ART, AESTHETICS, AND COGNITIVE NEUROSCIENCE

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Each rule of beauty is at the same time a psychological discovery. For, since it contains a prescription of the conditions under which a beautiful object can have the best effect on our mind, it must be possible for the rule to be derived from the nature of the human spirit [mind] and explained on the basis of its properties. Thus, if the philosopher pursues the traces of sentiments on their obscure paths, new perspectives in psychology must open themselves up to him, ones which he would otherwise never have uncovered by rational inferences and by experience (Moses Mendelssohn 1771).

Contemporary work in the cognitive neuroscience of visual aesthetics is derived from the conjunction of two research strategies: empirical aesthetics and aesthetic experimentalism (Rollins 2004). Empirical aesthetics describes a field of research dedicated to explanations of artworks and aesthetic experiences as categories of perceptual stimuli and phenomenal experiences respectively. Aesthetic experimentalism is an extension of the view that the history of visual art in Western Europe from the Renaissance through modernism can be conceived as the history of vision science. This research rests on the claim that, since artworks are stimuli intentionally designed to control for particular aspects of a viewer’s perceptual experience, artists’ techniques and methods, e.g. their formal sketches, maquettes, and color studies, represent an intuitive means to study the operations of perceptual systems (Gombrich 1960; Zeki and Lamb 1994). The conjunction of these two strategies suggests that empirical investigations of the aesthetic practices of artists are uniquely suited to reveal the structure and function of perceptual systems. Therefore, the cognitive neuroscience of visual aesthetics represents a methodological rapprochement between neuroscience and art in the study of perception. In what follows I evaluate the interrelationship between these two strategies in recent research in neuroaesthetics (Livingstone 2000; Zeki and Lamb 1994; Lato, 1996) and philosophical theories of art and imagination (Walton 1990) that this research can contribute to both vision science and philosophical aesthetics. On the one hand the study of viewers’ interactions with paintings can further our understanding of the integration of cognitive and sensory processes in attention and perception. On the other hand explanations of the neuropsychological processes subserving viewers’ perceptual interactions with visual artworks can clarify our understanding of the aesthetic features of artworks and the character of aesthetic experience.
Interestingly, this research does not represent a novel paradigm for the study of art, but rather is a return to the original eighteenth century conception of aesthetics. Alexander Baumgarten and Moses Mendelssohn argued that artists’ methods were a means to clarify the content of perceptual experience in order to support accurate depiction. On their account artworks were aesthetically interesting because these methods enhanced the resonance between a perceptual stimuli and the operation of perceptual systems (Baumgarten 1734; Mendelssohn 1771). For instance, Mendelssohn argued that the goal of artistic production was to “beautify nature,” or to present scenes and objects as if they had been designed to be perceived. This resonance was, in turn, felt as a sense of cognitive consonance, or clarity in perceptual representation that intensified the phenomenal experience of viewers. Some contemporary cognitive neuroscientists argue likewise that the function of artists methods is to develop formal vocabularies tuned to the receptive field properties of neurons in the visual system. It is argued that this resonance enhances the clarity and intensity of visual experience (Latto 1996) and explains particular aesthetic effects (Livingstone 2000; Zeki and Lamb 1994). Therefore, research at the junction of empirical aesthetics and aesthetic experimentalism is an extension of an eighteenth century conception of aesthetics.

The cognitive neuroscience of visual aesthetics (CSVA) rests on two related claims:

CSVA1: Cognitive neuroscience can explain how artworks work as perceptual stimuli.

CSVA2: Cognitive neuroscience can explain how artworks work as aesthetic stimuli.

The first claim is trivially true. Works of fine art are perceptual stimuli designed to control for particular aspects of a spectator’s perceptual experience, e.g. paintings and symphonies. Research in cognitive neuroscience can, at least in principle, be used to explain how perceptual stimuli function to control for various aspects of spectators’ perceptual experience. Therefore, cognitive neuroscience can explain how artworks function as perceptual stimuli. For instance, irradiation is a formal technique that is designed to enhance edges and amplify figure ground segregation in paintings. This technique is derived from the observation of Mach bands in the visual field. Mach bands are perceived light and dark stripes that occur at luminance boundaries in the visual field, but do not correspond to any objective features of the distal environment. They are instead artifacts of the way the visual system initially records information concerning the light that impinges on the retina. Therefore, irradiation is an explicit feature of artists’ formal vocabularies whose functional success in paintings is explained by the operation of a discrete neurophysiological mechanism in the visual system.

The appearance of Mach bands in the visual field is explained by lateral inhibition in the retina. Lateral inhibition is an architectural feature of neural networks that enables a neuron to modulate the outputs of its nearest neighbors. For instance, a ganglion cell in the retina that receives an excitatory signal from a particular photoreceptor also receives an inhibitory signal from the ganglion cells that surround it. Ganglion cells that respond to regions of even luminance receive identical excitatory inputs from their photoreceptors and identical inhibitory inputs from each of their neighbors. However, ganglion cells along the light side of a border between regions of different luminance receive less inhibition from their neighbors in the dark field. Therefore, the overall response of these cells is higher than their neighbors in the “light” field. The converse is true for the cell along the dark side of the border. Therefore, lateral inhibition produces an illusory light and dark stripe along the border between regions of different luminance that does not match the actual intensity of light reflected by the surface of the image.

The technique of irradiation is derived from artists’ understanding of a feature of the structure of appearances that is strongly correlated with a basic neural mechanism.
Lateral inhibition in the retina contributes to form recognition by enhancing both the perception of edges in the visual field and the luminance contrast between figure and ground. Painters used irradiation to deliberately amplify the contrast between coherent figures and their surround in paintings long before the development of mathematical descriptions of Mach bands or a neurophysiological model for retinal processing, e.g., the use of half shadows by Robert Campin (1375 – 1444) in the Late Baroque period (Latto 1996). Therefore, this case study also demonstrates that artworks reveal novel facts about the visual system.

What is the rationale for (CSVA2)? Artists' formal methods can be thought of as tools for recovering sets of formal image cues sufficient for adequate depiction. However, there is no preferred set of image features for accomplishing this task (Gombrich 1960). Rather, any of a number of possible formal vocabularies will do, e.g., formal differences between highly realistic Hudson River School and Surrealist paintings. This entails that artists don't discover, but rather choose the formal cues they use to produce a painting. These choices are constrained by aesthetic conventions for the production and perception of artwork. Therefore, the formal structure of an artwork encodes the aesthetic conventions of artists, schools, and eras. This in turn entails that understanding how artworks function as perceptual stimuli content ought to help explain how they function as aesthetic stimuli.

Semir Zeki's model for neuroaesthetics can accommodate the role of aesthetic conventions in viewers' perceptual interactions with artworks. Zeki argues that the formal features of an artwork are triggers for a broader cognitive event whose explanation will involve an understanding of the influence of memory, learning, and cultural conventions in perception (Zeki and Lamb 1994). This model is consistent with theories of art and imagination in philosophical aesthetics. Theories of art and imagination rest on the claim that viewers imaginatively perceive the content of artworks. Paintings can be used as a limiting case to illustrate this claim. Paintings are two dimensional visual stimuli that induce the perception of three dimensional scenes, objects, and abstract spaces. In this regard viewers fill in, or project, the depictive content of a painting onto the surface of the canvas in the act of perceiving them relative to prior knowledge of both the structure and function of object types and the aesthetic conventions that constrain the productive practices of artists (Walton 1990; Seeley forthcoming 2006).

Steven Kosslyn's hypothesis testing theory for visual search and object identification can be used as a model for theories of art and imagination. Kosslyn argues that the visual system uses incomplete sets of diagnostic cues culled from ambiguous retinal inputs to generate perceptual hypotheses that ground the processes of visual search and object recognition. Diagnostic cues are defined as sets of formal cues sufficient in ordinary contexts to determine the identity of a perceived scene object. In object recognition sets of diagnostic cues are matched to semantic knowledge of the ordinary shapes and functions of object types. When a good match is found, information from long term memory is backpropagated into the visual system and used to instantiate a neural representation of the object features that would confirm the identity of the scene object. This representation functions to enhance, and in some cases even augment, the perception of image features germane to a particular perceptual hypothesis.

Recent research on visual attention supports this model (Kanwisher and Wojciulik 2001). Endogenous attention shifts modulate the firing rates of populations of neurons in inferior temporal and occipital cortex associated with expected features, objects, object parts, or spatial locations prior to the onset of a stimulus. These processes function to enhance the encoding of sensory information and inhibit the perception of local distracters. Therefore, knowledge and expectations can be used to enhance the sensory inputs to visual perception.
In this context one can conceptualize artists' formal vocabularies as set of diagnostic cues whose function is to convey the meaning of a work of art by controlling for particular features of a spectator's phenomenal experience of a work. Here is how the model would work. The latent structure of a work of art, say, a painting, is the set of productive formal features that constrain a viewer's perceptual interactions with an artwork. Relative to relevant art historical knowledge, the latent structure of an artwork is diagnostic for a set of aesthetic conventions. The conjunction of these aesthetic conventions and the depictive content of the artwork functions to direct attention to image features salient to the meaning of the work, which function to further constrain attention. This set of process, in turn influences the way viewers' project depth into the picture plane and group its formal features. At each stage of this process prior knowledge generates hypotheses about the expected structure of the picture plane. These hypotheses function to enhance the perception of the painting via the feedback mechanisms of selective attention. This entails that the semantic content, or meaning, of a painting plays a constitutive role in how viewers project the depictive content and spatial dimension of the work onto the canvas. Therefore, cognitive neuroscience can be used to explain the role of aesthetic conventions and interpretation in aesthetic experience, and paintings can be used to demonstrate the contribution of top down cognitive processing to sensation and perception.

References


