Can Neuroaesthetics Earn Its Keep?

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Abstract:

Semir Zeki has coined the term neuroaesthetics to refer to a broad range of recent research in the cognitive neuroscience of visual aesthetics. Whereas it is acknowledged that this research is interesting to the study of vision science, philosophers have been generally skeptical about the role it can play in philosophical discussions of art. In what follows, I explain the general model underlying this research, briefly summarize a representative case study from the literature, and then evaluate the potential contribution of neuroaesthetics to our understanding of art.
Can Neuroaesthetics Earn Its Keep?

Semir Zeki has coined the term neuroaesthetics to refer to a broad range of recent research in the cognitive neuroscience of visual aesthetics. Whereas it is acknowledged that this research is interesting to the study of vision science, philosophers have been generally skeptical about the role it can play in philosophical discussions of art. In what follows, I explain the general model underlying this research, briefly summarize a representative case study from the literature, and then evaluate the potential contribution of neuroaesthetics to our understanding of art.

The general model for neuroaesthetics is derived from the following three related claims.

N1: Cognitive neuroscience can explain how artworks function as perceptual stimuli.

N2: Cognitive neuroscience can explain how artworks function as aesthetic stimuli.

N3: Explanations of how artworks function as perceptual stimuli can serve as the foundation for a biological theory of aesthetics.

Zeki argues that the function of works of fine art, works in perceptual media like painting, sculpture, music, and dance, is to selectively stimulate discrete


2. Philosophers generally distinguish between theories of art and theories of aesthetics, and between philosophical aesthetics and art criticism. See for instance, Noël Carroll, "Beauty and the Genealogy of Art Theory," The Philosophical Forum, 22:4, 1994, p. 307. Zeki does not make this distinction. Zeki’s bias is towards an aesthetic theory of art. However, he uses the term ‘aesthetics’ to refer generally to theories of art and aesthetics in either philosophy or art criticism. There are textual reasons to interpret Zeki this way. In particular, he argues that learning, memory, and cultural conventions contribute to explanations of our standard interactions with artworks. These variables are ordinarily associated in the philosophical literature with contextualist discussions of interpretation, not aesthetic theories of art. In what follows I will adhere to Zeki’s general usage of the term ‘aesthetics.’
neurophysiological processes in perceptual systems in order to control for artistically salient features of viewers’ phenomenal experience, e.g. formal aesthetic and expressive properties of aesthetic experience. He assumes, as a result, that (N1) suffices to establish (N2). He then uses the putative validity of this inference as the grounds for (N3).

The case studies in the literature support (N1). However, they do not support (N2). This generates a problem for Zeki’s theory. A minimum desiderata of a theory of art or aesthetics is that it identify a set of criteria by which spectators differentiate artworks or aesthetic practices from their non-art counterparts. These criteria need not suffice as a general definition of art. Nor need they generalize to all cases. Nonetheless they ought to contribute to explanations of how spectators categorize some subset of artworks as distinct from ordinary, non-art objects and events in practice. Given the failure of (N2), the explanatory framework of neuroaesthetics does not have the means to differentiate artworks from other types of non-art perceptual stimuli. Therefore, it would appear that neuroaesthetics cannot earn its keep as a novel, biological theory about the nature of art or aesthetics.

However, I argue that this difficulty is an artifact of the goal Zeki identifies for neuroaesthetics in (N3) and should not effect our evaluation of the general underlying model. Diana Raffman has argued that the function of cognitive science in philosophical aesthetics is not to generate a novel theory. Rather it is to help clarify difficult conceptual issues and contribute to the resolution of standing debates about the nature of art and aesthetic experience. This view is consistent with the predominant intuitions of contemporary philosophical aesthetics. Given the diverse range of objects, events, and

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practices that count as artistic, philosophers have abandoned the pursuit of broad
overarching theories of art in favor of piecemeal explanations of aesthetic practices.\(^5\) In
this context, the current function of definition of art strategies is to uncover and evaluate
features of aesthetic practice critical our understanding of particular types of artworks,
e.g. how does music express emotions, what is the relationship between cognition and
perception in our interactions with visual artworks, or what is the nature of a reader’s
relationship with characters in fiction.

Can cognitive neuroscience play the role suggested by Raffman in philosophical
aesthetics. Yes. It can, at the very least, verify whether the models of perception and
cognition that ground competing theories of aesthetics are psychologically sound. For
instance, aesthetic theories of art have traditionally bracketed off phenomenal from
cognitive responses to artworks, e.g. canonically aesthetic from interpretive or art critical
responses.\(^6\) However, contemporary research in object recognition and selective attention
suggests that these two types of responses are deeply intertwined and cannot be so
separated.\(^7\) This suggests that the traditional notion of aesthetic experience as
“detached,” “distanced,” or “disinterested” should be either amended or dropped.\(^8\)
Framed this way, the difficulty for neuroaesthetics is that the case studies in the literature
fail to vindicate the aesthetic intuitions that ground Zeki’s theory. However this does not

\(^5\) See for instance Noël Carroll, “Aesthetic Experience Revisited, British Journal of Aesthetics,

\(^6\) Edward Bullough, “Psychical Distance’ as a Factor in Art and an Aesthetic Principle,” British
Journal of Psychology, 5, 1912, p. 87; and Jerome Stolnitz, Aesthetics and the Philosophy of Art

\(^7\) For reviews of this literature see Nancy Kanwisher and Ewa Wojciulik, “Visual Attention:
Insights from Brain Imaging,” Nature Reviews Neuroscience, 1:1, 2000, pp. 91 – 100; Marvin
Chun and Renee Marois, “The Dark Side of Visual Attention,” Current Opinions in Neurobiology,
12:2, 2002, pp. 184 – 189; and Phillipe Schyns, “Diagnostic Recognition: Task Constraints,

\(^8\) See Noël Carroll, “Art and Interaction,” The Journal of Aesthetics and Art Criticism, 55:1, 1986,
pp. 57 – 68; and George Dickie, “The Myth of the Aesthetic Attitude,” American Philosophical
Quarterly, 1:1, 1964, pp. 56 – 66 respectively.
falsify the general model. Rather, it suggests that the narrow aesthetic theory of art Zeki uses to motivate (N2) fails to provide an adequate conception of the function of an artwork.

Neuroaesthetics is derived from the following two claims: the production of works of visual art is subject to the same functional constraints as visual perception; and artists’ formal techniques and methods are a means to harness these constraints in order to enhance the functional success of artworks as perceptual stimuli. In this regard, Zeki considers visual artworks, e.g. paintings, to be analogous with stimuli used to investigate perceptual processing in vision science. Vision scientists use theories of perception and prior experimental results to generate stimuli intentionally designed to control for discrete aspects of perceptual processing. The relative success of these stimuli is, in turn, used to evaluate the validity of their theories. Artists, likewise, employ their own unique depictive strategies along with theories of perspective, color mixing, and etc. to generate stimuli intentionally designed to control for aesthetically salient aspects of a spectator’s perceptual experience. Artists use the relative success of their artworks in practice to evaluate their formal vocabularies productive strategies. Zeki argues, as a result, explanations of the way works of fine art function as perceptual stimuli should reveal interesting facts about the nature of art and aesthetics.

Zeki uses the notion of a receptive field property to establish a close coupling between the operations of the visual system and the formal structure of visual artworks.

9. Although Zeki focuses on visual artworks to illustrate his theory the supposition is that, given the constructive nature of perception in general, the model can be extended to cover artworks in other perceptual media, e.g. music, dance, film. The scope of this paper is too narrow to consider this claim.
The retinal inputs to the visual system underdetermine the rich content of perception. Retinal images are two dimensional records of the relative intensity of light reflected from points in the visual field over time. However, we do not perceive a flat dynamic pattern of constantly changing points of light. Rather we perceive three dimensional scenes and objects in color. Zeki argues as a result that vision is an active process in which abstract information is collected from retinal inputs and transduced to form the building blocks of visual perception. The receptive field properties of neurons in the visual system are defined as either the discrete areas of retinal stimulation that result in the reaction of neurons or group of neurons within the visual system, or their projection of these areas of the retinal image onto the visual field. The receptive fields of neurons in the pathways of the early visual system are selectively sensitive to color, form, and motion cues. This information is, in turn, employed to build up representations of the constant and enduring properties of scenes and objects. Therefore, the receptive fields of neurons in the early visual cortex can be considered evolved mechanisms for selecting salient formal cues from the visual field to serve as the building blocks for visual perception.

The function of the formal structure of a visual artwork is to provide viewers with a set of visual cues sufficient to enable them to recognize its representational content. For instance, sets of visual cues embedded in the formal structure of a painting trigger the same sets of visual processes by which perceivers recognize objects in ordinary visual contexts. Artists learn to identify these stimulus features via a detailed examination of the phenomenal structure of ordinary perceptual experience. Zeki argues that this entails

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10. This claim can be extended to abstract visual artworks as well. In these cases artists’ methods are tools for recovering sets of formal image cues sufficient to induce the perception of particular two dimensional patterns or three dimensional spaces.
that artists' formal methods and vocabularies are the product of practices designed to cull visual cues from the rich content of ordinary perception that are sufficient to trigger the receptive fields of neurons of the early visual cortex. Cognitive neuroscience can explain how these basic neurophysiological mechanisms work and what role they play in perceptual processing. Therefore, cognitive neuroscience can explain how artworks function as perceptual stimuli.

What is the rationale for (N2)? Zeki does not explicitly address this issue. However, the analogy he draws between artworks and laboratory stimuli suggests the following interpretation. Artists formal methods can be thought of as tools for recovering sets of formal image cues from the content of ordinary perceptual experience that are sufficient for artistic production in a medium, e.g. adequate depiction in representational painting. However, even in the case of realistic representations, there is no preferred set of image features for accomplishing this task.\(^\text{11}\) Any number of possible formal vocabularies will do, e.g. formal differences between highly realistic Hudson River School and Superrealist paintings. This entails that artists do not discover, but rather choose the formal image features they use to produce a painting relative to aesthetic conventions for the productions and perception of artworks.\(^\text{12}\) The function of these formal features is to control for artistically salient aesthetic features of a spectator’s phenomenal response to the work. This entails that the formal structure of artworks encode the aesthetic conventions of artists, schools, and eras. Therefore, explanations of how artworks function as a perceptual stimuli should also explain how they function as aesthetic stimuli.

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The standard case studies in neuroaesthetics use canonically aesthetic visual artworks to illustrate this model, e.g. abstract Modernist paintings. However, it is important to note that the scope of the theory is not restricted to explanations of these types of artworks. Rather, the limited focus of neuroaesthetics is an artifact of the interests of the researchers and the state of knowledge in cognitive neuroscience. Works of fine art are perceptual stimuli in a range of media that exploit the visual and auditory systems to trigger broad cognitive events responsible for the production of their formal, expressive, depictive, representational, and semantic content. Explanations of these types of mental events will involve an understanding of the interplay of learning, memory, attention, and cultural conventions in perception. Cognitive neuroscience contributes to our understanding of these psychological processes. Therefore, neuroaesthetics can, in principle, be generalized to explanations of the way artworks in a broad range of media function as perceptual stimuli to trigger higher order perceptual, affective, and interpretive responses as well.

Richard Latto’s discussion of irradiation can serve as a case study to illustrate

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this general model for neuroaesthetics.\textsuperscript{15} Irradiation is a formal technique used to enhance edges and amplify figure-ground segregation in paintings. This technique is derived from the observation of Mach bands in ordinary perception. Mach bands are perceived light and dark stripes that occur at luminance boundaries in the visual field. However, these image features do not correspond to any objective features of the distal environment (figure 1). They are instead artifacts of the way the visual system initially encodes the information contained in the light that impinges on the retina.\textsuperscript{16}

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 cell to modulate the outputs of its nearest neighbors. For instance, a ganglion cell in the retina


\textsuperscript{16} Interestingly, although the scientific discovery of Mach bands is attributed to Ernst Mach in the mid-nineteenth century, painters have copied this feature of the structure of appearances into their paintings since at least Robert Campin (1406 – 1444) and Leonardo da Vinci (1452 – 1519) (Ratliffe, p. 94; Latto, 1995, pp. 73 – 74).

\textsuperscript{17} Stephen Palmer, \textit{Vision Science} (Cambridge, MA: MIT Press), 1999, p. 116. There are no sharp luminance boundaries between the light, dark, and gray regions of the image in figure 1. rather the broad gray region consists of an even gradient from white to black. However, one perceives a light and dark stripe, Mach bands, marking sharp boundaries between three discrete areas of different luminance.

\textsuperscript{18} Palmer, 1999, p. 116.
that receives an excitatory signal from a particular photoreceptor also receives an inhibitory signal from the ganglion cells that surround it. The output of this type of neuron is determined by the sum of its excitatory and inhibitory inputs. 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. Therefore, the outputs of these cells are identical. 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. 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. As a result, 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 distal stimulus.

Mach bands are quite useful in ordinary vision. The visual system interprets sharp variations in luminance as denoting boundaries between discrete surfaces that define objects in the visual field. Lateral inhibition enhances luminance contrast along these edges. Therefore, one function of lateral inhibition is to amplify the intensity of a feature of the sensory input that defines the boundaries between objects in perception.

This in turn contributes to form recognition by enhancing the luminance contrast between figure and ground (Palmer, 1999, p. 282). The function of irradiation is to amplify the effects of lateral inhibition in our perceptual interactions with a painting.\(^\text{20}\) For instance, Seurat used irradiation to enhance the intensity of the contour defining the back of the seated figure in the center foreground in "Bathers at Asnieres."\(^\text{21}\) This formal technique amplifies the luminance contrast between the figure and its surround and, and so sharpens the perception of depth in the picture plane (Figure 3).

Latto’s case study demonstrates that cognitive neuroscience can be used to explain how paintings function as perceptual stimuli. However, a problem arises if one takes this to be an explanation of either the aesthetic properties of, or viewers' aesthetic interest in, Seurat’s painting. The visual system exploits this mechanism to enhance figure-ground segregation in all ordinary perceptual contexts. Therefore, explanations of this type are equally relevant to our understanding of the functional success of many non-art perceptual stimuli as well, e.g. the luminance ramp used to introduce Mach bands in figure 1. Yet we neither experience this object aesthetically nor categorize it as an artwork. This entails that Latto's discussion of irradiation does not suffice to explain how either art or aesthetic experience differ from their ordinary counterparts.

Given the obvious shortcomings of this case study and others like it, one might wonder why neuroscientists like Zeki are so optimistic about the prospects of their theory. The answer lies in their model for aesthetics. Richard Latto argues that the

\(^\text{20}\) This technique first appeared in Robert Campin's paintings in the late 15th Century (Ratliffe, 1992, p. 95).
\(^\text{21}\) The image in figure 3 has been modified to enhance the effect of irradiation along the boundary between the back of the central figure and its surround.
function of artists’ methods is to uncover aesthetic primitives.\textsuperscript{22} Aesthetic primitives are formal image feature that are phenomenally interesting by virtue of their “resonance” with the basic mechanisms of perceptual systems. Likewise, Zeki argues that artists’ formal vocabularies are intuitively tuned to the basic operations of perceptual systems and that artworks that \textit{optimally stimulate} these basic neural mechanisms are experienced as aesthetically interesting. In this regard, neuroaesthetics rests on a general 18\textsuperscript{th} Century model for aesthetics that interprets aesthetic interest as the product of a pre-cognitive perceptual intuition of the structure of a sensory manifold.\textsuperscript{23} However, this model for aesthetic interest does not resolve difficulties with the case study. Laboratory stimuli like the Mach band display above are intentionally designed to optimally stimulate a basic neurophysiological mechanism. As a result, they exhibit a sharp resonance with the human visual system.\textsuperscript{24} If this model were correct we should, as a result, experience figure 1 as deeply compelling aesthetic stimuli. But we do not.

What does the failure of this case study and others like it signal for neuroaesthetics? The real difficulty for Zeki’s theory is that there is no natural entailment between N1, N2, and N3. In this final section I will analyze the relationship between these three claims in order to evaluate whether neuroaesthetics can earn its keep in

\textsuperscript{22} Latto, 1996, p. 67.

\textsuperscript{23} For instance, Moses Mendelssohn argued that the function of artists’ methods was to "beautify nature," or to represent scenes and objects as if they were to be perceived. Viewers experienced the resulting resonance between the artworks and perceptual systems as an intuitive sense of \textit{clarity} that, it was argued, enhanced the intensity of their perceptual experience. The notion of clarity here is not merely perceptual. Mendelssohn’s view, like his contemporary Alexander Baumgarten was that artists learn to enhance our intuitive access to those image features that enable us to perceptually identify objects. Therefore, like Zeki, he interpreted aesthetic experience as a form of epistemic clarity unique to perception.

\textsuperscript{24} In fact they exhibit a sharper resonance with the visual system than paintings like Seurat’s “Bathers at Asinieres.”
philosophical aesthetics. N1 is trivially true. Works of fine art are perceptual stimuli designed to control for artistically salient aspects of a spectator’s phenomenal 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 perceptual experience. Therefore, cognitive neuroscience can explain how works of fine art function as perceptual stimuli.

The failure of Latto’s case study demonstrates that the inference from N1 to N2, taken as a general claim about research in the cognitive neuroscience of aesthetics, is not valid. N2 is the critical assumption for the model. Therefore, the failure of this inference would seem to be disastrous for neuroesthetics. However, all is not lost. The solution is to narrow the scope of N2 to explanations of perceptual effects of a work of art that are either artistically salient as aesthetic effects or function as triggers for semantic associations constitutive of its meaning. These types of case studies, consistent with Raffman’s framework for cognitive science and aesthetics, can be used to evaluate both art critical judgments about particular artworks and competing theories about the nature of our perceptual and cognitive interactions with paintings. In this regard they can contribute to debates between competing theories about the nature of art and aesthetic experience.

There are examples of this strategy in the literature. Margaret Livingstone has focused her research on explanations of particular aesthetic effects constitutive of the artistic value of particular artworks, e.g. the way Leonardo used sfumato to generate Mona Lisa’s dynamic and elusive smile. These case studies contribute to debates about the validity of art critical theories about particular artworks and the works of particular
artists and schools. Mark Rollins has written on the way painters use the composition of a canvas to focus a spectator’s attention on the semantically salient features of an artwork’s formal structure. This research contributes to debates about the role of artists’ intentions in interpretation. Therefore, in the restricted sense of N2, neuroaesthetics can earn its keep in philosophical aesthetics. However, this interpretation of neuroscience does not preserve Zeki’s broad claim about the role of cognitive neuroscience in aesthetics. N2, in its restricted sense, does not entail N3. Explanations of how artworks function to generate artistically salient perceptual effects can help clarify conceptual issues and resolve debates among competing theories in philosophical aesthetics. But, there is no reason to expect that these sorts of explanations will form a coherent unified theory that generalizes to even a subset of artworks or aesthetic practices. This in turn entails that Raffman’s intuitions are correct. The goal of cognitive neuroscience in aesthetics should not be to generate novel, independent theories of aesthetics, but rather to contribute evidence to clarify difficult conceptual issues and help resolve standing debates in aesthetics and art criticism.