, the switch from peripheral to central vision when we focus on different parts of the painting may explain the elusiveness of Mona Lisa's smile (Livingstone 73).

Can Neuroscience Explain Art?

Some scientists have gone even further to theorize that a viewer's experience of art, and indeed what distinguishes "good" art, can be explained by of a set of neural correlates. Neuroscientist Semir Zeki originally coined the term "neuroesthetics" to describe his pioneering investigations of the neurological mechanisms that underlie art. Zeki, renowned for his discoveries about the visual brain, heads the Laboratory of Neurobiology at University College London and runs the Institute of Neuroesthetics (founded in 2001). He believes that "the artist is in a sense, a neuroscientist, exploring the potentials and capacities of the brain, though with different tools. How such creations can arouse aesthetic experiences can only be fully understood in neural terms. Such an understanding is now well within our reach" (Zeki website). Brain imaging studies using functional MRI (fMRI) techniques have thus far predominated Zeki's work, including studies that localize regions of the brain that correlate with human appreciation for aesthetic beauty (Kawabata and Zeki 2004). Zeki has also proposed that ambiguity is a distinguishing trait of great artworks, which offer the viewer multiple interpretations, all of which equally valid. He believes that we do not "sufficiently acknowledge that the almost infinite creative variability that allows different artists to create radically different styles arise out of common neurobiological processes" (Zeki 2001).

Neuroesthetics, however, has met with significant debate, and V.S. Ramachandran's seminal paper "The Science of Art: A Neurological Theory of Aesthetic Experience" instigated quite a discussion in its wake. The director of the Center of Brain and Cognition at University of California-San Diego, Ramachandran has taken a similar interest in explaining art through neuroscience. He argues in his paper that "all art is caricature", in the sense that all art contains a distortion along a single dimension, such as in form (Hindu sculptures) or color (Impressionism)."The purpose of art," he writes, is to "enhance, transcend, or indeed even to distort reality," and proposes experiments using brain imaging and galvanic skin responses to further elucidate those mysteries with empirical evidence (Ramachandran and Hirstein 1999).

One specific explanation he has presented is on the topic of cubism. In elucidating why simultaneous views of an object from multiple vantage points is "more pleasing" to the viewer, Ramachandran makes a specific physiological prediction. He explains that in the fusiform gyrus there are cells that only respond to certain views of a face and then there are so called "master face cells" that respond to all views of a face. Normally only one view of the face would be presented at a time, but in a cubist painting, the presence of multiple views could cause multiple "single view" cells to fire at once, thus hyperactivating the "master face cells" and exciting the limbic system accordingly (Ramachandran 2001).

In taking a neurological stance that joins Zeki in his argument that art stems from physiology of the brain, Ramachandran elicited much criticism for his oversight of other factors that contribute to the creation and appreciation of art. Formal commentaries to "The Science of Art" point out that Ramachandran's evaluation overlooks the contributions of emotion, intention, memory, and knowledge. Richard Gregory, Professor Emeritus of Experimental Psychology at the University of Bristol, comments that "there is an implicit phrenological view of the brian here, which may or may not be correct. Undoubtedly there are functional modules, but surely there is more and more evidence of feedback loops—and an enormous richness of downgoing fibres, which might mediate knowledge into perception. I would think the role of knowledge—both knowledge of the world and experience of art—is greatly underestimated in this paper" (Gregory 1999).

Oxford Philosophy Professor John Hyman characterized Ramachandran's theory as "brazenly reductionist" and points out its failure to address the fundamental idea that art is a product of its time made with "specific tools, materials, and techniques. Understanding 'what art really is' has to involve understanding how the ability that works of art have to express meaning, and to communicate thoughts and feelings and perceptions, depends on these tools, materials, techniques." (Hyman 2008) The limitations of Zeki and Ramachandran's theories also extend to their primary focus on specific eras of painting from the Western World, which in the world of art, is merely one niche of many. Art is a far more encompassing entity that often escapes definition. How then is one able to confine art within the domains of neuroscience?

In a follow up interview to his article, Ramachandran explained that he intended for his paper "to serve as a starting point" and acknowledged that a complete theory of art may not even exist, but that he hoped his essay would "generate a useful dialogue between artists, neuroscientists, perceptual psychologists and art historians—to bridge C.P. Snow's two cultures" (Ramachandran 2001). That the field of neuroaesthetics has sparked discourse between the two cultures is without debate, and clearly, great potential for innovative work lies in further dialogue between art and neuroscience. However, it is equally certain that both artists and scientists must appreciate the complexity of the subject and acknowledge that neuroscience in itself is not a sufficient theory of art, but it can enrich our understanding of art by adding yet another dimension.

Art and Cognition

While the question of whether neuroscience can aptly define art is a highly controversial topic among artists and neuroscientists, less contended is the idea that art contains much knowledge about the brain, and no one holds a better key to unlocking that knowledge than the artist, himself. The late Robert Solso, who headed the Cognition Lab at the University of Nevada-Reno, spent time as a post-doc at Stanford, where he conducted MRI scans of a distinguished portrait artist, while making 30 second drawings of faces inside the MRI machine. When the results of those scans were compared to those of a control—a Stanford graduate student in Psychology with no formal training in art—Solso not only confirmed that the brain area frequently associated with face identification (FFA) was specifically activated, he also found that the artist may be more efficient in processing facial features. In comparison to the student, the artist showed less activity in the FFA which processes faces, and greater activity in the right middle frontal area, "the part of the brain usually associated with more complex associations and manipulations of visual forms, " suggesting a "'higher order' interpretation." (Solso 2000).

Solso hoped that this experiment would push the preconceived methodological limits of fMRI research beyond button-pressing, bulb-squeezing, or simply thinking to the possibility of more mobile, interactive tasks, like drawing. Solso often came to Stanford as a visiting professor and even taught a course on cognition and the visual arts during his time here. He believed that "art and cognition have always stood as two convex mirrors each reflecting and amplifying the other. Yet surprisingly, in spite of monumental recent developments in both aesthetics and cognition, the connection between the two disciplines has not been studied systematically"(Solso xiii).

The time to study that connection has come, and in the arena of education, teachers are especially hopeful for answers to the question "What is art's role in cognitive development?" Many have written about the integral role of art in public education, including Stanford Professor Emeritus Elliot Eisner of the School of Education. Eisner argued that distinctive forms of thinking, artistically-rooted forms of intelligence, were relevant to all aspects of what we do and should be used to reshape education models. Harvard psychologist Howard Gardner has redefined cognitive ability through his theory of multiple intelligences, which notably includes categories such as bodily-kinesthetic and visual-spatial alongside more traditional "intelligences" such as verbal-linguistic and logical-mathematical. In his commencement speech to the Stanford class of '07, Chairman of the National Endowment for the Arts, Dana Gioia said "Art is an irreplaceable way of understanding and expressing the world—equal to but distinct from scientific and conceptual methods. Art addresses us in the fullness of our being—simultaneously speaking to our intellect, emotions, imagination, memory, and physical senses." Further scientific evidence of how art engages us in those complementary modes of thinking would greatly aid educators who face the challenge of teaching students to think creatively, during a time when art programs are vanishing from public education.

Gioia reminded us that "we live in a culture that barely acknowledges and rarely celebrates the arts or artists." What if instead of viewing art as a dispensable luxury, we could see it as a key ingredient in unlocking the great mysteries of neuroscience? University of California-San Francisco surgeon, art enthusiast, and author Leonard Shlain writes that just as combining information from our two eyes enhances the third dimension of depth, by "seeing the world through different lenses of art and science and, by integrating these perspectives, [we] arrive at a deeper understanding of reality"(Shlain 434).

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