ESSAYS ON SCIENCE AND SOCIETY

Artistic Creativity and the Brain

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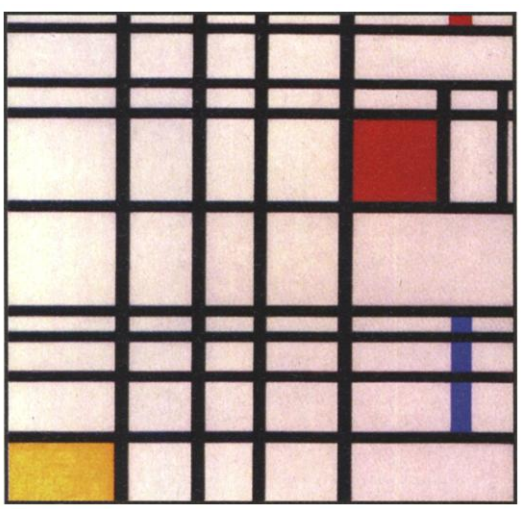
Charles Darwin argued in *The Origin of Species* that variability, one of the chief determinants of evolution, is greatest in structures that evolve fastest. In humans, the brain is the most variable and fastest evolving organ. We cannot at present ascribe this variability to any well-defined structure or component in the brain. Rather, we infer it through the wide differences in, for example, intelligence, sensitivities, creative abilities, and skills. Art is one expression of this variability. Its neurological study will therefore elucidate not only the source of one of the richest subjective experiences of which we are capable but also the determinants of the variability in its creation and appreciation, and hence elucidate one of the most important characteristics of the human brain.

Variability confers huge advantages: it enriches our cultures immeasurably and is a key factor in the further evolution of human societies. Yet, as an evolutionary imperative, it also exacts a high price. It is often the cause of serious injustice and marginalizes from society those whose conduct or inclinations are judged to be deviant from the norm. Paradoxically, this may benefit art and hence contribute to cultural evolution. Art renders the destructive, isolating, and individualizing effects of variability safe in its pages, canvasses, and scores. Mozart's *Don Giovanni* sets to sublime music the life of a lecher and serial rapist who would find no respite in the courts. His doom, announced musically in the opening bars of the opera, is dictated largely by his biological constitution. He faces that biological destiny with courage and dignity, as do Racine's incestuous Phèdre and Shakespeare's Coriolanus, who is constitutionally blighted by pride and arrogance. These artistic studies of variability have had little social or legal implications. But when neurobiology starts charting the neurological foundations of variability, the results will affect profoundly our social organization at all levels, including the educational, political, and legal.

If the quirks of humanity that find expression in artistic works are ultimately a result of the as-yet-uncharted variability in the structure and functioning of the cerebral cortex, so is the variability in how we experience art. This is why we normally assign art to a private, subjective world; its richness lies in the fact that its power to disturb and arouse varies between individuals. In so doing, we do not acknowledge sufficiently, if at all, the extent to which that subjectivity and variability is based upon a commonality. It is commonality that allows us to communicate about art and through art, with or without the use of the written or the spoken word. Nor do we sufficiently acknowledge that the almost infinite creative variability that allows different artists to create radically different styles arises out of common neurobiological processes. By probing into the neural basis of art, neurological studies can help us to understand why our creative abilities and experiences vary so widely. But it can only do so by first charting the common neural organization that makes the creation and appreciation of art possible.



Composition in Red, Yellow, and Blue. –Piet Mondrian

A beginning in this direction can be made by studying visual art, a product of the visual brain about which much has been learned in the past 25 years. Artists and neurobiologists have both studied the perceptual commonality that underlies visual aesthetics. For example, years before the discovery of orientation-selective cells* (which respond selectively to straight lines and are widely thought to be the neural "building blocks" of form perception), Mondrian, in search of "the constant truths concerning forms," settled on the straight line as the major feature of his compositions (see the first figure, this page). The straight line has also been used artistically in variable ways by many other painters, including Kazimir Malevitch and Barnett Newman. Similarly, long before the visual motion center of the brain (area V5) was charted, kinetic artists such as Alexander Calder and Jean Tinguely composed works that, in different ways, emphasized motion and de-emphasized color and form. Their compositions were thus admirably suited for stimulating the cells in V5 and anticipated artistically the physiological properties of motion-selective cells. This is why I believe that artists are, in a sense, neurologists who unknowingly study the brain with techniques unique to them.†

Visual art contributes to our understanding of the visual brain because it explores and reveals the brain's perceptual

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*D. H. Hubel, T. N. Wiesel, *J. Physiol. (London)* **160**, 106 (1962).
†S. Zeki, *Inner Vision: An Exploration of Art and the Brain* (Oxford Univ. Press, Oxford, 1999).
‡J. Constable, 10 December 1771, in *Discourse. Art* (No. 4), (1975).
§N. K. Logothetis *et al.*, *Curr. Biol.* **5**, 552 (1995).
||P. Picasso, interview with C. Zevros, *Cahiers d'Art*, 173 (1935).
¶J. Schulz, *Art Bull.* **58**, 366 (1975).

capabilities. As Paul Klee once wrote, "Art does not reproduce the visible; it makes things visible." But visual art also obeys the laws of the visual brain, and thus reveals these laws to us. Of these laws, two stand supreme.

The first is the law of constancy. By this I mean that the function of the visual brain is to seek knowledge of the constant and essential properties of objects and surfaces, when the information reaching it changes from moment to moment. The distance, the viewing point, and the illumination conditions change continually, yet the brain is able to discard these changes in categorizing an object. Similarly, a great work of art tries to distill on canvas essential qualities. A major function of art can thus be regarded as an extension of the function of the brain, namely, to seek knowledge about the world. Indeed, it was an unacknowledged attempt to mimic the perceptual abilities of the brain that led the founders of Cubism, Pablo Picasso and Georges Braque, to eliminate the point of view, the distance and the lighting conditions in their early, analytic period.

The acquisition of knowledge by registering the constant and essential characteristics of objects is the primordial function of the visual brain. It is also the primordial function of art. That is why many great philosophers concerned with the problem of knowledge, from Plato onward, have devoted large parts of their work to discussions of art.

The second supreme law is that of abstraction. By abstraction I mean the process in which the particular is subordinated to the general, so that what is represented is applicable to many particulars. This second law is intimately linked to the first, because abstraction is a critical step in the efficient acquisition of knowledge; without it, the brain would be enslaved to the particular. The capacity to abstract is also probably imposed on the brain by the limitations of its memory system, because it does away with the need to recall every detail. Art, too, abstracts and thus externalizes the inner workings of the brain. Its primordial function is thus a reflection of the function of the brain. In the words of John Constable, "The whole beauty and grandeur of Art consists ... in being able to get above all singular forms, local customs, particularities of every kind.... [The painter] makes out an abstract idea ... more perfect than any one original."‡

> "visual art ... obeys the laws of the visual brain, and thus reveals these laws to us."

How the brain forms abstractions is a central problem in cognitive neurobiology. Through a process that is only now beginning to be physiologically charted,§ cells in the brain seem to be able to recognize objects in a view-invariant manner after brief exposure to several distinct views, which they obviously synthesize. The artist, too, forms abstractions, through a process that may share similarities with the physiological processes now being unraveled but certainly goes beyond them, in that the abstract idea itself mutates with the artist's development. In a prescient statement that anticipates brain imaging studies, Picasso once said, "It would be very interesting to preserve photographically ... the metamorphosis of a picture. Possibly one might then discover the path followed by the brain in materializing a dream."‖ This possibility is now well within our reach.

But abstraction, a key feature of an efficient knowledge-acquiring system, also exacts a heavy price on the individual, for which art may be a refuge. The abstract "ideal" synthesized by the brain from many particulars can lead to a deep dissatisfaction, because the daily experience is that of particulars. Michelangelo left three-fifths of his sculptures unfinished (see the figure on this page), but he had not abandoned them in haste. He often worked on them for years, because, Giorgio Vasari tells us, "time and again the sublimity of his ideas lay beyond the reach of his hands."¶ I would put it differently—Michelangelo realized the hopelessness of translating into a single work or a series of sculptures the synthetic ideals formed in his brain. Critics have written in emotional and lyrical terms about these unfinished works, perhaps because, being unfinished, the spectator can finish them and thus satisfy the ideals of his or her brain. This is only qualitatively different from finished works with the inestimable quality of ambiguity—a characteristic of all great art—that allows the brain of the viewer to interpret the work in a number of ways, all of them equally valid. In art, Schopenhauer wrote, "something, and the ultimate thing, must always be left over for the imagination [the brain] to do."

The Rondanini Pietà. –Michelangelo Buonarroti

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Art has been a creative refuge for other unsatisfied ideals created by the brain through its abstractive process, thus hastening our cultural evolution. Dante had a life-long, unconsummated love for Beatrice, who died early in the poet's life. No woman, not even his wife, ever replaced "the glorious lady of my mind," the ideal woman that his brain constructed through her. Artistically metamorphosed and further idealized, she leads him to Paradise in the final section of *The Divine Comedy*. Similarly, Richard Wagner, seemingly never finding his ideal romantic attachment, wrote *Tristan und Isolde* as the "greatest monument to the greatest of all illusions, romantic love." But an illusion is a construct of the brain. Here, the impossibility of ever finding, in individual romantic attachments, the ideal romantic conditions constructed by his brain is emphasized by the belief that only in death can this be achieved.

The future field of what I call neuroesthetics will, I hope, study the neural basis of artistic creativity and achievement, starting with the elementary perceptual process. I am convinced that there can be no satisfactory theory of aesthetics that is not neurobiologically based. All human activity is ultimately a product of the organization of our brains, and subject to its laws. I therefore hope that neuroesthetics will broaden to tackle other issues, such as the neural basis of religious belief and the relation between morality, jurisprudence, and brain function—questions that are fundamental in man's quest to understand himself. Like art, these play a critical role in our lives and are also subject to the quality of variability that is at the heart of our civilization. I shall be surprised if such an understanding does not modify radically our view of ourselves and our societies.