Chapter 7
Embodied Aesthetics: Insight from Cognitive Neuroscience of Performing Arts

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Abstract Echoing the phenomenological tradition in philosophy, recent hypotheses have proposed that aesthetic experiences are grounded in the embodied simulation of the actions, emotions, and corporeal sensations represented in artworks. We refer to these simulative processes as "embodied aesthetics". Recent investigations in cognitive neuroscience have helped us to explore the mechanisms of complex human experiences and some of them have been specifically dedicated to the study of the neural underpinning of aesthetic experience. Their results have repeatedly suggested that the creation and the perception of artworks activate a set of shared brain mechanisms, especially as far as performing arts (such as music and dance) are concerned. For instance, pleasurable dance may resonate in the spectators' brain by enhancing the activity in motor-related areas. This evidence points to the universal involvement of a motor resonance mechanism in aesthetic experience. The present chapter will initially explore the general idea of embodiment. We will then describe some studies in the field of performing arts, where the human body is the object of aesthetic stimulation and the subject of the aesthetic experience. We will also describe how embodiment is modulated by different properties of the stimuli, by the performers' body or by the preference of the observer. Overall, we expect to provide a framework to better understand aesthetic experience from an embodiment perspective, taking into consideration the different factors that interact with these processes, especially as far as the performing arts are concerned.

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Introduction

A close link exists between action perception and action execution [55]: passive observation of an action executed by another agent (such as grasping a fruit) triggers the corresponding representation in the perceiver's brain. This phenomenon was originally discovered in the non-human primate brain, where a class of neurons – known as mirror neurons – are activated by the execution as well as by the observation of similar actions [52]. Later on, evidence for the existence of this mechanism has been observed also in the human brain. Indeed, following the seminal transcranial magnetic stimulation (TMS) work by Fadiga and colleagues [21], numerous studies have shown that we covertly simulate the actions that we observe [53], even when they are represented in a static medium (e.g., photographs depicting an agent executing a movement [69]). This mirror neuron mechanism (more left lateralized) is activated by action stimuli ranging from simple finger to whole body movements [57] and it is thought to mediate the understanding of others' actions [65]. Interestingly enough, further research in this field has isolated audio-visuo-motor neurons in the monkey premotor cortex that are activated not only when the animal performs a given motor act, or when it observes another agent executing it, but also when it listens to its sound [38]. This shared representation has been observed in the human brain too, where the sound generated by an action triggers the corresponding motor program in the listener's brain, even when the agent is occluded from sight [1, 61]. Taken together, this evidence suggests that the human and non-human primate brain is capable of inferring (and covertly simulating) the behavior of others not only when the action is directly observed, but also when the effect of others' actions is the only information available.

For those scholars interested in art, this phenomenon has triggered interesting hypotheses on whether action simulation has an active role in aesthetic appraisal and appreciation of art forms such as dance (where bodies are actually observed; see also [14]), music (where the motor behavior can be inferred by the sounds; e.g. [15, 44]), and pictorial art [64]. For instance, it has been hypothesized that the actions depicted on a canvas, either in the form of actual body representations (e.g., Caravaggio's *Boy with a lizard*) or in the form of brushstrokes (representing the actions performed by the artist in the artistic medium), could be embodied through an action simulation process homologous to that described above [24]. The degree to which action simulation may contribute to aesthetic appraisal is still controversial. However, some evidence suggests that the hypothesis may hold true. In this chapter, we aim at exploring some of the research that may help us better understand how action simulation relates to aesthetics.

Embodied Aesthetic and Dance

The human body has the ability to freely move in various directions, at different speeds and with complex combinations of limb postures. Sometimes, these movements are orchestrated with the aim of producing an aesthetic response in the observers' mind (e.g., in dance). How this may happen has been the object of many philosophical theories, dance studies, and recent visual neuroscience and neuroaesthetic investigations. Originally, neuroaesthetics described how the organization of artworks may reflect the properties of the human visual system [73]. What can we say instead about performing art, and dance in particular? In this context, a few neurocognitive hypotheses, focusing on how the human brain processes other people's movements, have led to Functional Magnetic Resonance Imaging (fMRI) studies describing stronger brain responses in mirror neuron areas (mainly parietal and premotor regions [52]) when we observe a movement belonging to our own motor repertoire [4, 5, 12, 45]. Overall, these studies have suggested a close link between the neural processes activated when we perform a movement and those triggered by movement observation.

When we observe a work of art, there are at least two ways of receiving an aesthetic experience. The first one is driven by the properties of the stimulus. For example, the sight of a pleasant object can evoke some aesthetic pleasure *per se*, even if the observer is not intentionally looking for the beauty in the object (implicit aesthetics). On the other hand, when an object is in a specific context, such as an art museum, the sensory processing of the stimuli is combined with the observer's intention to find its beauty (explicit aesthetics).

In order to investigate implicit aesthetics from a sensorimotor point of view, Calvo-Merino et al. [6] used fMRI to record brain activity in participants while they were watching a series of short dance video clips depicting different dance movements (half from classical ballet, half from capoeira). The aim of the study was to investigate whether our brain responds differently when we see movements that we like as compared to movements that we like less (in an implicit manner). For this reason, participants were instructed to look at the dance videos, and were asked to rate the videos according to their preference only after they had finished the scanning session. The authors described some areas sensitive to aesthetics (i.e. that respond more strongly when the participants observed preferred movements) localized in the early visual cortex, in the medial region, and in the premotor cortex of the right hemisphere. Interestingly, while these visual (and premotor) regions participate in the daily process of watching movements, the premotor cortex is also considered a mirror neuron area, suggesting that the degree of covert simulation of the movements is correlated to the level of liking.

Besides identifying brain areas sensitive to implicit aesthetics, this study described the kinematic properties of the dance movements that participants liked more, and that evoked stronger brain activity in the above mentioned aesthetic-related regions. The selected movements were classified on the bases of four kinematic properties: speed, body part used, direction of movement, and

vertical and horizontal displacement. The results show that, on average, whole body movements such as jumping on the spot or significant displacements of the entire body in space (e.g., horizontal jumps) are preferred. Obviously, this study investigated only a reduced number of movements, hence we expect that future investigations in collaboration with the art community will extend our knowledge of the aesthetic of dance.

Another series of studies have investigated other aspects of the aesthetic processing. For instance, Emily Cross and colleagues [13] conducted an fMRI study to understand how the observers' aesthetic evaluation of dance movements is related to the observers' physical ability to reproduce the movements they watch. The authors registered brain activity while participants performed an explicit aesthetic evaluation of a series of dance movements. At the same time, participants also rated how well they thought they could physically replicate the movement they were watching. The results showed stronger brain responses in occipito-temporal and parietal regions when participants watched videos that they liked more and that they considered more difficult to perform.

Both the studies of Calvo-Merino et al. [6] and Cross et al. [13] argue that the properties of the stimuli (i.e., related to the amount and difficulty of movements) evoke aesthetic-related activity in a series of brain regions often associated with the observation of actions. These studies, therefore, support the embodied aesthetic hypothesis, suggesting that the simulation of observed movements may be part of the aesthetic process, whether this happens in an implicit or in an explicit manner.

Very recently, Jola et al. [34] moved a step forward and carried out a study to investigate how covert simulation of actions is modulated by the level of visual experience that the observer has of the perceived movement. They used single-pulse Transcranial Magnetic Stimulation (TMS) to measure cortical excitability in three groups of observers with different levels of involvement in dance habits: some of them often went to Ballet performances (frequent ballet spectators), some to Indian dance performances (frequent Indian spectators) while other had no experience of watching any dance performance in particular. Cortical excitability was measured while participants watched life dance performances of Ballet and Indian dance. The results showed that the three groups differed in the amplitude of the motor evoked potentials (a measure of cortical excitability and hence of motor simulation) while watching the different dance styles. Therefore, the authors concluded that during dance observation the spectators' motor responses could be enhanced as a function of their visual experience or of the tendency to imaginatively transpose oneself into the fictional character. This evidence suggests again that the observers covertly simulate the perceived movements, and that this simulation is stronger when they have more visual familiarity with the observed dance.

Another issue that is often discussed in the aesthetic dance literature is the ecological validity of the results. Indeed, most neuroimaging studies employ short video clips to investigate the neural correlates of aesthetic experience. This allows greater experimental control over several important parameters when recording brain activity and minimizes the effect of uncontrolled factors. Importantly, Jola et al. have proposed a more ecological approach [34, 35] moving from standardized

dance video clips to real performance, either in the lab or inside the dance theatre (Jola et al. [36]; an elaborate discussion on this subject can be read in [11]).

Aesthetic and the Performed Arts

Sensorimotor embodiment is not only called into action during the viewing of dance performances, but also in the aesthetic appreciation of static artworks. In a seminal study, Di Dio et al. [18] showed a greater activation of the ventral premotor cortex and of posterior parietal cortex during observation of Classical and Renaissance human body sculptures that respected the gold section, an index of body proportion that is accepted as a normative Western representation of beauty. In a similar vein, Battaglia et al. [2] explored the effects of viewing Michelangelo's 'Expulsion from Paradise' fresco on corticospinal excitability. They found higher motor activity during observation of the action in the fresco compared to that recorded for a real hand photographed in the same pose. The results point towards a close relationship between the aesthetic quality of a work and the perception of implied movement within it. Similarly, an electroencephalographic (EEG) experiment [64] has explored whether the motor system is somehow triggered by passive observation of abstract art where the action of the artist can only be inferred (i.e., Lucio Fontana's slashed canvas). The results showed that these stimuli did affect the activity of the motor cortex (when compared to graphically modified versions of them), while familiarity did not change the motor involvement. It is still unclear, though, whether the brushstrokes (or cuts in this case) on canvas may transmit enough motor cues to represent the gestures that crated them and, more importantly, whether this process of embodiment would contribute to the affective appreciation of works of art. In other words, the link between motor activity and aesthetic and emotional feelings in art is still unclear.

There is, however, some evidence to suggest a match between affective states and motor activity, albeit in another context. For instance, Kornysheva and colleagues [39] found that transient disruption (by means of repetitive TMS) of the ventral premotor cortex affects the preference responses to rhythm. Other scholars suggested a bidirectional association between emotion and motor behavior: for instance, botox injections in facial muscles decreased the strength of emotional experience [16] and of amigdala activity [29]. And, in the monkey brain, insula stimulation (insula being an integral part of the system involved in affective processing) evokes emotional behaviors [8]. More direct evidence comes from a recent psychophysical investigation by Leder and colleagues [40], in which the authors tested covert simulation by manipulating the apparent painter's hand gestures present on the canvas in the form of static brushstrokes. In particular, the participants were asked to execute – with their (hidden from view) dominant hand – either a stroking or stippling movement while observing images of pointillism-style (e.g., Seurat) or stroke-style paintings (e.g., van Gogh). Executing either congruent or incongruent movements simultaneously with the

observation of the paintings increased or decreased aesthetic appreciation, respectively. This clearly demonstrates that motor simulation may systematically accompany the aesthetic appraisal of stimuli characterized by brushstrokes and therefore more prone to elicit an embodiment phenomenon in the brain of the observer. However important we may regard these findings, they do not allow us to draw definitive conclusions as far as the effects of motor activity on aesthetic states is concerned.

Aesthetic in the Performer's Body

Embodied aesthetic experience of watching movements is inherently affected by the aesthetic properties of the performers' body. Among the different stimuli we perceive, the aesthetic evaluation of the human body has a particular importance for our survival, being also related to attractiveness judgments and mate selection [9]. Considerable evidence has been accumulated in recent years supporting the notion that both facial and bodily physical attractiveness are 'health certifications' and thus represent honest signals of phenotypic and genetic quality [26]. Indeed, symmetry and consistency of movements [20, 28], on the one hand, and distribution and overall amount of body fat [22, 30, 56], on the other, are believed to have a strong impact on health and reproductive potential.

The ideal body shape and weight, however, seem to be influenced by sociocultural factors. It is well known that culture and media play a role in changing the aesthetic canons and the ideals of body beauty that are shared in a society. In Western societies especially a tendency for individuals to idealise thin body shapes has been noted, leading to the internalization of the ideal of beauty in a lean body. This is not only well documented in adults of both genders [23] but also appears to be present from earlier ages [48, 62], with strong implications for the well-being and body satisfaction of many adolescents and adult individuals [3, 54].

However, the neurocognitive mechanisms underpinning the influence of media exposure on the aesthetic appreciation of the body are still not well understood [58]. A possible mechanism to explain the influence of perceptual adaptation on the ideals of body beauty stems from norm-coding models of perceptual adaptation. In this view, the perception of the members of homogenous classes that share common configurations, such as faces and bodies, is based on the features of a template representation that is used as a reference point to perceive other exemplars [70]. The members that are more similar to the template receive higher aesthetic appreciation [71]. Such norm-based representations may be shaped by experience [51], thus favouring a preference for more familiar stimuli in aesthetic appreciation. Accordingly, recent studies have demonstrated that familiarity modulates the attractiveness judgments of faces [51] and also our perceptions of what is normal or average in a face [41]. Fewer studies have instead investigated how experience modulates body aesthetic perception. Winkler and Rhodes [72] showed that exposure to both thin and round bodies modulates normality judgments, with a tendency to

consider more normal and more attractive the adapted weight. Another study [25] provided evidence that the effects of body exposure were correlated with the degree of body dissatisfaction and internalization of Western ideals. This finding supports the relationship between the effects of perceptual adaptation and the development of body image disturbance. It is noteworthy for the purpose of the present chapter that, in keeping with the effects of motor and perceptual familiarity with movements, perceptual familiarity with given body forms strongly affects the aesthetic appreciation of the beauty of the body.

Although several studies have attempted an investigation of the distinct contributions of body motion and body shape, few studies have addressed the issue of how the perception of body motion and body shapes interact in body aesthetic perception. A recent study by Johnson and Tassinary [33] investigated the possibility that perceived attractiveness reflects the compatibility of biological sex and gender cues (i.e., masculinity and femininity as specified within the society). They presented computer-generated animations or static and dynamic line-drawings and requested participants to rate each stimulus for sex categorisation, perceived masculinity, femininity, and attractiveness. The results showed that perceived attractiveness co-varies with body shape and motion because they co-specify social percept (e.g., biological sex and gender, respectively) that may be either compatible or incompatible. Higher attractiveness judgements are typically attributed to stimuli in which body form and body motion cues are compatible. Recently, Cazzato et al. [9] asked participants to provide attractiveness, beauty and liking ratings on the shape and posture of virtual renderings of human bodies with variable body size and implied motion. Results showed that aesthetic judgements both for shape and posture of human models were influenced by body size and implied motion, with a preference for thinner and more dynamic stimuli. Interestingly, implied motion reduced the impact of extreme body sizes on the aesthetic evaluation of body postures, while body size variations did not affect the preference for more dynamic stimuli. Thus, perceived attractiveness is determined by the interaction between body motion and body shape cues.

The visual processing of the body involves specific neural structures that are at least partially segregated from those involved in the visual processing of object and face shapes [47]. Viewing non-facial body parts selectively engenders bilateral activation of a lateral occipito-temporal region called the extrastriate body area (EBA; Downing et al. [19]). EBA is activated by viewing partial or whole movies, photographs or sketchy drawings of human bodies and body parts but not faces and objects [47]. In contrast to the response pattern of areas belonging to the mirror neuron system that matches action observation and execution [52], EBA is involved in the visual processing of static human body forms [47]. In particular, magnetic stimulation of EBA impairs the visual discrimination of the form of human body parts, but not of face and object parts [49, 66, 68]. Furthermore, a neuropsychological study [43] showed that patients with lesions encompassing EBA were impaired in the visual discrimination of body parts but not of face and object parts, thus providing evidence for the existence of body form visual agnosia. More recent fMRI studies have demonstrated the existence of another body selective area that is

anatomically distinct from EBA. This area, located in the fusiform gyrus and known as fusiform body area (FBA), responds selectively to whole bodies and body parts and is adjacent to and partly overlaps with the fusiform face area (FFA) [46], which is selectively activated by visual presentation of human faces [37]. FBA responds to viewing complex body configurations but not single body parts [60]. This suggests that, on analogy with the role of FFA in the configural processing of faces, FBA is specifically devoted to the configural processing of whole bodies. In contrast, EBA may be more involved in the detail-based processing of single parts of the human body [60, 67].

As previously noted, body movements induce displacements of body parts along many directions, changing their overall configuration. In contrast, the general structure of the face and the relations among body parts is not altered during facial movements. Indeed, while faces may be processed as undifferentiated wholes [42], configural processing of bodies seems to be based on the spatial relationships among body parts in the context of the whole-body space [50]. In this context, the processing of whole body configuration needs to take into account the displacement induced by ongoing movements. In keeping with this view, Urgesi, Calvo-Merino and co-workers showed that body configural processing may imply the embodiment of observed postures onto the observer's sensorimotor representations [67]. In that study, configural body processing was investigated using the body inversion effect, which refers to the remarkable disruption in processing whole bodies when displayed upside down as compared with their canonical position. This effect is found for faces [42] and bodies [50] and is an indicator of configural processing. Indeed, inversion of faces and body stimuli is thought to prevent their configural processing, leaving only the detail-based processing of their single parts that is more typically used for less familiar objects. In the study by Urgesi et al. [67] participants were required to discriminate, in a matching to sample task, between two different dance postures shown in an upright or inverted position. The dancer model was kept constant across the different postures. Repetitive transcranial magnetic stimulation (rTMS) was applied to interfere with neural activity of EBA, ventral-premotor cortex and superior parietal lobe during task performance. Stimulation of EBA selectively impaired discrimination of inverted postures but did not affect discrimination of upright postures. Conversely, stimulation of fronto-parietal areas selectively impaired discrimination of upright body postures but not of inverted body postures. These effects led to an increase of the body inversion effects after interference with EBA activity and a suppression of it after interference with fronto-parietal areas. The results of this study suggest that while body representation in the extrastriate cortex is involved in the local processing of body-part details, the simulative representation of the body in the mirror neuron areas underpins the configural processing of whole body postures. Visual and simulative representation of the body may have different, complementary roles in its aesthetic appreciation.

In a companion rTMS study, Calvo-Merino et al. [7] presented the same dance postures used in Urgesi et al. [67], but asked participants to rate which one of two dance postures they liked more. Results demonstrated that EBA rTMS blunted aesthetic judgments about body postures relative to rTMS of ventralpremotor cortex,

thus disrupting the pattern of aesthetic preference observed for each participant in a rating session without stimulation. The authors interpreted these results within the framework of the above mentioned "dual-route model" of visual body perception [67], suggesting that disruption of the local system, housed in the EBA region, blunted aesthetic sensitivity. By contrast, the disruption of the ventral premotor cortex, involved in the configural processing of whole body postures, heightened aesthetic sensitivity.

All in all, the results suggest that simulative, configural and visual, local body processing routes seem to provide complementary information to body aesthetic perception. They also point to the need for future neuroscientific studies to investigate further the potential of body forms and the likely interaction between action and form cues in driving the appreciation of the beauty of the body. This is particularly important for a better understanding of the neural bases of the aesthetic appreciation of the body in the healthy brain and in body image disorders. In keeping with this view, studies have shown that the activity of lateral and medial occipito-temporal areas involved in body processing is modulated by the perceptual adaptation to extreme body weight [31]. Furthermore, the neurofunctional alteration of these areas is associated with body image disturbance, such us body size overestimation and negative evaluation of one's own body, in patients with Eating Disorder [59, 63].

Conclusion

We have revised recent studies exploring the relative contribution of body form and body action in aesthetic appreciation. Also, we have explored another factor classically associated with aesthetic and preference: the concept of familiarity, when previous exposure to the stimuli (for example, dancers watching dance) influences brain responses during an aesthetic experience.

Evidence has shown that, generally speaking, motor areas are active while watching artistic stimuli [10, 32], however we may argue that these findings report a general affective arousal in response to art that it is unrelated to motor simulation. As a matter of fact, positive as well as negative emotions equally facilitate motor activity [27], presumably preparing approach/avoidance behavior. Nonetheless, the works cited in this chapter appear to converge on the fact that a crucial element of response to bodily aesthetic stimuli consists in the activation of embodied mechanisms encompassing the simulation of actions, emotions and corporeal sensations [17, 24]. Finally, we have seen that embodied aesthetic experience of perceiving bodies and their actions is inherently affected by the aesthetic properties of the performers' body. Although cognitive neuroscience has classically separated static body and movement brain mechanisms, neural activity in these areas is strongly interconnected, shaping a brain network for human body perception. As such, the embodied

(continued)

aesthetic hypothesis positing that sensory and motor activation is a critical element for the affective response to art may indeed provide explanations as to why some people find enjoyment, for instance, in an evening at the opera house or a day in an art museum.

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