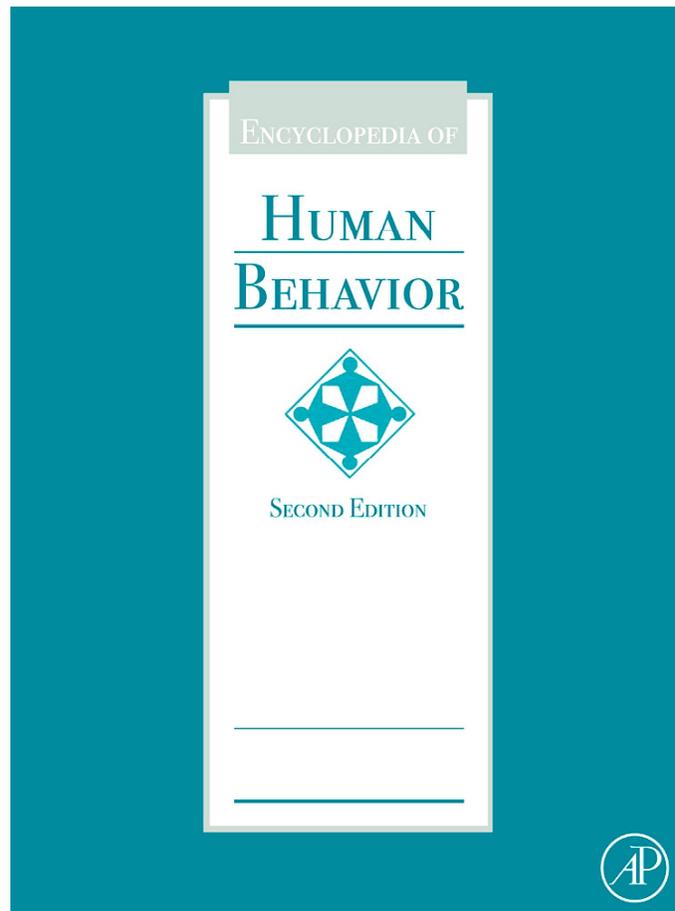


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Gallese V. and Di Dio C. (2012) Neuroesthetics: The Body in Esthetic Experience. In: V.S. Ramachandran (ed.) *The Encyclopedia of Human Behavior*, vol. 2, pp. 687-693. Academic Press.

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Neuroesthetics: The Body in Esthetic Experience

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Glossary

Esthetic appraisal The subjective evaluation of an object based on an introspective identification of the emotional responses to the object. It is not the expression of high-order cognitive considerations and mechanisms, but rather of association processes between the perceptual object and the beholder's emotional memories. It answers the question: 'Do you like it?'

Esthetic attitude The implicit mindset enabling to appreciate the esthetic content of the contemplated object by focusing attention to its esthetic qualities. It leads to esthetic experience.

Esthetic experience The response to perceptual objects consisting of the embodied simulation of the actions, emotions, and sensations that the content of the object evokes in the beholder. Such experience is not necessarily confined to the appreciation of artworks, although this is grounded on it.

Esthetic judgment The explicit esthetic rating of an object according to culturally and socially determined esthetic canons. It represents the most cognitive aspect of the relation established with artworks. It answers to the question: 'Is it beautiful?'

Introduction

In the last few decades, cognitive neuroscience has extended its field of investigation to the domain of art, focusing in particular on music and visual arts. For the sake of concision, in the present contribution we will exclusively deal with the neuroscientific investigation of esthetic experience in visual arts. The term currently employed to define this approach is neuroesthetics.

The term neuroesthetics was coined by Semir Zeki referring to the study of the neural bases of beauty perception in art. Zeki's approach to art is closely related to the definition he provides for the functioning of the visual brain, namely a search for the constancies (unchanging properties) of objects, situations and so forth, with the aim of obtaining true knowledge about the world. In this process, the brain (as the artist) needs to discard inessential information from the visual world in order to represent the real character of an object in an enduring manner. For instance, when defining color constancy, the brain needs to discard information regarding the exact composition of the wavelength reflected by objects' surfaces; with dimension, inessential information is the precise visual distance; whereas, with form, it would be the exact viewing angle. It is in this selection process that the brain is able to retain and categorize never-changing information about a world that, on the other hand, is in continuous transformation.

In brief, according to Zeki "the overall function of art is an extension of the function of the brain: the seeking of knowledge in an ever-changing world." It is for their ability of capturing the essential elements of the world that artists, according to Zeki, can be defined as 'natural scientists' able to elicit an esthetic response in the creative brain of the observer.

Another noteworthy construal of esthetic experience viewed from a neuroscientific perspective is that of the neurologist V.S. Ramachandran. Ramachandran's approach to neuroesthetics is concerned with the unfolding of 'universal rules' that govern beauty perception in art. The description of these 'universals' relates to the way in which visual perceptual rules can account for art processing in an observer and, most importantly,

to their underpinning brain mechanisms. In particular, Ramachandran's theory rests on the interaction between cognition and physical pleasure, which is claimed to be rooted in the human biological makeup. Indian representations of women's body, for example, often reflect attention to primordial elements that recall the idea of procreation, such as pronounced hips and breasts. This concept is accounted for by the 'universal' of *emphasis*.

As with Zeki's approach, Ramachandran's description of artistic experience ultimately results in the pleasure gathered from the unfolding of perceptual elements that capture conceptual cores. For example, *grouping*, a perceptual process that allows the brain to extract a figure from the background, may be an enjoyable process. Pleasure would be the ultimate stage of an evolutionary driven motivational process, whereby individuals' survival depends on the necessity to discover alerting events in the environment, such as predators. In this way, attention is drawn toward important features. According to this perspective, perceptual grouping comes about as reinforcement to early vision at every stage of visual processing. The resolution of visual ambiguity would then result in a pleasant 'aha' experience accompanying the perceptual experience we make of the world. Artists' skill would then hinge upon their ability to evoke these biological perceptual processes in the observer, who is urged upon a creative and pleasurable reconstruction of the observed artistic object.

The study of the brain as it responds to art implies the existence of neural mechanisms entailed in art appreciation that are common to all individuals. The elements that are able to elicit these neural processes, that is, the 'access keys,' though, may be various and variable. In fact, they are under the influence of cultural and experiential constraints that define fluctuating trends over time and across individuals, even within the same cultural frame. When we visit a museum or an art gallery, we do not simply perceive images, but we contemplate objects whose presence in that specific physical space is justified and determined by their status of artworks. Our fruition of art is certainly cognitively mediated because the peculiar quality of our esthetic experience is influenced by our culture,

by the environment in which we were educated, by the esthetic canons informing our time, by our level of expertise and familiarity with the artworks we contemplate.

Both Zeki and Ramachandran's approaches to neuroesthetics resolve this variability problem with the ability of the visual brain to process essential information from the world that remains immutable and that can most naturally find a biological access to the observers' creative mind. Yet, the complexity of the relation that builds between an artwork and the observer compels us to reason beyond the mere, though vital, perceptual – and mostly visual, as accounted for by Zeki and Ramachandran – ability of the brain to capture essential perceptual elements from the environment. In esthetic experience, there are components that, in our view, cannot be disregarded as they constitute the most direct 'access keys' to the observers' comprehension of the artwork; that is, the embodied motor and emotional components of esthetic experience.

Our idea is that through the involvement of sensory-motor processing, the esthetic experience of art allows the beholder to feel the artwork in an embodied manner. More specifically, our hypothesis follows from the proposal by Freedberg and Gallese that the esthetic experience of artworks consists of activating embodied simulation of actions, emotions, and corporeal sensations, and that these mechanisms are universal. Observing the world is a more complex enterprise than the mere activation of the visual brain, as it implies a multimodal notion of vision that encompasses the activation of somatosensory and emotion-related components, within the more general frame of the intrinsic pragmatic nature of every intentional relation with the external world.

Our proposal challenges more standard accounts of esthetic experience privileging the primacy of cognition in our responses to art. In particular, our hypothesis, echoing historical views (see below), stresses the empathic nature of the relationship automatically established between artworks and beholders and capitalizes upon the discovery of the mirror neurons mechanism.

The present article is composed of four sections. In section 'An Historical Perspective: Einfühlung and Esthetic Experience,' we will concisely review aspects of the historical contribution of the notion of Einfühlung (empathy) to esthetic experience and show why we believe that such tradition of thought in esthetics is still highly relevant, if discussed on the basis of recent neuroscientific evidence. In section 'Neuroesthetics: Explicit Appraisal and Reward,' we will chart the available empirical evidence in neuroesthetics in relation with the cognitive aspects of esthetic experience, particularly focusing on the dimensions of reward and of the explicit appraisal of the esthetic value of artworks. In section 'Neuroesthetics: Embodied Approaches,' we will address the putative role of mirror mechanisms in esthetic experience, dealing first with actions and then with emotions.

An Historical Perspective: Einfühlung and Esthetic Experience

Invoking a role for the body in esthetic experience while contemplating visual artworks is an old idea. The notion of empathy (Einfühlung) was originally introduced in esthetics by the German philosopher Robert Vischer in 1873, thus well before

its use in psychology. By Einfühlung, literally 'feeling-in,' Vischer meant the physical responses generated by the observation of forms within paintings. He described how particular forms aroused particular responsive feelings, depending on the conformity of forms to the design and function of the muscles of the body, from those of the eyes to our limbs and to our bodily posture as a whole. Vischer clearly distinguished a passive notion of vision – seeing – from an active one – looking at. According to Vischer, it is the act of looking that best characterizes our esthetic experience when perceiving images, in general, and artworks, in particular.

This account of art perception implies an empathic involvement, which, in turn, encompasses a series of bodily reactions of the beholder. Particular observed forms would evoke specific emotional reactions on the basis of the conformity of the former with the design and functionality of the body of the beholder. According to Vischer, symbolic forms acquire their meaningful nature first and foremost because of their intrinsic anthropomorphic content. Symbols are something different from the indirect manifestation of concepts. It is through the nonconscious projection of her/his body image that the beholder is able to establish a relation with the artwork.

Developing Vischer's ideas, August Wölfflin (1886) speculated on the ways in which observation of specific architectural forms engage the beholder's bodily responses. Very shortly afterwards, Theodor Lipps wrote at length about the relationship between space and geometry on the one hand, and esthetic enjoyment on the other (1897, 1903).

The work of Vischer also exerted a very powerful influence over two other German scholars whose contributions are highly relevant for our present proposal: Adolf von Hildebrand and Aby Warburg. The German sculptor Hildebrand in 1893 published a book entitled *The Problem of Form in Figurative Art*. In this book, Hildebrand proposed that our perception of the spatial characters of images is the result of a constructive sensory-motor process. According to Hildebrand, space does not constitute an a priori experience, as suggested by Kant, but its product. The reality of artistic images resides in their effectuality, conceived both as the end result of the artist's actions producing them and of the effects artistic images produce on the beholder. According to the same constructivist logic, the esthetic value of artworks would reside in their potentiality to establish a link between the intentional creative acts of the artist and their reconstruction on the side of the beholder. In this way, creation and artistic fruition are directly related. To understand an artistic image, according to Hildebrand, means to implicitly grasp its creative process. A further interesting aspect of Hildebrand's proposal concerns his notion of the fundamental motor nature of experience. It is through movement that the available elements in space can be connected, that objects can be carved out of their background and perceived, that representations and meaning can be formed and articulated. Ultimately, according to Hildebrand, sensible experience is possible and images acquire their meaning just because of the acting body.

Hildebrand exerted a strong influence on another famous German scholar, Aby Warburg. Warburg conceived art history as a tool to shed light on the psychology of human expressive power. His famous notion of 'pathemic form' (Pathosformel) of expression implies that a variety of bodily postures, gestures,

and actions can be constantly detected in art history, from Classic art to the Renaissance period, just because they embody in exemplar fashion the esthetic act of empathy as one of the main creative sources of artistic style. According to Warburg, a theory of artistic style must be conceived as a 'pragmatic science of expression' (pragmatische Ausdruckskunde).

Warburg, when describing the classic marble group known as the Laocoon, identified transition as a fundamental element to turn a static image in movement charged with pathos. Several years later, the Russian movie director Ejzenstejn, when commenting on the same Laocoon sculpture, wrote that the lived expression of human sufferance portrayed in this masterwork of classic art is accomplished by means of the illusion of movement. Such movement illusion is obtained by condensing in one image different aspects of expressive bodily movements that could not possibly being visible at the same time.

Phenomenologists such as Maurice Merleau-Ponty further highlighted the relationship between embodiment and esthetic experience. Merleau-Ponty suggested the relevance for art appreciation of felt bodily imitation of what is seen in the artwork. Consistent with the role of *Einfühlung*, Merleau-Ponty also emphasized the importance of the artist's implied actions for the esthetic experience of the beholder, exemplifying it by referring to the paintings of Cézanne. He famously stated that we cannot possibly imagine how a mind could paint.

In conclusion, these scholars and many others believed that the feeling of physical involvement with a painting, sculpture, or architectural form, provokes a sense of imitating the motion or action seen or implied in the work, and also enhances our emotional responses to such work. Thus, it constitutes a fundamental ingredient of our esthetic experience of artworks.

The last sections of this article show how contemporary neuroscientific research can revitalize and shed new light on the role of empathy in art appreciation.

Neuroesthetics: Explicit Appraisal and Reward

The empirical investigation of the basic neural mechanisms underpinning our responses to art and the ensuing esthetic experience are complex issues. There is great heterogeneity across results from investigations trying to clarify the neural correlates associated with esthetic experience of visual art.

The esthetic experience of visual artworks begins with the visual analysis of the stimulus, which then undergoes further processing. This progression may lead to an esthetic experience likely based on biological and embodied mechanisms that can be modulated by factors such as the context, individuals' interest in the artwork, prior knowledge, and familiarity. Thus, one possibility for the heterogeneous results of studies on neuroesthetics is that they may reflect the output of different esthetic processing levels. Even more fundamental is the distinction between the cognitive processes that produce rewarding experiences in the beholder and the emotions directly associated with esthetics. This distinction highlights the concepts of esthetic judgment and esthetic pleasure, which can be related to the cognitive and emotional aspects of esthetics, respectively.

In experimental tasks, the need to explicitly verify participants' subjective judgments leads to self-evaluation and

decision-making processes. These processes imply the involvement of high-order cognitive processes in which the effects of cultural and individual traits may play a crucial role in defining the esthetic experience. These evaluations may interfere with the ultimate goal of neuroesthetics to unfold the basic neural mechanisms involved in esthetic experience shared by all individuals. Thus, the data obtained may only be partially representative of the actual neural underpinnings under investigation or, in some cases, even misleading.

It is important to distinguish between processes underlying esthetic pleasure and those underpinning esthetic judgment. These two processing levels of esthetic experience are tightly bound, yet not interchangeable. Whereas esthetic pleasure is more concerned with an automatic emotional response to artworks, esthetic judgment requires the contribution of explicit cognitive appraisal, holistically grouping the individual's values, knowledge and personal taste, all factors that are influenced by cultural and experiential dynamics. Though separable, these two aspects are strongly related and continuously affect each other during the building up of the esthetic experience.

The study of neuroesthetics has mostly dealt with esthetic judgment, in that participants are typically asked to explicitly judge a visual stimulus either as beautiful or ugly. One of the first attempts to define the neural underpinnings of the esthetic experience of beauty was designed by the founder of neuroesthetics, Semir Zeki. Kawabata and Zeki used fMRI to investigate the neural correlates of beauty perception during the observation of different categories of painting (landscapes, portraits, still life and abstracts) that participants judged beautiful, neutral, or ugly. The brain imaging results revealed different brain activations for judged-beautiful stimuli versus both neutral and ugly images in medial orbitofrontal cortex (OFC). Additionally, comparison between judged-beautiful and judged-neutral images elicited activation in the anterior cingulate gyrus and the left parietal cortex. While showing that functional specialization lies at the basis of esthetic judgments, because during an esthetic experience different categories of stimuli elicit activation of brain areas specifically devoted to their visual analysis (e.g., the fusiform gyrus for portraits), Kawabata and Zeki also discussed OFC differential activation by the observation of beautiful, neutral, and ugly stimuli as an effect of reward.

This latter observation deserves a consideration. Activation of OFC, and particularly of its medial sector, has often been associated to the perception of rewarding stimuli. Reward-related processing may be reasonably expected in esthetic experience as being spontaneously evoked to reinforce behavior that produces positive experiences. This architecture has biological foundations since hedonic sensations associated with rewarding mechanisms are at the basis of the motivation that drives the consolidation of behavior.

These processes have to be distinguished from the basic emotions and sensations that hallmark esthetic experience in the first place, which are of a different nature and that are processed at other neural levels (see below). The activation of limbic structures such as OFC or the cingulate gyrus, found active by Kawabata and Zeki, underpins the involvement of rewarding processes that represent a component of esthetic experiences, though at a more cognitive level of processing.

Further neuroscientific evidence showing that rewarding processes are involved with esthetic experience comes from a

study of Vartanian and Goel. This event-related fMRI study investigated esthetic preference for representational versus abstract paintings in three versions: originals, altered, filtered. Participants explicitly appraised the presented images by entering their response during stimulus presentation and indicating their preference on a rating scale. Behavioral results showed that preference was accorded to representational more than to abstract paintings. In both categories, original paintings elicited higher preference. In terms of brain activations, a decreased activation was observed in the right caudate nucleus extending to putamen in response to decreasing preference for paintings (in depressed patients, low activity in caudate nucleus correlates with decreasing ability to experience pleasure and reward – anhedonia), while activity in left cingulate sulcus, bilateral occipital gyri, bilateral fusiform gyri, and bilateral cerebellum increased in response to increasing preference for paintings. Because the involvement of the striatum in processing emotionally salient and reward-based stimuli is well established, these results suggest, according to the authors, that the decrease in activation in right caudate nucleus in response to decreasing preference may be a specific example of its general pattern of reduced activation in response to less rewarding stimuli. Additionally, increased activation in the primary and extrastriate visual cortices is in line with their role in processing pictures and faces varying in emotional valence.

This evidence suggests that the reward mechanisms are involved in the course of esthetic experience. The pattern of activations observed in OFC (Kawabata and Zeki's) and in the right caudate nucleus (Vartanian and Goel) indicate that both brain structures respond with decreased activation, with respect to baseline, to esthetic stimuli. Decreased activation, in both instances, is more pronounced for stimuli judged of poorer esthetic value.

Neuroesthetics: Embodied Approaches

The Motor Component of Esthetic Experience

The biological mechanism upon which embodied theories of esthetic experience rest is the mirror neurons mechanism. Mirror neurons are motor neurons originally discovered in the ventral premotor cortex of macaque monkeys (area F5) that discharge when the monkey executes goal-related hand motor acts such as grasping objects, and also when observing other individuals (monkeys or humans) executing similar acts. Neurons with similar properties were later discovered in a sector of the posterior parietal cortex reciprocally connected with area F5. Mirror neurons provide the neurophysiological basis for primates to recognize different actions made by other individuals: the same neural motor pattern characterizing a given motor act when actively executed is also evoked in the observer when witnessing the motor behavior of others.

This matching mechanism has also been shown in humans, both indirectly by means of brain imaging techniques and, more recently, at the single neuron level. Furthermore, empirical evidence suggests that the same neural structures that are involved in the subjective experience of emotions and sensations are also active when we see others express the same emotions and sensations. A whole range of different 'mirror

matching mechanisms' is present in the human brain. These mirroring mechanisms have been interpreted as constituting a basic functional mechanism in social cognition, defined by Gallese as embodied simulation.

Since the activation of the mirror mechanism for action is typically induced by the observation of ongoing actions, its relevance for the esthetic experience while contemplating static artworks could be negligible. However, even the observation of static images of actions lead to action simulation in the brain of the observer, through the activation of the same brain regions normally activated by execution of the observed actions.

The significance of mirror neurons in understanding esthetic responses to art has not been fully assessed. Freedberg and Gallese recently proposed that a fundamental element of esthetic response to works of art consists of the activation of embodied mechanisms encompassing the simulation of actions, emotions, and corporeal sensations. As we have shown above, historically, theorists of art have commented on a variety of forms of felt bodily engagement with works of art, but the mechanisms by which this happens have remained unspecified or entirely speculative. Mirroring mechanisms and embodied simulation can empirically ground the fundamental role of empathy in esthetic experience. Freedberg and Gallese's theory of empathic responses to works of art is not purely introspective, intuitive or metaphysical, but has a precise and definable material basis in the brain/body system.

This theory is articulated in two complementary aspects. (1) The relationship between embodied simulation-driven empathic feelings in the observer and the content of artworks, in terms of the actions, intentions, objects, emotions, and sensations portrayed in a given painting or sculpture. This aspect can be viewed as the 'what' of esthetic embodied experience. (2) The relationship between embodied simulation-driven empathic feelings in the observer and the quality of the artwork in terms of the visible traces of the artist's creative gestures, such as brush work, chisel marks, and signs of the movement of the hand more generally. We can refer to this component as the 'how' of esthetic experience (see also next section).

The sensory-motor or 'cold' component of the mirror mechanism includes the activation of parietal and premotor areas, which have been often found active in neuroesthetic studies. The recent work by Di Dio and colleagues provides suggestive evidence compatible with this hypothesis. In this investigation, the observation of Classical and Renaissance sculptures elicited activation of the ventral premotor cortex and of the posterior parietal cortex, suggesting motor resonance congruent with the implied movements portrayed in the sculptures. The observation of sculptural representations of the human body, although depicted in a bidimensional image viewed under an unnatural context like that of an MRI scanner evokes motor resonance congruent with the implied movements portrayed in the sculptures and underpinning an embodied comprehension of the observed object. In other words, we do not only see an artwork with our eyes – and our visual system, but also experience it with our body as the repository of our potentialities for action.

The involvement of parietal and premotor areas in esthetic experience was also observed in the fMRI study of Jacobsen and colleagues. In this study, participants were required to make an esthetic appraisal of abstract geometrical shapes, whose

symmetry and level of complexity had been manipulated. Brain imaging results indicated that, in both the comparisons of symmetry judgment and esthetic judgment tasks versus the control condition (observation of an arrow), activations were enhanced in areas subserving visuomotor processes, including the intraparietal sulcus and the ventral premotor cortex.

Additional evidence in this respect comes from a study by Cela-Conde and colleagues, in which gender-related similarities and differences in the neural correlates of beauty were investigated. The experimental stimuli consisted of a set of images of either artistic paintings or natural objects, divided into five groups: abstract art; classic art; impressionist art; postimpressionist art; photographs of landscapes, artifacts, urban scenes, and true-life depictions. Through magnetoencephalography (MEG), which allows studying the various temporal stages of brain stimulus processing, enhanced activation for 'judged-beautiful versus judged-ugly' stimuli in several parietal foci was shown, bilaterally for women and mainly in the right hemisphere for men, with a latency of 300 ms after stimulus offset.

In humans, as in monkeys, the posterior parietal cortex is involved in the organization and recognition of action. Physiological and anatomical studies on macaque monkeys suggest that the posterior parietal cortex is part of the motor system. It has been shown that posterior parietal areas map different motor acts (such as grasping) on the basis of the goal of the action (such as eating) of which they are a component. This functional organization, shared by posterior parietal and ventral premotor areas, likely underpins high-order cognitive functions, such as understanding others' basic motor intentions through an embodied simulation mechanism. These functions have been observed in the inferior parietal lobule (IPL) where visual information of ventral and dorsal stream is integrated with motor information, to build a pragmatic description of the observed object.

Most studies in neuroesthetics show activation of parietal and, in some cases, premotor areas. This evidence supports the idea that esthetic experience is strongly characterized by visuo-spatial coding as well as, importantly, by motor mapping. The exact role of the motor component, though, can be better understood when considering this aspect of esthetic experience as the automatic access to emotional levels of stimulus processing. This aspect of esthetic experience is the focus of next section.

Emotion in Action

Emotions and sensations represent the esthetic quality that characterizes the success of the relationship established between the observer and the artwork. This concept can be readily understood when thinking of explicit visual representations of human emotional states, with which the observer can automatically relate through the mirror neurons mechanism. In this stance, embodied simulation mechanisms are in place, likely mediating the empathic feeling arising in the observer toward the representational content of the artwork.

A representative example of the idea of bodily empathy experienced by art viewers is given by I Prigioni (the Prisoners), a series of unfinished sculptures by Michelangelo. Through the observation of these sculptures, viewers are led to experience the struggle of the prisoners to free themselves from the

stone. The effect of the struggle is expressed through the effective and forceful representation of the muscles carved from the stone. In this example, one can appreciate the relevance of embodied simulation in art, whereby the mere visual description of the artwork develops into an esthetic experience in which the bodily sensation felt by the viewer is in consonance with the artist's intention to ultimately convey a specific emotional state. The expressed or implied movement within the representational content of a work of art becomes the vehicle through which viewers can find an automatic access to those emotions and sensations that underpin the esthetic experience.

On what grounds, though, can we describe the human tendency of ascribing feelings and emotions to inanimate objects, independently of their abstract or concrete nature? Philosophical accounts of emotion in esthetics suggest that emotion ascription to nonsentient objects is due to imagination processes that either associate or impute states of mind to the object as representative of the emotion state of the artist or of the character depicted in the artwork.

These accounts differ considerably from our conception of an emotional embodied esthetic experience. For example, what is there in the representation of a landscape displaying the violence of the blowing wind if not the marks left behind by the artist's violent brush strokes? The observers' eyes catch not only information about the shape, direction and texture of the strokes, but most importantly – by means of embodied simulation – breach into the actual motor expression of the artist when creating the artwork.

Observers are likely able to appreciate the violent nature of the artwork because those brush strokes feature the movements they resonate with by means of the mirror mechanism. In this example, the artwork becomes the mediator of the motor and emotional resonance that establishes between the artist and the observer. The sensory-motor component of stimulus processing represents the most direct and automatic level of processing, which allows the beholder to feel the artwork in an embodied manner.

The marks on the painting/sculpture are the visible traces of goal-directed movements, hence capable of activating the relevant motor areas in the observers' brain, as suggested by the mirror neuron research. While at present there are no published experiments specifically targeting this issue, there is empirical evidence indirectly suggesting that this could be the case. Studies by Longcamp and colleagues show that motor simulation is induced in the observer's brain also when observing the static graphic consequence produced by the action, such as a letter or a graphic stroke. This shows that our brain can reconstruct actions 'a posteriori' by merely observing the static graphic outcome of the agent's past action. We posit this reconstruction process during observation to be the expression of the embodied simulation mechanism, relying on the activation of the same motor centers required to produce the observed graphic sign. We predict that similar results could be obtained using as stimuli artworks characterized by peculiar gestural signs of the artist, as in the case Fontana's or Pollock's works.

The relationship between esthetic experience and emotion was recently revealed by the abovementioned fMRI study by Di Dio and colleagues. Analyses of the imaging data showed that esthetic experience of artworks is marked by an emotional

component that is processed at different anatomical levels. The areas involved in the emotional portrayal of esthetic stimuli were the insula and the amygdala.

In this experiment, Classical and Renaissance sculptures were presented in two versions: originals and proportion-modified. The distinctive feature of this study was to allow participants to observe the images without expressing any explicit judgment. In the attempt to induce the required implicit 'esthetic attitude,' participants were instructed to examine the images as if they were in a museum (as much as they could in a scanner). Explicit esthetic and proportion evaluations were required only in subsequent conditions. Imaging results showed that the observation of original sculptures, relative to the modified ones, produced activation of lateral and medial cortical areas (lateral occipital gyrus, precuneus, and prefrontal areas) and, importantly, of the right anterior insula. Activation of the insula was particularly strong during simple observation condition, in which observers, hence their brain, responded most spontaneously to the presented images.

The contrast of canonical versus proportion-modified images in the study of Di Dio and colleagues highlighted the brain areas that preferentially code for esthetic stimuli, so defined by their intrinsic physical properties. In particular, insular activation may be involved with a matching mechanism relating the artwork or some of its attributes with some descriptive processing levels in the beholder's brain. We can define this kind of esthetic experience an 'objective' one: it emerges from the processing of sensory-motor input and, crucially, from the feeling of pleasure, mediated by the activation of the insula.

Though, esthetic experiences are only partially built on objective measures. In order to separate the objective esthetic value from subjective esthetic evaluation, a further analysis was carried out, contrasting brain responses to liked versus disliked images as judged by each participant during the explicit esthetic judgment condition in which they were asked how much they liked the displayed stimuli. Here, preferred stimuli selectively activated the right amygdala, a brain structure mapping the emotional salience of stimuli for the observer. These results support the idea that the more 'subjective' aspect of esthetic experience is mediated by association processes with the observer's own emotional experiences.

Overall, these results suggest an overt neural link between esthetics and emotion, showing that core emotion centers like the insula and the amygdala mediate esthetic preference, at least at basic levels of processing.

Of particular interest for the emotional and sensory comprehension of an artwork is insular activation and, more specifically, its anterior portion. Anterior insula is often found active in studies investigating social empathy or emotional mirror resonance. The anterior sector of the insula has an agranular/disgranular structure and is characterized by its extensive connections with prefrontal and premotor areas as well as with limbic structures and with centers involved in autonomic functions. Functionally, the anterior insula is thought to mediate feelings and the behavioral dispositional attitudes associated to specific emotional states. It is plausible to assume that insular activation during esthetic experience mediates the specific esthetic quality defining artworks and the feelings associated

with them by bridging evoked motor resonance with the associated emotional state.

A study by Cupchik and colleagues supports this idea. In this study, participants viewed various categories of representational paintings (portraits, nudes, still-life, and landscapes) that were classified as 'hard-edge' (containing well-defined forms) and as 'soft-edge' (containing ill-defined forms). The underlying rationale for this classification was based on the hypothesis that 'soft-edge' paintings should facilitate esthetic experience by stimulating active image construction. Both 'hard'- and 'soft'-edge paintings were presented in two conditions: one that required the participants to observe the images in an objective and detached manner to gather information about the content of the stimulus (pragmatic condition), and one that required the participants to observe the paintings in a subjective and engaged manner, appreciating the feelings evoked by the stimuli (esthetic attitude condition).

Observation of representational paintings under the esthetic attitude condition versus baseline condition (viewing of non-representational paintings accompanied by no explicit task-related instructions) elicited bilateral activation of the insula, suggesting that this area is crucially implicated in the emotion feeling specifically associated with esthetic experience.

Like in the paper by Di Dio and colleagues, in this study too insula activation was particularly enhanced in conditions in which no explicit judgment of the stimulus was required, but where participants were induced to appreciate the artworks by explicit instruction given prior to scanning. Under these conditions, observers viewed the artworks with an implicit 'esthetic attitude.' In an experimental setting, explicit judgments are usually required to induce specific task-related states of mind that, however, may mask basic neural processes. In fact, self-evaluation and decision-making processes may diminish spontaneous hedonic responses associated with stimulus processing. Intention guides attention, and this is possibly the reason why participants' intention and 'attitude' play a crucial role in the classification of a visual experience as an esthetic one.

Conclusions

More than being a discipline, neuroesthetics is a specific field of neuroscientific investigation that has just begun to identify the functional relationship between the brain/body system and esthetic experience. One crucial problem concerns the specific quality of esthetic experience related to artworks. To which extent the same perceptual content – the beauty of a sunset – evokes the same esthetic experience when observed in nature or in a painting by Turner? Does the a priori definition of an image as an artwork affect the esthetic experience of the perceived object qua artwork? And does it entail the activation of specific brain mechanisms? These are only some among many excruciating questions neuroscience can perhaps help to answer.

The term esthetic experience connotes a multilayered state in which several dimensions can be distinguished. The current available evidence suggests that specific attention must be paid to the distinction between mere observation, esthetic attitude, esthetic appraisal, and esthetic judgment. These different ways

of relating to an object are apparently underpinned by different brain mechanisms. It is possible that what really counts in esthetic experience is not the quality defined a priori of an object as artwork, but the way we decide to relate to it. Such decision can dramatically modulate the quality of an esthetic experience. A variety of contextual and culturally determined factors affect this decision.

The contemporary way of appreciating artworks is historically and culturally determined. However, while believing that esthetic experience is multilayered, we still posit it to be grounded on a core component without which it cannot be fully understood. We posit that this component can be found in the variety of embodied resonance mechanisms we concisely reviewed in the present article.

Art is the ripe fruit of the way in which human beings at a given point of their cultural evolution were able to relate with the external world. The material world was no more exclusively considered as a domain to exploit for the utilitarian satisfaction of biological needs. Material objects lost their unique status of tools to become symbols, public epiphanies able to make visible something absent, something that apparently is only present in the mind of the artist and of the beholder. Human beings, thanks to the expression of their artistic creativity, acquired the possibility to give shape to material objects, conferring them a meaning they intrinsically lack. Such meaning is the outcome of the artist's action of laying colors on a canvas or turning a marble block into a David or a Proserpina's Rape. Today cognitive neuroscience has the tools to shed new light – from its own peculiar and reductionist perspective – on the esthetic quality of human nature and its natural creative inclination. This new research field has the potentiality to help us understand how and why artworks are probably the most fundamental expression of our human nature.

From a certain point of view, art is more powerful than science. With much less expensive tools and with greater power for synthesis, artistic intuitions show us who we are, probably in a much more exhaustive way with respect to the objectifying approach of the natural sciences. Being humans square with the ability to ask ourselves who we are. Since the beginning of mankind, artistic creativity has expressed such ability in its

purest and highest form. It is therefore perhaps understandable why many scholars in the field of the humanities are afraid that a neuroscientific approach to esthetics may hinder, if not even destroy, the magic and wonder normally accompanying our appreciation of art.

We believe that such fears are unjustified. We think that the empirically based approach to art and esthetic experience provided by neuroesthetics can in principle enable a further valorization of the most distinctive feature of human creativity.

Further Reading

- Cela-Conde CJ, Ayala FJ, Munar E, et al. (2009) Sex-related similarities and differences in the neural correlates of beauty. *PNAS* 106: 3847–3852.
- Cupchik GC, Vartanian O, Crawley A, and Mikulic DJ (2009) Viewing artworks: Contributions of cognitive control and perceptual facilitation to aesthetic experience. *Brain and Cognition* 70(1): 84–91.
- Damasio A (1999) *The Feeling of What Happens: Body and Emotion in the Making of Consciousness*. New York: Harcourt Brace.
- Di Dio C and Gallese V (2009) Neuroesthetics: A review. *Current Opinion in Neurobiology* 19: 682–687.
- Di Dio C, Macaluso E, and Rizzolatti G (2007) The golden beauty: Brain response to classical and renaissance sculptures. *PLoS ONE* 11: e1201.
- Fogassi L and Luppino G (2005) Motor functions of the parietal lobe. *Current Opinion in Neurobiology* 15(6): 626–631.
- Freedberg D and Gallese V (2007) Motion, emotion and empathy in esthetic experience. *Trends in Cognitive Sciences* 11: 197–203.
- Gallese V (2010) Mirror neurons and art. In: Bacci F and Melcher D (eds.) *Art and the Senses*, pp. 441–449. Oxford: Oxford University Press.
- Hammermeister K (2002) *The German Aesthetic Tradition*. Cambridge: Cambridge University Press.
- Jacobsen T, Schubots RI, Hofel L, and von Cramon DV (2006) Brain correlates of aesthetic judgment of beauty. *Neuroimage* 29: 276–285.
- Kawabata H and Zeki S (2004) Neural correlates of beauty. *Journal of Neurophysiology* 91: 1699–1705.
- Ramachandran VS and Hirstein W (1999) The science of art: A neurological theory of aesthetic experience. *Journal of Consciousness Studies* 6: 15–51.
- Rizzolatti G and Sinigaglia C (2010) The functional role of the parieto-frontal mirror circuit: Interpretations and misinterpretations. *Nature Review Neuroscience* 11: 264–274.
- Vartanian O and Goel V (2009) Neuroanatomical correlates of aesthetic preference for paintings. *Neuroreport* 15: 893–897.
- Zeki S (1999) Art and the brain. *Journal of Consciousness Studies: Controversies in Science and Humanities* 6: 76–96.