The Neuroscience of Art: A Research Program for the Next Decade?

Jean Pierre Changeux

ABSTRACT—Works of art can be viewed as elements of a human-specific nonverbal communication system, distinct from language. First, the cognitive abilities and skills required for art creation and perception are built from a cascade of events driven by a “genetic envelope”. Essential for the understanding of artistic creation is its epigenetic variability. Second, artistic contemplation and creation may be tentatively viewed as a discrete and singular conscious synthesis taking place within the personal global neuronal workspace of external perceptions, internal memories and stored emotions. Third, there is a need for rules that constrain and restrict in a top-down manner the selection of representations generated by the artist’s brain. Finally, artistic creation is a part of the personal history of the artist and stems from an anterior historical evolution.

“Une peinture est une organisation, un ensemble de relations entre formes sur lequel viennent se faire et se défaire les sens qu’on lui prête.”

—Pierre Soulage

The neuroscience of art still largely escapes our present understanding, but there is emerging a plausible program of multidisciplinary research for the next decade at the crossroads of the biological sciences and the humanities. Works of art can be tentatively viewed as elements of a human-specific nonverbal communication system, distinct from language “halfway between scientific knowledge and mythical thought” (Lévi-Strauss, 1962). Esthetic communication specifically uses symbolic forms that mobilize altogether emotional states and rational experience under the constraints of characteristic “rules of art.”

From a molecular neurobiologist’s perspective, the cognitive abilities and skills required for art creation and perception are built from a cascade of events driven by a genetic envelope that cannot be simply related to genome size, nor number of genes. The total amount of DNA present in the haploid genome comprises approximately 3.1 billion base pairs, but no more than 20,000–25,000 gene sequences (1.2% of our genome code for exons [DNA components of genes]) and this number does not significantly differ from mouse to human. However, the total number of cells in the human brain is on the order of 85 billion neurons, with each neuron possessing its particular connectivity and its set of genes expressed. Molecular explanations are needed to account for the nonlinear relationship between complexity of genome versus brain phenotype in the course of evolution—for instance, at the level of the combinatorial expression of spatio-temporal patterns of genes that affect development (Changeux, 1985, 2008).

Another aspect of brain organization—often underestimated, but essential for the understanding of artistic creation—is its epigenetic variability, the ways that it varies as a function of epigenesis (development that expressly joins genetic and environmental influences). Such variability is introduced during the development of brain neuronal connectivity, based on the facts that (a) in humans about half of all adult connections are formed after birth at a very fast rate (approximately 2 million synapses every minute in the baby’s brain) and (b) a significant number of connections are eliminated in the course of development in the process called “pruning” (Lagercrantz, 2010). This process of synaptic stabilization and elimination is exceptionally long in humans and proceeds at least through the age of 15. It stores the traces of trial-and-error learning processes, possibly through selection mechanisms based on shared rewards and emotions (Changeux, 1985, 2005; Gisiger et al., 2005). It is altered under pathological conditions like schizophrenia, a disease that involves susceptibility genes affecting the development of...
intra- and inter-regional brain connectivity (Karslgodt et al., 2008). Comparative studies suggest that this prolonged period of postnatal development in humans is positively associated with the genesis and internalization of culture (Changeux, 1985, 2008), in particular with the acquisition of skills and cultural imprinting associated with the symbolic experience and emotions characteristic of aesthetic experience and the arts.

From a cognitive perspective, artistic contemplation and creation may be tentatively viewed as a subjective, conscious experience, or conscious access. The neurobiological mechanisms for this kind of experience are being actively explored in several laboratories through objective measures of brain imaging and theoretical modeling (Changeux & Dehaene, 2008). The experience can be viewed as an endogenous process that makes incoming and/or internally generated information globally available to multiple brain systems through a distributed network—or Global Neuronal Workspace—of neurons with long-range axons, particularly dense in prefrontal, parieto-temporal, and cingulate cortex. Esthetic experience might then be hypothesized as a discrete and singular conscious synthesis taking place within the personal global workspace of external perceptions, internal memories, and stored emotions, bringing into play “emotions in harmony with reason” (von Schiller, 1983/1794). This process can be selectively altered by drug consumption and by neuropsychiatric disorders and is investigated with functional brain imaging (Cela-Conde et al., 2004; Kawabata & Zeki, 2004).

Any neurobiological hypothesis about artistic creation faces the combinatorial explosion of the 85 billion neurons that compose the human brain. There is a need for rules that constrain and restrict in a top-down manner the selection of representations generated in the artist’s brain, which result in the personal style and quality of the work together with its efficient social communication and shared interpersonal recognition. These règles de l’art, hypothetically viewed as acquired patterns of connections or scaffoldings, stored in long-term memory, include, among others, novelty, the coherence of the parts within the whole (Alberti’s consensus partium. Alberti, 1972/1435), parsimony or the most frugal route of expression (Simon, 1979), the tension between bottom-up realism and top-down abstraction, the search for shared social recognition, and the artist’s conception of the world—for instance, the “noble ideas” (belles idées) of Nicolas Poussin (Changeux, 2008).

Finally, artistic creation is a part of the personal history of the artist and stems from an anterior historical evolution that can be made possible because the artist often borrows from others’ patterns, figures, and forms, which become units that are perpetuated through time. There is an evident evolution of art. Yet this evolution surprisingly seems to show no obvious progress although it demonstrates constant renewal, possibly as a consequence of still largely unexplored universal features of human brain interaction with fast-changing social and cultural environments. Perhaps multidisciplinary research in the next decade can illuminate the nature of this evolution and its connection to brain functioning in relation to societies and cultures.

REFERENCES


