Where Neuroscience and Art Embrace; The Neuroaesthetics

Mohammad Torabi Nami[1,*], Hasan Ashayeri [2]

1. Institute for Cognitive Sciences Studies, (ICSS), Tehran, Iran.
2. School of welfare and Rehabilitation, Tehran University of Medical Sciences, Tehran, Iran

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ABSTRACT

Neuroscience has recently contributed a lot to the understanding of aesthetic experience features. Science, art and creativity are not really distinctively different entities. The parallelism seen between the properties of art and organizational principals of the brain has been highlighted through neuroaesthetic studies. Aesthetic as a subjective experience has comprehensively been studies through neuro-scientific, psychological, sociologic and cultural standpoints.

This is a controversial topic in cognitive neuroscience, meanwhile seemingly varied results of the conducted researches in this field may be conceptualized in a framework linking aesthetics to neuroscience of affective visual processing, reward circuitries and the nature of decision making. Approaching the question of art-brain parallelism, is along side with elucidating the relation between perception and aesthetic experience,and the features of aesthetic judgment and reward. Moreover, other factors such as cultural underpinnings undoubtedly come into play.

In this review we used expert opinions and literary notions to present a report on how neuroscience has so far elaborated on different features of the aesthetic phenomenon hoping to probe areas of neuroaeshetic research which can potentially assess our cultural interface with the aesthetics and cognitive neuroscience.

Key Words:
Neuroaesthetics,
Visual Art,
Synaesthesia,
Neural Circuitry,
Perception

1. Introduction

In neuroscience, art is believed to have a divergent scope for problem solving (Zeki,1999). An artist focuses on ordinary every day happenings in depth, uses the higher cortical abilities of the brain, but finally what makes the artistic work out of his/her creativity is an output of the emotional system at subcortical level. In fact artists utilize the combinatorial properties of visual attributes to generate aesthetic effects. (Zeki, 1999; Leder, Belke, Oeberst & Augustin, 2004; Kawabata & Zeki, 2004; Chatterjee, 2011).

Today the controversial concept "neuroaesthetics" is being argued in areas not limited to philosophy, psychology and sociology (Zaidel, 2005).

Over the past two decades the experimental scientific approach to neuroaesthetics is the focus of scientists attention. Quantitative and qualitative analysis of data entering the brain in terms of structure, coding and interpretation, leads to clearer insights for aesthetic neuropsychological investigations over emotional and rational features of this phenomenon. Today studies are advantaged through more mature domains on inquiry and investigational modalities in cognitive neuroscience, not limited to fMRI, ERP and transcranial magnetic

**** Corresponding Author:***
Mohammad Torabi Nami MD, PhD,
Department of Neuroscience, Cognitive Studies. Institute for Cognitive Sciences Studies (ICSS), No. 17, Pezeshkpour St., Valiasr Ave. Tehran 15948, Iran. Phone: +98917 314 0076. Fax: +987112309199.
E-mail: torabi_m@iricss.org

stimulation. (Leder, Belke, Oeberst & Augustin, 2004; Chatterjee, 2011).

Literacy, emotional intelligence, social and cultural particulars are potential confounders affecting the quality of aesthetic perception of individuals in neuropsychological studies. The drastic effect of combined emotional and expressive presentations arising from higher cortical functions, have long been reviewed in Wittgenstein, Locach and Freud theories (Cupchik & La szlo, 1992).

The neuropsychological approach, leaves the artistic evaluation of "art" to the "artists", however where experiments in interpersonal relations and sociologic aspects of aesthetic perception are being done, a more comprehensive neuroscientific understanding of creativity and aesthetics is in place. Such a scientific approach will serve implications in every day information processing through aesthetic viewpoint (Zaide, 2005;Ashayeri, 1990; Ghasemzadeh, 2006).

To reach this, scientists in the field of aesthetics from both eastern and western countries need to share their sociologic, cultural and scientific insights at expert forums.

In Iran, although only few studies and comprehensive reviews have been done so far, the perspective encourages further works to further elaborate on the neuro-scientific features of aesthetic experience amongst Iranians. Studying aesthetic experience in Persian culture is at it first steps; although Iranian culture is unique and rich in visual Islamic art, carpet and rug design and architecture, no local study have applied Persian art to examine our neural localization of aesthetic processes. (Ashayeri, 1990; Ghasemzadeh, 2006)

There have been lots of researches leading to several theories on elucidating the cognitive contents of art and the basis of creativity, which could have been reached merely through the way one percepts visual or auditory arts and explaining his/her emotional reaction to them. There are points where art and neuroscience vividly embrace and this has been the rationale for all works aimed to discover the features of that commonality. The aim of this review is to commence some aspects of a recent controversial debate: Neuroaesthetics.

Neuroaesthetics as a term coined by Zeki (1999) refers to the investigation of beauty perception of neural bases in art. The current report, mainly focuses on visual art through a neuroscientific view.

Zeki's approach to art lies on his precise understanding of what is called the seeing brain and focusing on constants i.e. unchanging aspects of objects and situations he could model to obtain the true knowledge about our surrounding environment (Zeki,1999). In this model, our brain just like an artist would discard unnecessary inputs from the visual world in order to represent the appropriate characters of the seen objects.

Withstanding Zeki's parallelism hypothesis and its conceptual strength, studying the basic neural mechanisms contributing to the brain response to art and defining the aesthetic experience is considered as quite a complex issue.

Going over the so far done investigations, there is a noticeable heterogeneity across results of studies which have attempted to clarify the neural correlates associated with aesthetic feelings. One of the reasons for such discrepancy may also be the lacking consensus on the definition of 'aesthetic feelings'. Therefore, it is crucial to define what notion of aesthetic we refer to prior to reviewing the empirical findings and putting them into comparison. Some investigators have used the brain to address the psychology of aesthetics (Kawabata & Zeki, 2004; Vartanian & Goel, 2004) and some applied the aesthetic objects to probe properties of the brain (Reber, Schwarz &Winkielman, 2004; Leder, Belke, Oeberst & Augustin, 2004; Locher, Krupinski, Mello-Thoms & Nodine, 2007).To us, the former approach seems to generate more consistent and rational models.

In this review, an aesthetic experience is one that allows us to perceive, feel and sense an artwork which would activate our sensory, emotional and cognitive biomechanisms. In the current report we confine the scope to the neuroaesthetics of visual arts and will describe the relative findings discussing their relevance within the span of the above definition.

The Aesthetic Experience and its Neural Attributes

The aesthetic experience of a visual artwork begins with a visual analysis of the stimulus which then undergoes further levels of processing. The complex process of aesthetic experience is under impact of some biological and embodied mechanisms which in turn can be modulated by variables like the individuals interest in the art work, prior knowledge about the stimulus and overall familiarity (Reber, Schwarz &Winkielman, 2004). Based on this, the other possible reason for the heterogenicity in the result of the studies dealing with neuroaesthtics is that they have considered different processing levels of aesthetics (Leder, Belke, Oeberst & Augustin, 2004; Locher, Krupinski, Mello-Thoms & Nodine, 2007).

The emotions which are associated with the aesthetic experience and the cognitive processes producing the sense of reward in an individual are even more fundamental to be of distinction. This distinction signifies concepts of aesthetic pleasure and appraisal, which are related to emotional and cognitive components of the aesthetic experiences, respectively.

How Reward and Aesthetics Correlate

The study of neuroaesthetics has mostly dealt with aesthetic appraisal, in that participants are usually asked to explicitly judge a visual stimulus either as beautiful or ugly. Kawabata and Zeki (2004) applied fMRI to study the neural correlates in perception of beauty when observing different categories of paintings (landscapes, still life, portraits, etc.) which were judged by participants as beautiful, neutral or ugly. The core imaging results showed different brain activations for judged-beautiful stimuli versus both neutral and ugly images in medial orbitofrontal cortex (OFC). The observed activation on OFC was diminished than baseline when subjects judged stimuli ugly and conversely they evoked highest level of ac-

tivation in OFC when judged stimuli beautiful. Such studies have not yet sorted out how much of the aesthetic experience resides in a perceptual experience and how much resides in the emotional response to artwork. This is indeed a challenging probe question.

Although fMRI revealed that Paintings of landscapes are likely to activate the para-hippocampus, still lives lateral occipital cortex, and portraits the fusiform gyrus, findings of localized brain activities to a specific stimuli only would guide us towards the mental processes involved rather than confirm a one-to-one correspondence fact. Other confounders such as cultural factors, mood, memory, emotions and in general, the inner psychophysics make conceptualization of such findings even more complex.

Vartanian and Goel (2004) used the same methodology to implement an event-related fMRI study, inwhich the examinees were required to explicit aesthetic preference for tangible versus abstract in three different stimulus-versions: originals, altered and filtered. Participants were asked to press a button on each stimulus presentation to indicate their preference. Tangible and concrete paintings evoked higher preferences than abstract paintings. In both categories, the original paintings were the ones with the highest preference. Since the brain imaging revealed diminished activation in caudate nucleus on decreased preference for observed paintings, this may suggest that aesthetic experience is also reliant to areas processing the stimuli with reward properties (Delgado, Locke, Stenger & Fiez, 2000).

The study additionally revealed that the more preferred the presented paintings were, the more was the activation in distinct areas including the left anterior cingulate cortex (ACC) which is a known area for reward related processing of the stimuli with varied emotional valence (Devinsky, Morrell &Vogt,1995).

Visuomotor Processing Along with Aesthetics

In a recent investigation by Cela-Conde et al.,(2009) gender-related similarities and differences in the neural correlates of beauty using magnetoencephalography (MEG) was studied. Conde and his team used a set of images of both artistic paintings and natural objects, segmented into five different art categories: abstract, classic, impressionistic, postimpressionistic, photographs of landscapes, artifacts, urban scenes and true-life depictions. MEG, demonstrated enhanced activation for 'judged-beautiful versus judged-ugly' stimuli in different parietal foci, bilaterally for women and mainly in the right hemisphere for men. The latency was 300 ms after stimulus offset.

In another recent aesthetic fMRI study by Cupchik et al. activation of parietal foci during the aesthetic experience was reported (Cupchik, Vartanian, Crawley& Mikulis,2009). In Cupchik's work, participants viewed various categories of representational paintings, i.e. portraits, still life and landscapes mainly classified as "hard-edge" and soft edge where the paintings contained well- defined and ill-defined forms, respectively.

The rationale for this classification was based on the hypothesis that 'soft-edge' visual stimuli should facilitate aesthetic feeling through stimulating active image construction. This is in compliance with Birkhoff's theory and equation for aesthetics where orderliness divided by complexity (M=O/C) defines aesthetic innate character of stimuli. In their appraisal both 'hard'-edge and 'soft'-edge paintings were presented to participants in two different circumstances: one that engaged participants to observe the images in an objective and detached manner to gather information for the content of the stimulus and one that required them to observe the paintings in a subjective manner to appreciate and report their feelings evoked by the stimuli (pragmatic and aesthetic conditions respectively). What the examiners observed was enhanced activation of the left superior parietal lobe for the 'soft-edge' artworks, especially in 'aesthetic' condition (Zaide,2005; Ashayeri, 1990; Ghasemzadeh, 2006). Visuo-spatial coding is occurred in parietal regions and activation of these areas during aesthetic experience (Kawabata &Zeki,2004; Cela-Conde et al,.2009; Cupchik, Vartanian, Crawley & Mikulis,2009) support the interrelated aspects of these two entities processing. There is now cumulative evidence denoting that posterior parietal regions including inter-parietal areas play a distinctive role in visuomotor transformation (Fogassi & Luppino, 2005).

In Jacobsen et al. study using fMRI, engagement of parietal and premotor areas in aesthetic experiences was noted (Jacobsen, Schubots, Hofel & Cramon, 2006). In that study the participants were asked to appraise abstract geometrical shapes that their symmetry and complexity level had been_ somehow_ manipulated. Symmetry followed by the stimulus complexity was observed to markedly affect the aesthetic judgment.

Results of the imaging showed that in the comparison of symmetry judgment and aesthetic judgment tasks versus the control condition (an arrow observation by participant), there were enhanced activation in areas involved in visuo-motor processes, namely, intraparietal sulcus and the ventral premotor cortex (Di Dio, Macaluso & Rizzolatti,2007). Symmetric patterns are shown to be perceived more beautifully than non symmetric ones. This is due to the conjoint activation of intrapariatal sulcus both for symmetry and beauty judgment (Chatterjee, 2011). Looking at the traditional Iranian and Islamic visual arts, symmetric patterns are abundantly evident. The so called "Islimi" patterns all look symmetric.Persian rug patterns are also the same however this kind of symmetricity is less observed in western art (Fig 1).

"Are symmetricity and complexity considered as universal components of beauty and, have they shared neural underpinnings for aesthetic perception in western and eastern communities?", is the question deserving dedicated research to address.

Francis Hutcheson (1694-1747) who stated the fundamentals of classic theory considered the embodied intellectuals of the human as his sixth perceptual sense by which he perceives the characteristics of the visual stimuli. There are artists who strongly have the ability to interrelate and transform sensory

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Figure 1. Symmertic pattern evident in an Iranian tile painting block, is considered specific to aesthetic judgment: youngartists.com/islamic

stimuli and perceive them in other ways. For instance they paint the music or listen to paintings. Seeing sounds or listening to colors (Synesthesia) is an extraordinary ability of these artists in creating unique artworks. These artists in a sense are more contributing to neuroscientific understanding of art by exploring the potentials and capacities of the brain, though with different tools. The way that these creations evoke aesthetic experiences can only be fully understood in neural terms. Such an understanding is now well within our reach. The first step is to get to a better understanding of the common organization of our visual and emotional brains, before we can even proceed to enquire into the determinants of neural variability. But there is no reason to doubt that a study of variability, of how a common visual activation can arouse disparate emotional states, will constitute the next giant step in experimental studies of the visual brain (Zaide,2005; Ashayeri, 1990).

Artists create the object that stimulates states of our perception by intuition or by trial and error. Art is the human creativity and like all human activities depends upon and obeys the laws of the brain however sometimes there are minor exception to those laws, one of those exceptions is synesthesia which is inter relation between sensory perceptual abilities.

While reviewing the artistic works of some contemporary painting art masters we heard about their cross-sensory abilities in creation of their art works. Over discussions we had in depth with Manouchehr Niazi, one of the synaesthetic painting masters and reviewing his works, He claimed that he can clearly "see" a classical music part from Franz Schubert when looks at one of his paintings. He states that the image of classical music parts of Ludwig Van Beethoven and Franz Schubert are evident in a sense in some of his paintings. He draws the music he listens to, and interestingly, the output is a landscape. This can be a typical example of syneasthesia in visual art. These representations deserve case oriented investigations to be more elucidated in nature (Fig 2).

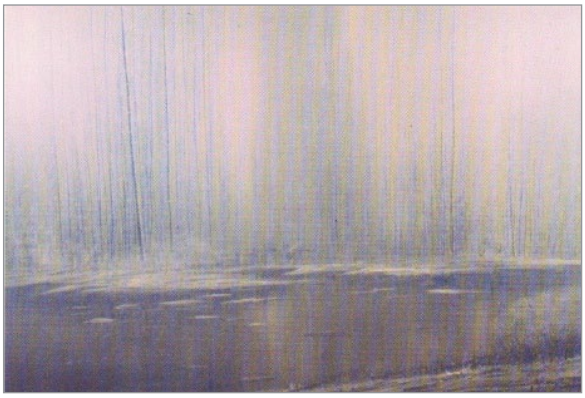

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Figure 2. The synaesthetic experience. A Schubert's classical music part turned into a painting.
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Aesthetics and Personification in Concrete Form

Based on recent proposed theories, a crucial element of aesthetic experience of artworks consists of the activation of the embodied simulation of actions, emotions, and corporeal sensations, where these mechanisms are universal and referrers to embodiment theories (Freedberg & Gallese,2007). This notion has challenged the preferred role and primacy of cognition in our responses to art (Warburg& Forster,1999; Cupchik, La szlo,1992; Zaide,2005)

According to the phenomenological traditions in philosophy, the empathic nature of the relationship automatically established between artworks and beholders is what helps in judging the aesthetic aspects of what is named visual art (Warburg& Forster,1999; Berenson, 1896; Rizzolatti & Sinigaglia,2007).This phenomenon has been more strongly described upon discovery of mirror neuron mechanism(Cupchik & La szlo,1992). Therefore the embodied view of aesthetic experience refers to two issues : first, the relationship between embodied simulation-driven empathic feelings in the observer and the representational content (here, the visual art), next, the relationship between embodied simulation-driven empathic feelings in the observer and the visible traces of the artist's creative gestures (i.e. brushwork and signs of the movement of the painting artist's hand, for instance) (Zaidel,2005).

In a recent study by Di Dio and his associates (2007), participants who were encountered visual stimuli as classical and

Renaissance sculptures (standing gestured man) had elicited activation in their ventral premotor and posterior parietal cortex viewed in fMRI suggesting the motor resonance congruent with the implied posture and movement portrayed in the sculptures. This finding further supports above theory for aesthetics and embodiment.

Aesthetics and Emotions

In most investigations the experimental setting is seen as the main problem since it is quite difficult to induce the proper mind state in participants especially where EEG, MEG and fMRI studies are in place (Di Dio, Macaluso & Rizzolatti, 2007; Rizzolatti & Sinigaglia,2007; Hofel, Jacobsen,2007;Smith,2005).

In studies to search for very subtle human abilities, the examinees attitude (Hofel, Jacobsen, 2007) and intention (Smith,2005) are crucial in translation of a visual experience to an aesthetic one.

Making an explicit judgment is required to evoke distinct mind-states which however can mask the basic neural processes.

Results of various investigations on aesthetic perception and emotion support an overt neural correlation between these two entities and show, at basic levels of processing, aesthetic preference is mediated by core emotion centers, namely the insula and the amygdala (Damasio, 1999; Chatterjee,2011; Damasio et al.,2000; Phelps & Le Doux,2005; Koelsch &Siebel,2005).

Future Directions

There are unveiled aspects of neuroaesthetics which really deserve precise investigations to be understood.

Do we first have the "conscious perception" or the "aesthetic feeling" of the visual art?. Which comes first?. Does ventral visual cortex choose to attend more to beautiful objects?. Is there any way we can explore the relation between attention, emotional memory and aesthetic perception?. What is the nature of aesthetic judgment?. How does reward system contribute to the aesthetic feeling?. And a lot of more of such interesting probe issues to which one can devote his/her career to explore and understand. Neuroscience technologies are valuable means for pursuing our aims in future neuroaesthetic research.

Conclusions

Although researchers of the herewith reviewed works have arrived at some preliminary insights regarding the localization of activated cortices in perceptual process of visual art, exploration of the relationship between the aesthetic experience and perception, defining the nature of aesthetic judgment and characterization of aesthetic reward is yet to be done. Scientists are still at the beginning of the journey towards a good understanding of neuroaesthetics.

Cumulative evidence suggest that aesthetic experience of visual art is commenced by visual description of art work where followed by emotional processes and sensorimotor mechanisms. The effective aesthetic response to visual art is mainly brought about through distinct attributes of visual art such as color, line, texture and form. Measuring the contribution of every single one of these attributes to the aesthetic feeling is really tempting. Cross cultural differences in perception of beauty call for further multi faceted cognitive neuroscience studies using investigational tools not limited to fMRI, EEG, ERP, MEG by which such important questions like "whether aesthetic experience shares common neural bases across different artistic domains and community cultures" could be addressed.

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