Opinion TRENDS in Cognitive Sciences Vol.11 No.5

Motion, emotion and empathy in esthetic experience

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The implications of the discovery of mirroring mechanisms and embodied simulation for empathetic responses to images in general, and to works of visual art in particular, have not yet been assessed. Here, we address this issue and we challenge the primacy of cognition in responses to art. We propose that a crucial element of esthetic response consists of the activation of embodied mechanisms encompassing the simulation of actions, emotions and corporeal sensation, and that these mechanisms are universal. This basic level of reaction to images is essential to understanding the effectiveness both of everyday images and of works of art. Historical, cultural and other contextual factors do not preclude the importance of considering the neural processes that arise in the empathetic understanding of visual artworks.

Introduction

> 'The painting will move the soul of the beholder when the people painted there each clearly shows the movement of his own soul...we weep with the weeping, laugh with the laughing, and grieve with the grieving. These movements of the soul are known from the movements of the body.' ([1], p. 80).

Although no consensus has been reached on how to define art, the problem of the nature of art (however so defined) has attracted the interest of cognitive neuroscientists who opened a field of research named 'neuroesthetics' [2,3]. Other attempts have been made to derive invariant universal perceptual rules to explain what art is, and what esthetic pleasures we derive from it, on the basis of psychophysical and neurocognitive knowledge of the visual part of the brain (see, for example, Refs [2,4–8]).

Here, we pursue a different strategy. First, we 'bracket' the artistic dimension of visual works of art and focus on the embodied phenomena that are induced in the course of contemplating such works by virtue of their visual content. We illustrate the neural mechanisms that underpin the empathetic 'power of images' [9] and show that embodied simulation and the empathetic feelings it generates has a crucial role (Box 1). Second, we address – within the same empathetic framework – one aspect of the effects of works of art, namely the felt effect of particular gestures involved in producing them.

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Available online 7 March 2007.

Most spectators of works of art are familiar with feelings of empathetic engagement with what they see in the work itself. These feelings might consist of the empathetic understanding of the emotions of represented others or, most strikingly, of a sense of inward imitation of the observed actions of others in pictures and sculptures. These observations raise two questions: how relevant is empathy to esthetic experience, and what are the neural mechanisms involved?

Empathy in esthetic experience

We begin with examples of the ways in which viewers of works of art report bodily empathy. For instance, in the case of Michelangelo's *Prisoners*, responses often take the form of a felt activation of the muscles that appear to be activated within the sculpture itself, as if in perfect consonance with Michelangelo's intention of showing his figures struggle to free themselves from their material matrix (Figure 1). In looking at scenes from Goya's *Desastres de la Guerra*, bodily empathy arises not only in responses to the many unbalanced figures, where viewers seem to have similar feelings of unbalance themselves, but also in the case of the frequently horrific representations of lacerated and punctured flesh (e.g. Figure 2). In such instances, the physical responses seem to be located in precisely those parts of the body that are threatened, pressured, constrained or destabilized. Furthermore, physical empathy easily transmutes into a feeling of empathy for the emotional consequences of the ways in which the body is damaged or mutilated. Even when the image contains no overt emotional component, a sense of bodily resonance can arise. These are all instances in which beholders might find themselves automatically simulating the emotional expression, the movement or even the implied movement within the representation.

Simulation occurs not only in response to figurative works but also in response to the experience of architectural forms, such as a twisted Romanesque column [10]. With abstract paintings such as those by Jackson Pollock (Figure 3a), viewers often experience a sense of bodily involvement with the movements that are implied by the physical traces – in brushmarks or paint drippings – of the creative actions of the producer of the work. This also applies to the cut canvases of Lucio Fontana (Figure 3b), where sight of the slashed painting invites a sense of empathetic movement that seems to coincide with the gesture felt to have produced the tear.

Box 1. Mirror neurons and embodied simulation

The discovery of mirror neurons in macaques and of related mirroring mechanisms in the human brain [15], together with the new emphasis on the relevance of emotional processes for social perception, have changed our understanding of the neural basis of social cognition. Neuroscientific research has shed light on the ways in which we empathize with others [15,39,44,51,52] by emphasizing the role of implicit models of others' behaviors and experiences – that is, embodied simulation [42,43]. Our capacity to pre-rationally make sense of the actions, emotions and sensations of others depends on embodied simulation, a functional mechanism through which the actions, emotions or sensations we see activate our own internal representations of the body states that are associated with these social stimuli, as if [39] we were engaged in a similar action or experiencing a similar emotion or sensation. Activation of the same brain region during first- and third-person experience of actions, emotions and sensations suggests that, as well as explicit cognitive evaluation of social stimuli, there is probably a phylogenetically older mechanism that enables direct experiential understanding of objects and the inner world of others.

During the second half of the 19th century, several German scholars writing on the visual arts set out their views on the felt bodily engagement of the spectator in her or his responses to paintings, sculpture and architecture [11,12] (Box 2). In the work of Maurice Merleau-Ponty [13], much attention was paid to the esthetic consequences of the sense of physical involvement that paintings or sculptures arouse. He also suggested the possibilities of felt bodily imitation of the implied actions of the artist, as in the case of the paintings of Cézanne. David Rosand has devoted attention to the sense of empathetic engagement with the actions of implied hand movements in drawings by artists from Leonardo through to Tiepolo and Piranesi [14]. Although these theories were often respected, the phenomenological position has not found much traction in the field of art history.

Most 20th century art history and art criticism neglected the evidence for emotional responses and privileged a fully cognitive and disembodied approach to

Figure 1. Embodied simulation in esthetic experience: actions. The sense of exertion, which Michelangelo intended his figures to show as they struggle to escape from the block of stone, is effectively conveyed to the spectator. Michelangelo, *Slave called Atlas*, Florence, Academia (ca. 1520–1523), marble © Scala/Art Resource, NY.

Figure 2. Embodied simulation in esthetic experience: empathy for pain. The viewing of images of punctured or damaged body parts activates part of the same network of brain centers that are normally activated by our own sensation of pain, accounting for the feeling of physical sensation and corresponding shock upon observation of pressure or damage to the skin and limbs of others. Goya, *Que hay que hacer mas?* (*What more is there to do?*), plate 33 from *Los Desastres de la Guerra (Disasters of War)*, etching, Biblioteque Nationale, Paris, France © Bridgeman-Giraudon/Art Resource, NY.

Box 2. Empathy and esthetics

Although 18th century writers from DuBos onwards (including Hume, Burke, Adam Smith and Herder) commented on the inward imitation of the feelings and actions of others [53], the importance of empathy for esthetics was first emphasized by Robert Vischer in 1873 [54]. By *Einfühlung*, literally 'feeling-in', Vischer meant the physical responses that are generated by the observation of paintings. He described how particular forms aroused particular responsive feelings, depending on their conformity to the design and function of the muscles of the body. Developing Vischer's ideas, Wölfflin [55] set out his views on how observation of specific architectural forms engage the beholders' bodily responses. From 1893 onwards, Aby Warburg wrote of the *Pathosformel* [56], whereby the outward forms of movement in a work revealed the inner emotions of the figure concerned. At almost the same time, Bernard Berenson [57] outlined his views on how observation of the movements shown in Renaissance works of art enhanced the beholders' sense of the capacities of the comparable muscles within their bodies. Berenson's notion of 'tactile values' also prefigures aspects of current empathy theory. Theodor Lipps was also developing his views of the relationship between esthetic enjoyment on the one hand and bodily engagement with space on the other, in architecture as well as in the other arts [10].

All these writers believed that the feeling of physical involvement in artworks not only provoked a sense of imitating the motion seen or implied in the work, but also enhanced the spectator's emotional responses to it.

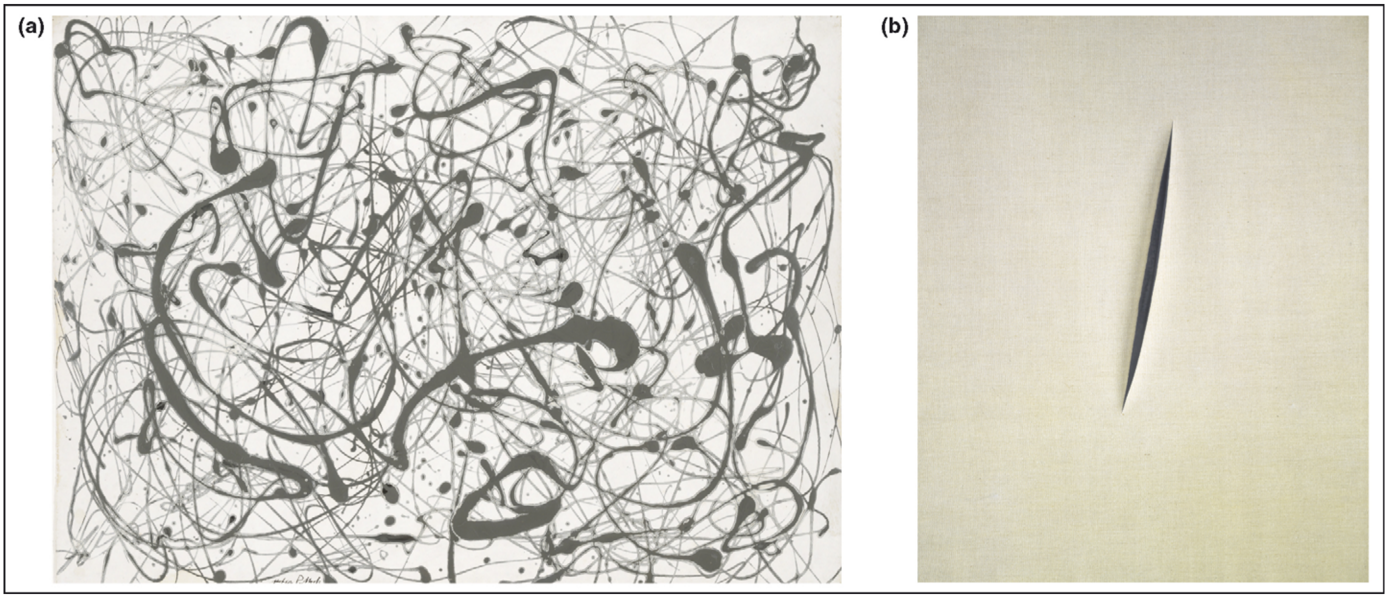

Figure 3. Embodied simulation in esthetic experience: implied gestures of the artist. The gestures that are only implicit in the marks on these works of art are corporeally felt by their spectators. **(a)** Jackson Pollock, *Number 14: Gray* (1948), enamel over gesso on paper, Yale University Gallery, The Katharine Ordway Collection © 2004 The Pollock-Krasner Foundation/Artists Rights Society (ARS), New York. **(b)** Lucio Fontana, *Concetto Spaziale 'Atteza' ('Waiting')* (1960), canvas, Tate Gallery, London © Tate Gallery, London/Art Resource, NY/ Fondazione Lucio Fontana, Milano.

esthetics (Box 3), on the grounds that the emotions are largely contextual and incapable of classification. Indeed, the considerable neuroscientific evidence clarifying the nature of empathy and the role of sensorimotor activity in empathy and emotion has been completely overlooked in current writing about art and its history. Our purpose is to fill this gap by proposing a theory of empathetic responses to works of art that is not purely introspective, intuitive or metaphysical but has a precise and definable material basis in the brain. Although the evidence we consider enables modulation by a wide variety of contextual factors (historical, social, cultural or even personal), here we are concerned with the basic mechanisms that have been brought to the fore by recent research on mirror and canonical neurons, and the neural underpinnings of empathy and embodiment.

We concentrate on two components of esthetic experience that are involved in contemplating visual works of art (as well as other images that do not necessarily fall into this category): (i) the relationship between embodied empathetic feelings in the observer and the representational content of the works in terms of the actions, intentions, objects, emotions and sensations depicted in a given painting or sculpture; and (ii) the relationship between embodied empathetic feelings in the observer and the quality of the work in terms of the visible traces of the artist's creative gestures, such as vigorous modeling in clay or paint, fast brushwork and signs of the movement of the hand more generally. Both components are always present, although in different proportions. In non-figurative modern and contemporary art, the relationship between embodied empathetic feelings in the observer and the quality of the work forms a substantial part of the experience of the artwork.

Box 3. 20th century views

E.H. Gombrich's *Art and Illusion* of 1960 was devoted to 'the psychology of pictorial representation'. Yet practically nothing in it was devoted to emotional and empathetic responses to art. By this time, the emotions had entirely dropped out of the field of esthetics. This position was canonized by R.H. Collingwood's *The Principles of Art* (1938). Following Kant, Collingwood believed that art should be separated from the emotional and from the realm of physical and spontaneous responses. Art came to be thought of as a matter of pure cognition. Nelson Goodman emphasized that 'in esthetic experience the emotions function cognitively' [58]. Clement Greenberg was devoted to the cognitive assessment of the perception of the picture plane. In its insistence on purely historical, cultural and social factors in responses to art, the 'new art history' of the 1970s remained intensely resistant to approaches that suggested the possibility of precognitive levels of response [59]. This elimination of the emotional, the empathetic and the realm of non-cognitive corporeal response remained typical for most of the 20th century.

Embodied simulation in esthetic experience: actions and intentions

The discovery of mirror neurons illuminates the neural underpinnings of the frequent but hitherto unexplained feeling of physical reaction, often in apparent imitation of the actions represented within a work of art or suggested by the implied movements involved in its making; mirror neurons also offer the possibility of a clearer understanding of the relationship between responses to the perception of movement within paintings, sculpture and architecture (and not just in their anthropomorphic or figurative modes) and the emotions such works provoke. For the sake of clarity and concision, we will treat the observation of actions, intentions and objects separately from emotions and sensations. These domains, far from being independent, are intimately intertwined in many ways and by means of mechanisms we are just beginning to investigate. We start with the observation of actions.

As the discovery of mirror neurons in the premotor and posterior parietal cortices of macaques made clear (Figure 4a), the same neurons discharge when an action

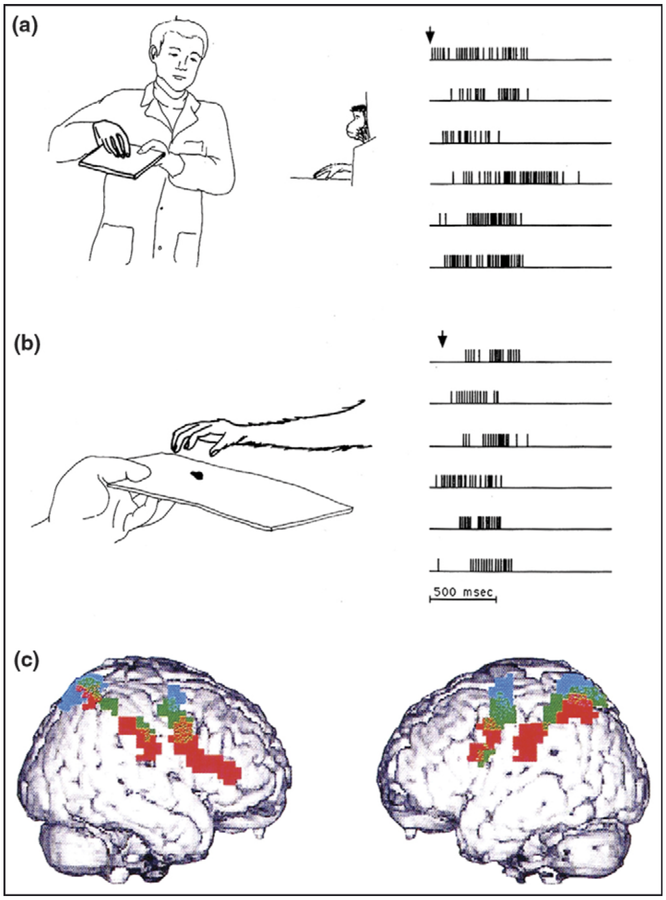

Figure 4. The mirror neuron system in monkeys and humans. **(a)** Activation of the area F5 mirror neuron during motor-act observation. **(b)** Activation of the area F5 mirror neuron during action execution. For both conditions, six consecutive rasters (spike recordings) during six consecutive trials are shown. The arrows indicate the onset of observed and executed grasping. (a) and (b) modified, with permission, from Ref. [60]. **(c)** Somatotopy of premotor and parietal cortices as revealed by fMRI during action observation. Activation foci are projected on the lateral surface of a standard brain (MNI). Red, activation during the observation of mouth grasping; green, activation during the observation of hand grasping; blue, activation during the observation of foot kicking. Overlap of colors indicates activation foci present during observation of actions made by different effectors. (c) modified, with permission, from Ref. [61].

is observed as when it is executed [15]. Later, it was shown that a mirror neuron system (MNS) also exists in the human ventral premotor cortex (encompassing Brodmann's area 44) and posterior parietal cortex. When the MNS is activated, the observation of an action – in particular, a goal-oriented action – leads to the activation of the same neural networks that are active during its execution. This in itself suggests a possible account for the frequent feelings of empathetic involvement with movements in works of art.

Mirror neurons have now also been shown to respond to actions that are implied where, for example, their final stage is occluded [16]. Thus, they enable the understanding of the action of others by means of embodied simulation, by activating the motor representation of the same action, even when its conclusion is only implied.

The MNS for actions in humans is somatotopically organized, with distinct cortical regions within the premotor and posterior parietal cortices activated both by the observation and by the execution of mouth, hand and foot actions (Figure 4b). It has also been shown that the MNS in humans is directly involved in the perception of communicative facial actions, in the imitation of simple movements and in the learning of complex motor acts even when not previously practiced (reviewed in Refs [15,17]). Recent studies in macaques [18] and humans [19] demonstrated that mirror neurons not only underpin action understanding, but they are also involved in understanding the intentions that underlie action.

Research on the human MNS has shown that the observation even of static images of actions leads to action simulation in the brain of the observer. The observation of pictures of a hand reaching to grasp an object [20] or firmly grasping it [21] activates the motor representation of grasping in the observer's brain. Furthermore, Calvo-Merino *et al.* [22] showed that repetitive transcranial magnetic stimulation over the ventral premotor cortex, but not over the visual extrastriate body area, disrupts the capacity to perceive still figures of dancing bodies as visual wholes, thus suggesting that activity in the MNS is crucially involved in the global processing of bodies.

On the basis of these results, it stands to reason that a similar motor simulation process can be induced by the observation of still images of actions in works of art. It is not surprising that felt physical responses to works of art are so often located in the part of the body that is shown to be engaged in purposive physical actions, and that one might feel that one is copying the gestures and movements of the image one sees – even in cases where the action seems to serve as the outlet for an emotional response (as with scenes of mourning and lamentation, for example). But what happens in the case of observation of static objects?

Embodied simulation in esthetic experience: objects

The discovery of 'canonical neurons' in the macaque premotor cortex [17,23] and the discovery of parietal neurons with similar properties [24,25] showed that the observation of static graspable objects activates not only visual areas of the brain but also motor areas that control object-related actions such as grasping. The observation of a graspable object leads to the simulation of the motor act that the object affords. This implies that the same neuron not only codes the execution of motor acts but also responds to the visual features that trigger them, even in the absence of overt movement.

In congruence with the data on canonical neurons in macaques, brain imaging experiments in humans have shown that observation of manipulable objects like tools, fruits, vegetables, clothes [26–31] and even sexual organs [32] leads to the activation of the ventral premotor cortex, a cortical region that is normally considered to be involved in the control of action and not in the representation of objects. Furthermore, an fMRI study of visual occlusion [33] shows a systematic activation of the ventral premotor cortex during the observation of occluded objects, thus suggesting the crucial role of motor simulation in establishing object permanence.

The particular intentional interactions that objects specify – that is, how they are supposed to be manipulated and used – make up a substantial part of their representational content, whether they are man-made or not and however different they might be. This is why the perception of these objects leads to the activation of motor regions of the brain that control our interactions with the same objects. Static 3D objects are identified and represented also to the effect of their interaction with an observer that is simultaneously a potential emotional agent. This mechanism of motor simulation, coupled with the emotional resonance it triggers, as suggested by Lipps [10], is likely to be a crucial component of the esthetic experience of objects in art works: even a still-life can be 'animated' by the embodied simulation it evokes in the observer's brain. The role of embodied simulation in esthetic experience becomes even more evident if one considers emotions and sensations.

Embodied simulation in esthetic experience: emotion and sensation

The historic theories of physiognomic expression, such as those of Charles Le Brun from 1688 onwards, suggested correlations between specific facial expressions and specific emotions [34]. They have generally not been taken as seriously as they merit [35]. Despite the work of Paul Ekman on the correlations between emotion and physiognomic expression [36], the earlier claims continue to be regarded as having no empirical foundation. Yet current neuroscientific research has begun to unveil the bases for such correlations. For example, electromyographic responses in the facial muscles of observers are congruent with those involved in the observed person's facial expressions [37]. The integrity of the sensorimotor system is crucial for the recognition of emotions displayed by others [38] because it supports the reconstruction of what it would feel like to be in a particular emotion, by means of simulation of the related body state.

The implication of this process for empathy should be obvious. An important step was taken by the research of Antonio Damasio and co-workers on the neural correlates of the relationship between emotions and the body states that accompany them [39,40]. Damasio showed how feelings – defined as the conscious awareness of emotions – are related to neural mappings of the body state. His 'as-if body loop' referred to the ways in which a variety of areas of the brain react so as to assume the same state they would have had if the observers of the actions and emotions of others were engaged in the same actions or if they were subject to the conditions they observed. Thus, Damasio [39] also proposed that when one observes pictures that arouse strong responses such as fear, the body is bypassed (for the most part, we do not actually run away, although we might) and the brain – within 'simulation mode' [41] – reproduces the somatic states seen in or implied by the painting or sculpture, 'as if' the body were present.

This perspective is consonant with our proposal, which capitalizes upon the research on mirror neurons and the embodied simulation account of empathy [42,43]. Much evidence is available for the activation of the same emotional circuits in observers as in the observed, particularly in the case of expressions – whether physiognomic or with the entire body (e.g. fear, disgust and pain). These results clarify the many ways that spectators precognitively grasp emotions that are either explicitly shown or implicitly suggested by works of art (as well as images more generally). The same holds true for our perception of others' sensations like touch or pain (reviewed in Refs [15,44]).

When we see the body part of someone else being touched or caressed [45,46], or when we see two objects touching each other [45], our somatosensory cortices are activated as if our body were subject to tactile stimulation. Empathetic feels can no longer be regarded as a matter of simple intuition and can be precisely located in the relevant areas of the brain that are activated both in the observed and in the observer.

These results provide the neural substrate for empathetic somatic feels in response to representations of figures touching or damaging others, as in the case of Goya's *Desastres*, as noted earlier. Empathetic simulation of the somatic feeling that is evoked by an image where flesh is shown to yield to the pressure of touch also enters into esthetic responses to works such as Caravaggio's *Incredulity of Saint Thomas* (Figure 5).

Together with the empirical findings reviewed in the previous sections, such results enable us to account for three of the chief forms of response to visual images that have hitherto remained unexplained: (i) the feeling of bodily engagement with the gestures, movements and intentions of others; (ii) the identification of the emotions of observed others; and (iii) a feeling of empathy for bodily sensations. But there is also a fourth possibility that is suggested by the discovery of mirror neurons and the theory of embodied simulation and that fleshes out the evidence for their role in specifically esthetic responses. It arises from a consideration of the formal qualities of a work and the observation of the gestural traces of the artist.

Embodied simulation and implied gesture: feeling the movement behind the mark

Whether in response to a wide range of non-figurative works or to figurative works where the marks of the maker's instruments are particularly clear, observers often

Figure 5. Embodied simulation in esthetic experience: empathy for tactile sensations. Vision of another person being touched automatically activates the cortical network of areas that are normally involved in the experience of being touched, as is clear from our experience of viewing paintings such as Caravaggio's *Incredulity of St Thomas* (1601–1602), oil on canvas, Potsdam, Sanssouci, © Stiftung Preußische Schlösser und Gärten Berlin-Brandenburg.

feel a form of somatic response to vigorous handling of the artistic medium and to visual evidence of the movement of the hand more generally. Such issues cast considerable light on esthetic experience because it is here divorced from any form of overt imitation of a realistically portrayed gesture or movement, but rather it is related to what is implicit in the esthetic gesture or movement.

We propose that even the artist's gestures in producing the art work induce the empathetic engagement of the observer, by activating simulation of the motor program that corresponds to the gesture implied by the trace. The marks on the painting or sculpture are the visible traces of goal-directed movements; hence, they are capable of activating the relevant motor areas in the observer's brain. Despite the absence of published experiments on this issue, the mirror-neuron research offers sufficient empirical evidence to suggest that this is indeed the case.

Several studies show that motor simulation can be induced in the brain when what is observed is the static graphic artifact that is produced by the action, such as a letter or a stroke. Knoblich *et al.* [47] showed that the observation of a static graphic sign evokes a motor simulation of the gesture that is required to produce it. Recent brain imaging experiments have confirmed these results and localized their anatomical bases. Using fMRI, Longcamp *et al.* [48] showed that the visual presentation of letters activated a sector of the left premotor cortex that was also activated when participants wrote the letters. This double activation was lateralized to the left hemisphere in right-handed participants and to the right hemisphere in left-handed participants. Previous studies have demonstrated that oscillations within the 20 Hz band are suppressed both by action execution and by observation [49]. Longcamp *et al.* [50] studied the modulation of 20 Hz oscillations in the hand representation in the primary motor cortex during observation of letters. This revealed a suppression of the oscillations both during hand movements and during the observation of static letters. The modulation effect was stronger for the observation of handwritten than of typed letters.

All this evidence shows that our brains can reconstruct actions by merely observing the static graphic outcome of an agent's past action. This reconstruction process during observation is an embodied simulation mechanism that relies on the activation of the same motor centers required to produce the graphic sign. We predict that similar results will be obtained using, as stimuli, art works that are characterized by the particular gestural traces of the artist, as in Fontana and Pollock.

Concluding remarks

Automatic empathetic responses constitute a basic level of response to images and to works of art. Underlying such responses is the process of embodied simulation that enables the direct experiential understanding of the intentional and emotional contents of images. This basic level of reaction to images becomes essential to any understanding of their effectiveness as art. Historical and cultural or contextual factors do not contradict the importance of considering the neural processes that arise in the empathetic understanding of visual works of art.

Box 4. Questions for future research

- Given the relevance of embodied simulation for the understanding of negative emotional response, how might further light be cast on positive responses to the observation of movement and action?
- What experiments can be devised to assess the distinctions between empathetic responses to movements and objects in real life and to visual representations of these?
- What is the emotional relevance of colors in esthetic experience?
- What are the therapeutic possibilities of the observation of movement and emotion in works of art?

Clearly a question arises about the degree to which empathetic responses to actions in real life differ from responses to actions that are represented in paintings and sculptures. Here there is scope for further research (Box 4). In the case of figurative art, one might assume that it is the artist's conscious and unconscious skill in evoking an empathetic response that most directly impacts the esthetic quotient of the work. Our discussion of embodied responses to implied gestures and to movements that underlie pictorial and sculptural marks suggests the further significance of the MNS for understanding esthetic responses to the formal aspects of the work.

Acknowledgements

This work was supported by MIUR (Ministero Italiano dell'Università e della Ricerca).

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