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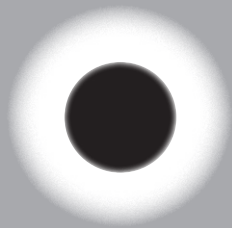
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Focus Article



THE BODY IN THE PICTURE THE LESSON OF PHANTOM LIMBS AND THE ORIGIN OF THE BIID

David Freedberg, Antonino Pennisi

Abstract

What do phantom limbs have to do with art and body images? What unifies two such distant fields as neuroaesthetics and neuropathology? These questions can be answered by the important results of some of Ramachandran's neurobiological research in which both fields of research in relation to phantom limb experiments have been explored. These researches have been used by the authors to hypothesize an embodied theory of body images that is reflected both in the production and fruition of visual arts and in the analysis and therapy of body self disorders. The general principle is that the visual sensations are experienced as somatic sensations and the somatic sensations are transformed into mental images thanks to the autonarrations of the subjects endowed with descriptive or therapeutic power. In art this is manifested in an empathic involvement of the user who perceives the same physical sensations as the images he sees, immersing himself in these visions. One of the lessons of the phantom limb experiment is that it is possible to project into an image we see the feeling of our own limbs - even if they are tragically lost. This shows that visual sensations are experienced as somatic sensations. More precisely, it is about keeping in mind that sight activates other sensory modes in the brain and gives the sensation of physically feeling what you see. In neuropathologies called BIID (Body Integrity Identity Disorder), in particular the Xenomelia, which causes a permanent sense of splitting between the real parts of the body and their mental images, it comes, instead, to the point of amputating (or getting amputated) these parts. Also in this case, the dyscrasia between a corporeity impossible to be overcome and the creation of mental images dissonant with the neural mappings can be explained through the parallel flow of perceptual experience and intellectualization of body images. According to the authors, these analyzes could open new perspectives not only on neuroaesthetics and neuropathologies but also on the more general functioning of mental images and the formation of the body self in human animals.

Keywords: Body Image, Corporeal Self-Awareness, Gender Dysphoria, Xenomelia, Neuroaesthetics

I. THE BODY IN THE PICTURE

By what process do viewers feel their body to be in the picture? How do they see that hand or that leg as somehow their own?¹ The question of how viewers understand the sufferings, joys and pains of others through their own bodies is of a different order².

Viewers of pictures, films, and sculptures often feel they have a physical sense, however attenuated, of the physical pain of others. It is through a sense of their own bodies that they seem to understand how that body out there, in the image, is affected. To some degree or another they experience that body's physical circumstances as if – but only as if – their own bodies were there, subject to the same pressures, pleasures, and extensions.

But could they not know the body in the picture intellectually?³ They could, but this would only be half the story. The question is a different one. It is not just about *thinking* that that hand could easily be theirs; it is not just about thinking-in, or seeing-in, or even just imagining themselves to be in that body's position. It is that rarer case, in which they see a hand, over there, and believe it to be their own. To feel *that* hand as their own, not to feel those pains there in this hand here.

Much of what humans see activates their motor cortices and the emotional correlates of motor experience. In studies of out-of-body experiences, the premotor cortex has been shown to be critical to corporeal self-awareness as well as to the felt embodiment of observed body parts (as one might expect from the activation of mirror neurons there)⁴. Not surprisingly, the premotor cortex turns out also to be involved in the capacity to imagine the movement and, in particular, the rotation of body parts⁵.

While the question of out-of-body experience has been much discussed⁶, it is not clear that the way in which viewers see the body in the picture as an actual body (and not just a represented body) has always to do with seeing one's *own* body in the picture.

The question is really twofold: Firstly, how is that when we look at a scene in picture, we often feel ourselves to be participating in it? How does our own body come to feel as if it were there in the picture? Secondly, how is it that we feel other bodies or other body parts as if they were somehow subject to the same pressures and inclinations as our own? To have this latter experience is different from having a

purely out-of-body experience – except in those cases where we do indeed seem to leave our own bodies for another body in a picture. But for the most part it would be hard to claim that we entirely lose our sense of ourselves when we feel the movements and pains of others (though often and significantly enough we do).

I. I. PHANTOM LIMBS

In 1995, V.S. Ramachandran performed an unforgettable experiment. He devised a way of relieving phantom pain, the pain that amputees feel in the imagined limb they no longer possess.

What could the relief of such pain have to do with the enjoyment of art or the seductions and terrors of pictures? What have phantom limbs to do with the history of art and images? More than one might suppose. Ramachandran's experiments have received increasing attention in the last few years, largely because of their implications for the understanding of brain plasticity, the ability of parts of the brain to change or adapt their functions, but their relevance to understanding the bodily consequences of looking at visual representations has only recently begun to be understood.

As is well-known, people who lose a limb often continue to feel that they still possess it. They also have sensations there (hence the term «phantom limb» – one thinks and feels that the limb is there, even though it is not). Indeed, in many cases the sense of feeling in the lost limb becomes excruciatingly and all-too present⁷. The phenomenon is universal, has been known since antiquity, and has long been studied⁸. It occurs not only in the case of amputees, but also in that of congenital limb absence⁹.

The manifestations of continuing phantom presence can be extraordinary. They extend to the smallest details of habitual behavior and use. Patients wake up in the morning with the phantom arm or leg feeling stiff or in an awkward position; they attempt to shake hands or wave goodbye with their lost limbs; they try to ward off blows or break falls with their them¹⁰. They think and feel they have the limbs they don't. The phenomenon of as-if responses – in this case the sense and felt use of a non-present limb as if it were actually there – could hardly be better illustrated.

Already in 1912, Sherrington and Brown showed that when they repeatedly stimulated the face region of a chimpanzee, it soon expanded to occupy some of the territory initially representing the hand¹¹. This demonstration of the possibility of cortical plasticity was taken up in a series of experiments conducted by Pons and others in the 1980s, in which they showed that in monkeys where the nerves from the arm to the brain had been cut, the region corresponding to the hand in the somatotopic map (area 3b) could be stimulated by touching the monkey's ipsilateral face¹² – «direct evidence that a massive reorganization of topography had occurred in area 3b», as Ramachandran wrote in 2000¹³. In other words, if you stimulated the deafferented hand nothing happened (as you might expect); but if you touched the face, that part of the somatosensory cortex dedicated to the face took over some of the functions of the neurons that would normally have served the hand. And so for the rest of the arm too¹⁴.

Ramachandran then decided to apply these results to human amputees. Using magnetoencephalography, he found that immediately after amputation of an arm, sensory input from the face began to activate the hand area of the Penfield homunculus. Then, taking 18 patients who had had their arms removed by amputation or accident, he found that if you touched their cheek, they felt a sensation in the fingers of the phantom arm. What happened was that when the brain no longer received signals from the lost arm, the somatotopic area relating to it withered, and was partly transferred to the adjacent area, namely the cheek. In other words, the somatotopic map had been reorganized, over quite a distance – up to 2-3 cm away – so that there was now a map of the hand on the lower face region. Moreover, «the referred sensations were modality-specific... hot, cold, vibration, rubbing, metal, or massage, are felt as hot, cold, vibration, rubbing, metal and massage at precisely localized points on the phantom limb»¹⁵. This modality-specific referral from face to phantom limb occurred even a few hours after amputation.

The implications of these findings about neural plasticity and referred sensation were considerable. They opened up a number of therapeutic possibilities. They subverted then-current views of the stability of brain structures and neural circuitry by adding to the repertoire of the ways in which body maps can be updated over the course of a life.

The notion of a hard-wired brain took a knock. It became possible to conclude that despite the clear structural relationship between

body part and specific areas of the cortical body map, the sensory homunculus itself, like the whole being in which it is embedded, reflects the pressures of context and experience in its very physical constitution. (Of course the fact of cortical plasticity following injury is not sufficient argument against the evidence for task-dedicated cortical regions).

But there is more. One of the most frequent difficulties experienced by amputees is the phenomenon of pain in the phantom limb, sometimes very acute. Indeed, severe pain occurs in up to 70% of phantom cases for many years after loss of limb¹⁶. The classic example is that of Lord Nelson, who after the loss of his right arm at Santa Cruz de Tenerife, suffered from a terrible pain in his phantom arm, including the sensation of fingers digging into it (Nelson thought that the continuing sense of the existence of his limb offered proof of the existence of the soul).

«Some patients experience vivid voluntary movements in their phantom limb, presumably because reafference signals from motor commands sent to the phantom limb are monitored in the cerebellum and parietal lobe. However, over time, the phantom limb becomes «frozen» or «paralyzed», *perhaps because of a continuous absence of visual and proprioceptive confirmation that the commands have been obeyed* [my emphasis]. Some patients experience excruciatingly painful involuntary clenching spasms in the phantom limb; they experience nails digging into their phantom palm and are unable to open the hand voluntarily to relieve the pain»¹⁷. It was in working with such patients that Ramachandran and his student William Hirstein devised a simple but remarkable experiment to alleviate their pain and give them a sense of mobility in their lost limb.

They constructed a «virtual reality box» consisting of a box with a mirror placed down its center. On either side of the mirror they made holes through which the patient could place his living arm and his phantom. The living arm was inserted so that it was on the side facing the mirror; the phantom was held in proximity to the other side. Then they made the patient look down at the side of the box that contained the living arm and its reflection. In almost every case the pain disappeared, and the phantom seemed to regain sensation. A man who had felt his phantom arm completely frozen for nine years after his amputation suddenly experienced the most vivid sensation of movement in that arm. Another patient who had lost his arm 6» above the elbow had

experienced terrible pain in his phantom hand as he tried to make voluntary movements with it. It went into involuntary clenching spasms, rather Lord Nelson's; but when he looked at the illusory resurrected arm in the mirror, and was asked to clench and unclench both hands, he exclaimed that his movements had come back, and that he found the sensations enjoyable! 6 out of 10 patients they examined claimed that they could actually feel – not merely see – movements emerging in the phantom limb¹⁸. And most expressed pleasure or delight in the release from pain or the sense of a moveable limb.

The prospects for motor therapy via looking multiply. But in the context of the present argument, what Ramachandran's experiment demonstrates is the possibility of seeing a body, or actually feeling a body in a picture – even if one lacks the actual physiological resources to do so. The mere sight of a body part in an image is capable of making viewers think that it is part of their own.

1.2. VISUAL SENSATIONS AS SOMATIC SENSATIONS

The implications of these findings are clear. They offer powerful evidence of how «visual sensations are experienced as somatic sensations»¹⁹. They demonstrate that even in the absence of a limb, sight of a corresponding limb can have significant therapeutic benefit. Looking at a limb (or the image of a limb) can stimulate that part of the somatosensory cortex devoted to a limb that is lost. Even when the somatotopographic area related to a lost limb falls into desuetude, some of its sensitivity is taken over by an adjacent area. Perhaps most movingly of all, the results of the experiment suggest the possibility of healing a lost or disabled limb by looking at an image of a functioning one²⁰.

Ramachandran saw his experiments as instances of synesthesia – which, in a relatively limited sense, they are too; but their importance is greater than this²¹.

Most people have had the experience of a sense of physical engagement, or of some form of muscular arousal or another upon looking at a painting, sculpture, print, photograph, movie, or cyber-image. It does not happen always, but it happens often enough. That the quality of the experience may vary both from case to case and from genre to genre is not at issue here. Many viewers have the feeling of imitating

an action in picture or film, even when they do not actually imitate it. Museum visitors all over the world give outward physical demonstrations of an action they see in a picture (whether they have an audience or not). Sometimes their imitative action seems so spontaneous and apparently unprovoked that anxious guards rise from their chairs in anticipation of imminent damage to the work.

Who, in looking at scene showing a blow to another person, or about to be delivered to another person, has not had a startlingly vivid sense of the corporeal effects of such an action? Assaults to the seen body are transformed into a sense of assault on one's own body²². Even when the seen action is only imminent, one ducks, or feels the blow (or the imminence of the blow) to one's face, or nose, or solar plexus. A wound in the flesh, a gouge in the side – any form of violence to the flesh – is registered within the body of the viewer, often more vividly than we care to acknowledge. Such feelings may be especially strong in the case of the viewing of still pictures, precisely because the paradox of identification with a two-dimensional representation is all the more striking than in the case of moving or three-dimensional images.

Felt corporeal responses to the sight of all such insults and threats to the vulnerable body fall into two categories: either a sympathetic shudder; or a strong sense of warding off a potential threat to the body. We seem to feel the imminence of the blow to the body. We shudder, we move out of its way. It is as if physical feeling were transferred from the object of sight to the beholder herself²³. Indeed, one may shudder at the sight of a damaged, slashed or broken work too.

The phenomenon extends in unexpected directions. One may move one's body (or seem to move it) in the direction of brushstrokes; or attempt to re-enact the illusion of movement in a picture or film, irrespective of what it shows (it may not show anything recognizable at all), or of the figure at the center of the illusion. Viewers seem to feel in themselves, in their bodies, not just what the represented subject-matter is taken to feel, but also a sense of emulation of the gesture of the *maker*, of the marks of representation itself – even of the traction of the instrument that produces such marks.

Sometimes an image may have these kinds of effect; on other occasions it may not. It does not happen always, but it happens with sufficient frequency to merit attention and analysis.

It would be a mistake not to acknowledge the degree to which felt responses, as well as actual ones, are contextually dependent and

contextually modulated. Some movements and gestures carry the same meanings across cultures; others do not. Some basic movements and gestures, depending on the skill with which they are represented, provoke emulative responses universally and always; reactions to other kinds of movement may be entirely the result of cultural context or individual training. In many cases (but not all; the fashion would be to say all), viewers may be trained (or have to be trained) in order to be sensitized to particular movements; in many others a movement shown in an image may elicit an emulative response irrespective of its particular cultural meaning and irrespective of its existence within the motoric repertoire of a viewer. In such cases action imitation trumps learning and hermeneutics. You respond physically, or have a sense of responding physically, before you know exactly what the stimulus means. Your own body then provides a clue to interpretation.

1.3. THE RUBBER HAND AS MY HAND

At about the same time as Ramachandran was publishing his results, he and a group of other researchers did a number of experiments showing that the cross-modal transformation of seeing into feeling occurs not only in the case of phantom limbs, but in normal subjects too.

For example: the experimenter takes a dummy rubber hand and places it on a table in front of the subject. Just behind the dummy hand, he places a vertical partition. The subject places her hand behind the partition. When her hand is stroked, she thinks that the sensation of stroking comes from the dummy hand, not her own²⁴. The experiment demonstrates not only the projection of an observer's own somatic sensations onto some other body or object, but also the sense that one's own physical sensation comes from an object one looks at. The intimate and often intense relationship between looking and physical feeling emerges clearly enough: even though it is your own hand that is being stroked, the sensation seems to be in the rubber hand out there.

When Matthew Botvinick and Jonathan Cohen wrote their original article on this subject in 1998, they appropriately entitled it *Rubber hands «feel» touch that eyes see*²⁵. They made a realistic looking rubber hand, which they put on the table in front of them. Then they had someone stroke their own hand, placed under the table, with a small paintbrush, at the same time as the hand on the table was stroked.

What they – and then other subjects – felt, was that the sensation clearly came from the rubber hand, not from their own hand. *They experience the rubber hand, the hand out there, as part of their own body.*

Viewers experience a limb they see out there as their own: «experience», because not only do they *think* the limb is their own, they also feel it, they feel in that hand there a sensation that affects their own body, intimately and directly. It is a form of perceptual experience that is not at all conceptual²⁶.

Botvinick and Cohen's experiments offered further evidence for the fact that sometimes viewers feel the bodies of others – or even dead objects – as their own²⁷. While such a phenomenon may indeed have a large variety of psychological roots, what is fundamentally at stake is the neural basis for the very tendency to feel the bodies of others as one's own, both in reality and representation. I use the phrase «dead objects» partly because of its exceptional historical resonance: during the Reformation, Luther's challenge to rigid Catholic doctrine about images (in fact, it was a feeble riposte to what were seen as popular abuse of images) was to insist that people invested too much faith in what were after all only dead pieces of wood and stone. We now know more precisely what made them more than that. Images exercise the hold they do according to the degree to which they are capable of activating beholders' ability to enliven them. We are able to invest what we see – even in an image – with a sense of the activation of more or less equivalent parts of our own body, and of its muscles in particular.

In the experiments just cited, the sense of inward physical feeling of what you see out there, as if you yourself were in possession of such and such a body part out there, was assisted by actual actions, like stroking and touching; but what happens in the absence of any tactile stimulation at all? This is the critical question that arises in the case of a viewer's engagement with pictures, when she feels in her own body the very sensations she may attribute to represented others. In other words, what are the corporeal consequences of seeing a hand being touched, or the body of a represented other subject to some more violent touch, or physical assault?

One of the lessons of the phantom limb experiment is that it is possible to project into an image we see the feeling of our own limbs – even if they are tragically lost. And the vast literature that Botvinick and Cohen's article spawned provided further evidence of how easily one may have the vivid perception that one feels what an image of

a body, or a part of a body, appears to be feeling. Their article, like many of the following ones, was quite specifically about the relationship between touch and vision (your hidden hand is touched and yet you have the impression that the feeling comes from the represented hand, the hand that does not belong to you). Botvinick and Cohen themselves continued to insist that the displacement of feeling from what one sees onto oneself is a result of «intersensory integration» (as indeed it is), but Ehrsson went still further and referred to the phenomenon in terms of the «dominance of vision over proprioception». It is this that produces the illusion of owning part of the body of another (even though, as he and his colleagues emphasized in the same article «the feeling of ownership of our limbs is a fundamental aspect of self-consciousness»)²⁸.

Ramachandran's phantom experiment suggested how bodily feeling can arise from sight alone²⁹. In Ehrsson's experiments, test subjects typically developed a profound sense that the rubber hand they saw out there was their real hand within fifteen seconds. Moreover, they flinched when he threatened to smash his fist on the rubber hand. Subjects were also surprised when they realized they were unable to lift a rubber finger. They knew what was going on, but no amount of rational thought could dispel the sensory illusion. «They don't just think it», Ehrsson noted. «They feel it. They can't think it away», or, as Botvinick put it, «there's a very vivid perception [...] that you are feeling what it should be feeling»³⁰. But Ehrsson's observation that «they don't just think it» turns out to be most pertinent of all.

Botvinick, Ehrsson and others all spoke of these experiments as illusions. But the issues at stake had not simply to do with the deceptiveness of a particular illusion in making one think that the limb of another is a part of one's own body (as the popular press suggested). It was not simply a matter of hallucination. Their questions were rightly about the tractability and transferability of body ownership, and the correlative issue of self-identification (clearly subverted when we see and feel ourselves in the body of another). But the question of the nature of the projection of one's bodily self on to those of others in pictures (or vice-versa) was not addressed.

Critically for our experience of what we see, and of images of what we see, we now have at least an inkling of how and why we so often *feel* what we see, and why we so often react to the sight of the limbs and movements of others *as if* they were our own. But this elision

between self and other, between self and representation, is not only to be understood in terms of psychological and psychohistorical factors. The neurological dimension has now become much clearer too.

The out-of-body experiences Botvinick and Cohen described were set out on the basis of their own and their subjects' first-person reports; but – as they would not have been surprised to discover – it has recently been demonstrated that the main brain activity in the rubber hand illusion occurs in the premotor cortex, the area that prepares muscles for movement³¹. Indeed, the first article outlining these findings was entitled *Activity in premotor cortex reflects feeling of ownership of a limb*³². Shortly afterwards, Ehrsson and colleagues devised fMRI experiments to show that the internal sense of a physical threat to the rubber hand out there (which, as he puts it «you feel is yours») provokes a cortical anxiety response in areas critically associated with anxiety and interoceptive awareness, namely the anterior insula and the anterior cingulate cortex – both areas of considerable significance for the awareness of emotional responses of one kind or another³³. In providing a first step to understanding how we feel the bodies of others as our own, these experiments also suggest important clues to our identification with the corporeal and emotional sensations of others. They pave the way to a better definition of the role of empathy in the understanding of pictures.

But all this is not just a matter of responses to the living body. Even things out there, as we have just indicated, can be assimilated into the beholder's sense of her own body. Potential threats to objects, can generate emotional arousal too – not just in the case of sensations on rubber hands, or masks, but even of insensate objects like tables³⁴.

It is not surprising that Ramachandran should have begun his career principally as a student of vision. His research demonstrated some of the ways in which sight alone activates other sensory modalities in the brain, and gives a sense of physically feeling what one sees. It offered insights into the feeling of and relief from pain. It also led to a better understanding of the relations between emotion and movement, and of how we so often seem to imitate the actions of observed others. As the phenomenologists have long noted, we seem to move in the way we see their bodies move. While I am certainly not suggesting that a good work of art necessarily involves the creation of the illusory sense that the viewer's body is somehow in the work itself, subject to whatever pressures the representation implies, the new findings about polysensory

integration cast substantial light on the kinds of pleasure many people find in the movements they actually feel – and not merely see – when they look at works of art (and as much, for example, as they may find in watching the movements of the bodies of great dancers and sportsmen).

So to speak of «sight alone» or «merely seeing» would be to tell only half the story. All seeing involves the body and its movements. As Milner and Goodale concluded, «vision did not evolve to provide perception of the world in any obvious sense, but rather to provide distal sensory control of the movements in order to survive and reproduce in that world»³⁵. Perception itself acquires an essential dimension: that of the inevitability of its relation to the moving body, and to action for avoidance as well as for pleasure. To think of a history of images simply in terms of «merely seeing», or to analyze them simply in terms of their formal qualities, without linking sight or form to bodily feeling – to feeling *with* the body – entails neglecting their constant and irrevocable effects on our identities as persons. And a history of art that relies on merely seeing, on purely formal analysis, turns out to be futile, unless it involves a consideration of how seeing always involves the body.

1.4. BODILY RESPONSES IN THE HISTORY OF ART

In their various demonstrations of how visual responses may be transformed into bodily feels – even when that feeling involves a body part that no longer (or ever did) exist – the work of Ramachandran and his colleagues offered profound lessons for the entire question of embodied responses to images. But if the present vogue for this question in the humanities owes much to the work of feminist writing of the early 1970s and on, its earlier history was much less overtly political.

From Bernard Berenson, the art historian, to Maurice Merleau-Ponty the philosopher, and on to the ethnographic filmmaker David MacDougall, many writers discussed the ways in which spectators' bodies seem to be physically involved in the image she or he observes – even to the extent of seeming to mimic or participate in the actions shown there. Most of them acknowledged that a sense of felt movement could ensue not only from observation of figures in action, but also from the actions implied by the strokes and marks that are used in depiction itself.

More recently, the insistence on bodily responses to images has become an almost standard reaction to the kinds of disembodied formalism that prevailed for many years in the analysis of works of art³⁶. At last the history of art can look forward to a formalism that acknowledges the impact of seen form on beholder's body. It will take into account the bodily effects of the implied movements behind the maker's mark, and the traces of movement in the stroke, the chisel mark, and the moving camera itself – as well, of course, as the effects of bodily movement in the full range of performance art.

Already in the second half of the nineteenth and early twentieth centuries, German writers from Robert Vischer and Heinrich Wölfflin through Theodor Lipps and Johannes Volkelt made the bodily dimension of looking the basis of their theories of empathy (what Vischer significantly called *Einfühlung*, «feeling-in»)³⁷. A little later than Vischer, Berenson developed a striking theory about how the body is involved in the best works of art (particularly Renaissance art): in the first instance through what he called their «tactile values», their ability to evoke the sense of touch; and secondly through their ability to arouse in beholders a sense of imitative movement.

For Berenson the «life-enhancing» qualities of Renaissance art were directly predicated on the muscular feels evoked as a consequence of looking at particular works. To see figures engaged in muscular action of a kind the viewer does not actually possess induces in his body a sense of muscular potential that transcends reality. This produces the heightened esthetic response that Berenson notoriously described as «life-enhancing». Though his language may sound sentimental, the notion itself turns out to be of considerable relevance to the understanding of art – and it anticipates recent experiments on the felt imitation of observed actions.

Merleau-Ponty's phenomenology of art was founded on what he called the bimodality of seeing, on the ways in which the eye incessantly implicates the body. For him, sight is fundamentally embodied. When we see pictures, we are physically involved, even down to the level of the application of the paint, the brushstroke. Our hands seem to emulate the action of the hands of the artist³⁸. We have the sensation that our bodily responds physically to the picture, or to the actions of the bodies within the picture, or, even more critically, to the ways in which movement may be suggested by the artist, as if we were some sort of ghostly participant in her actions, or as if our bodies were physi-

cally emulating those same strokes and movements of the brush within in the painting, or in carving the chiseled planes – or modelling the forms – of this or that sculpture. And so on.

Many find these views attractive; others, more intellectual in their responses, feel they are not so plausible. But it is now possible to test not just our corporeal sense of others in pictures, or of the strokes within it, or the forms themselves, but also how these factors evoke emotional responses. The relationship between physical and emotional responses takes us even more by surprise in the case of responses to pictures than to humans themselves, precisely because it is so apparently mysterious – and therefore even more gripping.

For all its insistence on the physical, Merleau Ponty's work remained metaphysical. Berenson's views were predominantly impressionistic and subjective, a little too lyrically and sentimentally expressed for more recent taste – though much of it was derived from his mentor and subsequent friend, William James. Few of the very many contemporary writers about embodied responses to art and images have tried to define the actual bodily roots of embodiment – let alone consult the abundant recent neurobiological research on the physical consequences and correlations of looking. The phantom limb researches show how the mere sight of a limb can stimulate the physical feel of such a limb, even in one that is absent.

1.5. FROM VISUAL SIGNAL TO BODY PERCEPTION

What does it mean to say you see a body in a picture, say, a human body?

In the first instance it means that visual signals from a form that will later be perceived as a body pass from the retina along the optic nerve via the lateral geniculate nucleus to the primary visual cortex; and from there it goes upwards along the dorsal stream to the parietal lobe for processing in terms of movement and object location, and downwards via the ventral stream towards the temporal lobe for recognition. The dorsal stream for movement (like the other direct route from superior colliculus to parietal lobe) is, as already observed, the evolutionary older one, and thus prepares the observer for movement before the object is actually recognized as such; but the identification of this body of ours here with that body there – both preconsciously

and subsequently – is dependent in the first instance on the activation of the extrastriate body area (EBA), located in the lateral occipitotemporal cortex.

The implications of the phantom limb and rubber hand experiments for the ways in which we see the body in the picture through, with and even as our own, were further expanded by the out-of-body research by Olaf Blanke and his group in Lausanne, but earlier by the work on the EBA by Downing and Peelen, Kanwisher, and de Gelder. Blanke and others emphasized the role of both EBA and the temporoparietal junction in multisensory body-related integration, but suggested that they code differentially for embodiment and self-location³⁹.

When Downing and Kanwisher named the EBA in 2001, they found that it responds to both bodies and body parts, whether represented as photographs, line drawings, stick figures or silhouettes. It responds slightly less to eyes, ears, and mouths, and also less to the bodies of other mammals; and has still lower levels of response to faces and to objects and object parts, as well as to scrambled figures of the body (in whatever form presented – whether as line, silhouettes, or stick figures)⁴⁰.

It also responds to eye movements, gaze directions, the sounds of voices, and the inferred intentions of animate bodies more generally. For this reason, EBA has also been considered to play a critical role in the perception of socially relevant information.

Fast processing of configural information is not only typical of responses to faces, but also of responses to bodies, both in infants and in adults. In a set of careful experiments Gliga and Dehaene-Lambertz showed that even three-month old infants are able to recognize both configurations of faces and of bodies. They noted that «this could either be related to an innate knowledge of this particular type of biological object, or to fast learning through intense exposure during the first months of life»⁴¹.

And how very fast! It is hard not to say innate. The processing of faces and bodies, as Gliga and Dehaene-Lambertz note, is of the order of about 170 ms. after stimulus presentation (body images, like face images, produce a waveform known as the N170 that peaks after this interval – a waveform that is not generated in the case of objects)⁴².

And further cognitive processing follows.

1.6. SEEING-IN: FROM FORM TO FEELING

On the one hand, perception of the body as *form* of the body; on the other, awareness of how it *feels* to have a body, even that body. It is not just a matter of visual perception, but rather of the sensory aspects of bodily possession that very swiftly ensue upon sight of the body (or body parts) of others. Seeing-in becomes the projection of our own bodily knowledge into the bodies and limbs of others. It is not only recognition of the body seen as the form of the body, but also the instauration of the body seen as the site of sensory capacities which we feel through our own. The essence of multimodality: seeing as feeling.

One could argue that perception of the body could never be perception of form alone, that it is always experience of the body as body: either *that* real one, or *that* one in the photograph, or possibly even *that* one that is only a stick figure but somehow seems, on the basis of sight alone, subject to the same motoric, sensory and emotional conditions as the bodies we more fully know (or the bodies we flesh out, as we significantly say, on the basis of even the most rudimentary schemata).

But there is no such thing as sight alone: it is automatically transformed (for the most part) into bodily feels, especially at the sight of other bodies, or the suggestion of other bodies. The implications for our understanding of whatever it is we call imagination – whether understood as the evocation of mental images or of the whole range of sensory responses – are clear enough. They remain to be fully set out. The lessons of phantom responses provide a start.

Here novel possibilities for art open up as well. One begins to have an intuition of vast new areas of therapeutic potential. The imagination of seen movements can be trained, and such training can lead, even in the absence of limbs or of actual motor capacity, to the activation of parts of the motor cortex that would otherwise be inactive. Such training might help recover negatively impacted motor skills, or lead to the pleasures and rewards of a sense of the activation of previously dormant areas. And here the formal quality of an image might well be relevant to its therapeutic efficacy, and – possibly – coincide with perceived esthetic value that may or may not also coincide with its status as a work of art. At stake would be the kinds of emotional arousal that bring pleasure not merely not through the actual execution of a movement but also through the sense of such a movement. Two large practical questions immediately arise. How, through look-

ing, might one acquire motor expertise? And how might such looking be trained? Unguided looking would not be enough – though it would certainly be a start. Practice in looking becomes essential. At this point one must think much more critically than hitherto about the forms of education and practice that take one from looking to healing in the domain of body image pathologies.

2. THE PICTURE IN THE BODY

What happens, in fact, when the positions overturn? That is, what happens when a subject who has an intact body perceive it as defective and ardently wishes to amputate one or more of their healthy limbs? And, more generally, what happens in the mind of a person who feels a cognitive incompatibility with the image of a part or of his whole body? In short, how's the brain of those who hate their body so much that they want to get rid of it?

These are not purely rhetorical or speculative questions. Indeed, the history of the clinic puts many cases of this kind before our eyes. Cases in which there is a cognitive dissonance between a subject's own bodily image and his own corporeal consciousness. These cases certainly include the phantom limb perceptions that have been discussed in the first part of this essay in relation to the history of the perception of images in art, photography and, in general, in all visual cognition. In the many cases of phantom limb, it is, however, the body that perceives to possess or even seeks a disappeared part. The mind feels the weight of a «loss» and it is possible to imagine or experimentally demonstrate all the paths it has taken to reconstruct not only a representation, but also an embodied simulation by refocusing the mental states of the past.

Less well known and studied are the cases in which it is precisely this loss that the body consciousness invokes. It is a question of anticipating an event that will happen, that must necessarily happen, and therefore imagine a future state of mind. However, this does not make this state of mind, expected for the future, less embodied than the ones induced by the cases of a loss of what has already been possessed in the past. Actually, this urge to lose a limb is stronger than the desire of those who want to regain a missing part of the body.

This is what happens in those cases that are currently classified under the all-encompassing category of BIID (*Body Integrity Identity Disorders*), including the mental states of gender dysphoria.

2.1. BODIES THAT LOVE THEMSELVES AND BODIES THAT HATE THEMSELVES

The BIID are forms of pathologies that affect the relationship between the imagined body, which arises from an internalized narrative, and the real body.

Even in anorexia, in vigorexia and in the infinite manifestations of body hacking, this relationship is clearly altered (Pennisi 2020; Pennisi, Capodici 2020). But the alteration, as we will see shortly, goes in the opposite direction to that of BIID and gender dysphoria. The anorexic who looks at himself in the mirror is a skeleton who sees himself obese. Just as a superpalestrate who flaunts monstrous muscular mountains still judges himself frail. Or like an individual tattooed all over his body who, looking at his reflected image, only notices that he still lacks the coloring of the sclera (eyeball tattoo).

This kind of dysphoric behaviors, however, wants to improve the body to make it attractive and, maybe, to make it a love object for others. Obviously this happens only in front of one's own mental mirror which tells himself everything that the universal biological principle of sexual selection pushes him to. Even among non-human animal species, in fact, something very similar happens: the peacock, under the pressure of natural selection, has developed a wonderful colorful tail adorned with showy shapes, but this anomalous genetic evolution has made him lose the ability to fly and sing. The same can be said of the superb antlers of the alpha-male moose that ended up damaging its ability to move in forests full of low branches. One could continue to list a dense series of other «marvelous monstrosities» that have benefited sexual selection but, at the same time, have drastically limited other bodily possibilities of the more genetically showy subjects. Here it will suffice, however, to observe that among non-human animals the selection process takes place through gradual modifications of the body structure between generations without any contribution of a voluntary individual choice. This does not happen, on the contrary, in all cases of body modifications in the BIID, as we will see shortly.

We can therefore certainly unify the whole set of these pathologies or mental states under the label of «bodies that love themselves». In these cases the body image is always oriented towards the conservation and idealization of the body picture. It is the body that wants to love itself that produces conflicts. If we didn't love our body we wouldn't take care of it, we wouldn't do anything to improve it, to adorn it, to keep it intact. It is sexual selection that naturally pushes us in this direction. To put it with in the words of a famous anorexic (Fabiola De Clercq), anorexia is nothing more than hunger for love:

Disruptive and absolute hunger – the hunger that anorexic people try in vain to erase to pursue the radical myth of thinness, and bulimic people hope in vain to satisfy themselves by devouring everything – is only apparently aimed at food. In reality it is an insatiable hunger for love, hunger for authentic relationships, hunger for a fuller and more meaningful life (1998).

In BIID and gender dysphoria, on the contrary, we are dealing with bodies that hate themselves. The *Misoplegia* (now *Somatoparaphrenia*), e.g., described by Critchley in 1955 is a condition in which patients with hemiplegia refer disdain or even hatred for paralyzed limbs. Misoplegics verbally attack their diseased limb and often strike it with their hands or with an object. An elderly misoplegic woman spoke to her offended leg as if it were another person, cursing at it and repeating how much she hated it, as if she wanted to «get rid of this bugger» (the left limb, Loetscher *et al.* 2006, 1099). She often cried and declared that she would only feel happy if her left leg «were just dead». To persuade her to die, she would sometimes embrace her and caress her, reciting prayers in a gentle voice. In this case, and in almost all similar cases of misoplegia, there are always two concomitant events: a piece of the body that does not work or works badly and a neurocerebral alteration. In a certain sense, therefore, the misoplegic has serious reasons to hate his body: there are no «mystifications» of this body, they are not mental images generated exclusively by ruminations or inner narratives, but rather of jams in the body scheme. He is right to hate that defective piece of his body:

«Look at it!» – exclaimed with a grimace of repugnance a somatoparaphrenic patient of Oliver Sacks addressing his sick leg which he saw as separated from his own body and every time he thought he threw it on the floor he inexorably fell out of bed – «Have you ever seen such a creepy,

horrible thing? I thought a cadaver was just dead. But this is uncanny! And somehow – it's ghastly – it seems stuck to me!» (Sacks 1970, 54).

There is, however, a second category of bodies that hate themselves. At least apparently it's about, this time, healthy bodies, with all the organs functioning well from a physiological point of view. In this case the conflicts are generated by an apparently inexplicable disagreement between the body and its image. Body and mental image not only appear different but are completely incompatible, generating severe psychic and social suffering. People who live this condition cannot think – as in anorexia or in the other «bodies that love themselves» – to adapt, modify, improve their body using tools such as food, training, resistance to pain, while always remaining themselves. On the contrary, those who hate their bodies for an incurable conflict with their corresponding mental image must intervene at all costs and in a radical way: they want to deny it, amputate it, take it out. All the sacrifices and sufferings that these subjects impose to themselves, in these cases, have the purpose of transforming them into individuals different from those they are, or at least were at the time of birth. By not realizing this purpose, living becomes simply impossible.

All the sacrifices and sufferings that are imposed, in these cases, have the purpose of making us become individuals different from those we are, or at least were at the time of birth. By not realizing this purpose, living becomes simply impossible.

2.2. GENDER DYSPHORIA

The most frequent incompatibility between the body that the individual has and the one he feels is gender dysphoria. Males born in female bodies or females born in male bodies: a profound discrepancy between sexual identity and gender identity:

As a child I felt uncomfortable – says Matthias, the fictitious name of a dysphoric interviewed by us, who has gone from female to male – I was not in the right place, in the right body. I know: when I peed while standing, when I was different from my friends, when I played with them, and the ordeal started there. I didn't feel in the right body. It was not the right identity. To survive, I pretended it wasn't true, I ignored it. Until I was able to ignore it, I ignored it. It was with adolescence, when the body changes, that I started my forty-year journey. I was afraid. I was afraid of

the interventions, I was afraid of suffering physically. But it was nothing in the face of the discomfort I felt while remaining as I was (Spicuglia 2019).

Called «transsexualism» until the third edition of DSM, the Gender Identity Disorder (GID) has been used to indicate subjects with severe maladjustments towards birth sexual identity, persistent discomfort with their anatomical sex, and a sense of inappropriateness in the gender roles of that sex. GID always involves the concern to free oneself from the original sexual properties and the unwavering belief to be born in a body of the opposite sex to one's own. GID has long been confused with transsexuality or even homosexuality.

The transsexual, however, can also partially modify parts of his body, adopt psychological habits and existential behaviours different from those of the sex in which he was born, but he wants to preserve his identity, believing that his preservation goes far beyond the anatomical differences that, in many cases, he intends to maintain. In the same way the homosexual claims the integral preservation of the original body and would judge the anatomical change of sex in the same way as a violation of his civil rights, an undesirable homologation, a socially violent «normalization».

This normalization is, instead, exactly what the person who lives the GID wants. Not only he wants to close forever with the anatomy of his original body, but he also wants his new gender identity to be formally and administratively recognized. To achieve this, he is willing to do anything, even to risk his life. The murder of the «old» body is the only way to make the mental image reconnected with one's body self. The change of mental image in GID always involves undertaking an ontological adventure. In the case of Andreas Sparre, the first historically documented case of body transformation from male to female, this adventure begins with what in the autobiography of Lili Elbe (the new female identity of AS) is defined as the «emotional moulding, which is preceding the physical moulding into a woman» (Hoyer 1923, 165)⁴³.

A cognitively difficult development for the reformatting of his new gender identity:

It is certainly unjust of me to think bitterly of Andreas, but sometimes I am obliged to think of him, and then I do not quite know what to call him. I think I must call him my dead brother, and to this I must get accustomed. So much so that I cannot any longer realize that he and I have

dwelt in the same body and this body now belongs to me alone. [...] Perhaps I am the murderer of Andreas, and this idea tortures me fearfully, as I surmise that I shall perhaps be of much less value than he. He was a creative person (*ibidem*).

The old body from the Parisian past was dead. The new Lili returned to live in her hometown (Copenhagen). She understood that the experience of labor had been a natural consequence of the new bodily implant embodied on her. He perceived clearly «how her whole cerebral function had received a new direction» (*ibidem*, 243). Writing to the famous surgeon – Kurt Warnekros – who had operated on it in a Dresden clinic after the consultation of the Berlin sexologist Magnus Hirschfeld, Lili specified in detail this conversion, first physical and then cognitive:

In the first months after my operation it was necessary above all else to recuperate. When this had happened to some extent, the physical change in me began. My breasts formed, my hips changed and became softer and rounder. And at the same time other forces began to stir in my brain and to choke whatever remnants of Andreas still remained there. A new emotional life was arising within me. [...] I feel so changed that it seems as if you had operated not upon my body, but upon my brain (*ibidem*).

Andreas' sacrifice was not enough, however, for Lili to survive the *via crucis* of her much-desired bodily transformation. A few days after the last operation that would definitively change her body and mind, Lili died. Her extreme corporeal sacrifice had been more important than the danger of living an incomplete life, a missed existence.

In DSM-V the GID has now become «Gender Dysphoria», with an eye to both organic and psychological factors. The most obvious trait is that the person with gender dysphoria experiences an unbridgeable disharmony between biological aspects and gender identity, with the unshakeable belief to belong to the opposite gender and to be imprisoned in a body that is not of his own nature. The label «Gender Dysphoria» was created with the aim of depathologizing the phenomenon that in the ICD / 11-2019, the standard manual of the World Health Organization, was removed from the list of mental disorders. Like Lili, however, many other gender dysphorics have died or committed suicide. According to data surveyed by the National Transgender Discrimination Survey (NTDS) and published in September 2019 (UCLA) in the US as many as 80% of them have seriously thought

about suicide while 42% among males (MTF) and 46% among females (FTM) actually attempted it. Gender dysphorists commit suicide 10 times more than other people (4.5%). Desperation for a body they feel as alien by themselves is highest among young people (18-25 years) and lowest among older people (over 65 years) but it knows no limits or compromises. Just like for xenomelics.

2.3. XENOMELIA

An even more dramatic case of BIID is the Xenomelia. It is a pathology that affects, as in all other cases, individuals who experience difficulties in the relationship between the imagined and narrated body and the real body. In Xenomelia, however, the former denies the latter until he wants to physically eliminate it, abolish it, kill it not metaphorically but *carnally*. According to Kasten (2009, 17) these persons are firmly convinced that their body will only correspond to their mental body image after an amputation. The most frequent case concerns the refusal of one or both of the hind limbs whose amputation is desired. However, cases of desire for amputation of the hands, arms, or permanent damage to the auditory or visual organs are not uncommon.

Xenomelia doesn't want to destroy body function. The mobility of amputated legs or arms, deafness and blindness are in fact recovered through the use of artificial prostheses: the «transabled paradox» as Marie calls it, a twenty-year-old transsexual who has become hearing loss xenomelic-oriented. It consists of the apparent paradox that any xenomelic who manages to remove a piece of her body then wants to replace it with a mechanical prosthesis that ensures its behavioural continuity. One of the most disconcerting aspects of BIID is the dichotomy between incompleteness and hyper-completeness. The desire for amputation is not determined, as in phantom limbs, by the feeling that our body is incomplete but, on the contrary, by the feeling that it is *excessively complete*.

«I feel myself complete without my left leg. I'm overcomplete with it» – writes Tom, a case study for First (2004, 922) author of the first organic BIID questionnaire. A tragic case that leads a child to feel the unusual desire to lose a limb that exceeds his mental image of the body and that, within 20 years of frustrating attempts to realize it

with or without the assistance of doctors, ends with the surrender of suicide.

In First's questionnaire, as much as 77% of the Xenomelics of the sample indicates «feel whole, complete, set right again» (*ibidem*, 923) as the main cause of their choice to amputate. Furth-Smith (2000) also suggest that the subjects interviewed by them consider the idea of amputating a way to feel more skilled and more fully functioning, more whole, more complete. Their testimonies are in agreement on this point:

Sounds paradoxical – I would feel whole without my leg (*ibidem*).
I felt like I was in the wrong body; that I am only complete with both my arm and leg off on the right side (*ibidem*, 922).
The soul feels as if it belongs to a body with one leg. The body does not correspond to this inner reality (Kasten 2009, 17).

The logical argument is very clear: I feel *excessively* complete with that leg and, therefore, the amputation serves to bring my body back to completeness, becoming regular again as it should be. The function of that limb (or other organ) remains in the state of cognitive normality and, therefore, is re-implanted in the amputated part activating it through a mechanical substitute. The transition of functional ability therefore constitutes a transition from bodily technology to extracorporeal technology:

I feel like an amputee with natural prostheses – they're my legs but I want to get rid of them – they *don't fit my body image* (First 2004, 922).
I want to be deaf but I'd also use hearing aids to restore my hearing (Marie, Makemedead, 21/4/2007).

It is not the functional component, therefore, that defines the conflicted relationship between mind and body. This component works both before and after the amputation and must still be satisfied. The xenomelic wants to hit the body, or rather: his *brain-body* wants to hit his *not-brain-body*, to use the terminology of Alva Noë (2009; in Hutto-Myin 2017: *neural body and non-neural body*). The natural organs of this body are always fully functional. However, they are not perceived as harmonic parts of one's body: they are alien, depersonalized clippings, extraneous to both the scheme and the body image.

These are the only questions that absorb the full-blown xenomelic. He begins to devote all his time to realizing his aspiration, neglecting any other existential motivation: work, family, passions. His problems are all technical: «Will I be able to convince a doctor to amputate? how much will it cost me? and if I can't convince any surgeon how can I amputate myself without dying?». A single certainty feeds the aspirant: I must manage to free myself from this piece of body that torments me, which I do not accept, with which I cannot share anything about myself. And I'll do it.

Moreover, xenomelia forces the subject to immerse himself in a condition of social bodily solipsism. A condemnation to the inner isolation of one's own carnal feelings, to unbelief or even hostility of people, which even extends to the clinical sphere. Especially in the first cases of xenomelia (today there is some change of bioethical orientation on the problem) surgeons refused to take into consideration the desire of the aspirant amputee. In fact, clinical considerations are very often intertwined with ethical and religious ones, in the ideological sense of both terms (Pennisi 2020).

The xenomelic determination is however always stronger than any social pressure even if it appears as the most spectacular negation of common sense. A denial applied, moreover, to the most natural and obvious relationship not so much between the mind and the body, but between the brain body and the non-brain body: «The brain tells you you're one thing and your body is another» (NoJoke, 2/04/2007). «I am therefore confronted every second of the day with an unreconcilable incongruity between what my brain tells me I should be like and what my body is actually like» (*ibidem*, 28/03/2007) – writes April, an aspiring blind. The degree of irreconcilability between input received from the non-brain body and sensory-motor representation, in the case of sight, is truly absolute:

I should be ecstatic, as should every sighted person, that I can see all the wonders the Earth has to offer but the sad fact is that I can't enjoy those things because my brain is constantly telling me that the signals it is receiving from my eyes are wrong. At best I should see a murky, clouded blur of colors, maybe even nothing at all, and I cannot escape this. [...] In order to resolve the self-conflict to which I am subjected I have to be able to change one of two things. Either I can change my mind to make it accept my actual existence as «right» or I can change my body to match my self perception. I cannot change my mind though, the technology does not exist and is unlikely to exist at any point in my lifetime. I am therefore left

with one option: to end the ever-present, gut-wrenching sickness caused by this condition, I need to become blind (*ibidem*).

The constancy of all the testimonies of BIID subjects on the inevitability of body self-mutilation is an extraordinary case of compact and invincible cognitive coherence. The argumentative apparatus is the same for all types of body conflict. It is a calculation of the lesser evil between the physical damage to be done to oneself and the mental damage in persisting asynchronously with the state of affairs. As we have seen, social pressure, which can be very strong, does not alter the outcome of the calculation in the least. The only conflicts that xenomelic are forced to engage with the outside world and with themselves relate to the technologies to arrive at the fulfillment of their choice. The coldest one is the naked and raw self-mutilation:

I am left-handed [...]. I cannot use my right hand for it is not mine. My right hand is not attached to me mentally as it is physically. I don't feel complete with my right hand, every time I look at that thing I feel this overwhelming sense of emptiness and despair. The only way to end this feeling is obvious: amputation. [...] There is no way I can explain this disease that I carry with me [...] They would look at me as if they were talking to a madman. Furthermore, it is not so simple to enter a hospital and ask a surgeon to take your hand away for no reason [...]. So I will have to do it alone [...]. Taking my butcher knife from the cabinet drawer, I gently placed it on my right wrist. Looking at my pulse, I imagined what it would be like when he became free. I made the first cut. It hurt and stung. I winced but I knew I couldn't stop. I dug deeper into the first wound. Then even deeper, deeper, deeper. When I made the last incision, with tears running down my face, my lower lip dripping with splashed warm blood I tried to hold back the screams of pain. When I fell to the ground my hand was next to me on the cold, blood-soaked floor, no longer attached to me. The pool of blood around me shone in the light – like the feeling of looking at a lake under a full moon on a cold and peaceful autumn night. That nice feeling began to fade as my boundaries faded and blurred. I was finally free (Hurley, BIID. Perfect).

For the hands are very successful also the guillotines with a cutter, typically used by ISIS to punish thieves or harassers: tools already widespread in the Middle Ages. Much more complicated and hardly effective are technologies for amputating the legs. There are reported cases of gunshots in the knees; prolonged immersion of both legs in dry ice; «hanging» of the limbs – i.e. ligatures so tight that the blood

does not pass and the leg is gangrenous – even the use of electric saws and other risky methods of self-mutilation. Cases in which the subject craves total immobilization are not uncommon. It involves losing both hind limbs to always live in a wheelchair. In this case the only solution is that of illegal surgical intervention, not even being conceivable a «do it yourself» that contemplates the simultaneous cutting of the sciatic and femoral nerves.

In cases of deafness, we go from inserting long oil-soaked swabs into the ear canals, to using powerful ear buds that are used daily to expose the hearing to very high volumes, to pouring powerful acids into the ear canals. Similar treatments are found in those who want to lose their sight: exposure of the retina to sunlight for a long time; pouring of loctite glue or other cyanoacrylates (the well-known «Attack») into the pupils, as if they were normal eye drops. This small catalog of self-cruelty against oneself – which could be very extensive – nevertheless provokes in almost all cases the achievement of the aim pursued: a state of serenity and recomposed synchronization with one's body... in short: the *pax corporis!*

2.4. MESTRUAL, BREASTS, PENISES AND OTHER GHOSTS OF BIID

All studies conducted in the field of body image disorders converge on the complexity of these phenomena that involving biological and psychosocial factors. Hating the body in which you live is a mental attitude certainly induced also by cultural and social customs, sexual repressions, latent libidinal pressures. However, with the same pressures and repressions, not all individuals show such an unshakeable willingness to change not only psychologically but also physiologically their sex or body by submitting themselves to endless torments both in the case of Gender Dysphoria and Xenomelia. In the case of BID and BIID is certainly easier that organic substrates of various kinds favor the evolution of body identity if compared with the cases of the anorexics or other subjects that we have listed here as «bodies that love themselves».

From the sources that have disseminated all the medical reports of Lili's history – of which we have previously reported – we learn that even in her previous life, when she was Andreas Sparre, she had ru-

dimentary ovaries already in her original body. Furthermore, Lili was probably suffering from Klinefelter syndrome – unknown until 1942 – characterized by a chromosomal anomaly in which a male individual has a supernumerary X chromosome (47, XXY). His always looked like a female body, and in social life in both Denmark and Paris, Andreas was regularly mistaken for a young woman dressed as a man. On the other hand, even before the surgery, Lili had a greater amount of female hormones than male ones:

I have to say that when Andreas was taking part in Iven's ballet in Paris, he suddenly started to menstruate, without knowing it, just like a woman, that these discharges then recurred at regular intervals. [...] But that Andreas' blood was already my blood before the first operation, full of excretions of my ovaries? (Hoyer 1923, 282-283).

Not very dissimilar from Andreas's menstrual period, it is the phantom penis syndrome in gender dysphorics. In an important experiment conducted by Vilayanur Ramachandran and Paul McGeoch (2008) was, in fact, it was shown that a high percentage (62%) of the GID completely transformed from females to males, clearly felt the ghost's penis syndrome.

As we have already seen in the first part of the essay, the phantom limb syndrome consists in the sensation of still retaining a part of the body after an amputation, especially of the hands or legs. It is a very widespread phenomenon and on which there are many studies. The amputated part is part of a mental image which is not an «invented» narrative but is based on the corresponding mapping of the old limb in the cerebral cortex. In case of GIDs concerning females born in a male body – these subjects declared that they had felt the vivid sensation of possessing a phantom penis with relative phantom erections even before the phalloplasty operation. Some males feel absolutely similar sensations after a spinal cord injury or some women after a mastectomy (phantom of the breast). All humans, in essence, have a hard-wired representation of their gender organs as part of their body image in the brain. This would be the reason why even the women who pass through the other genus would feel the phantom penis:

This finding provides a striking vindication of the hypothesis that there is a hard-wired, neural basis for an individual's gender-specific body image down to the precise details of external sexual anatomy. It is especially remarkable that, in these individuals, the sensation of having a phantom

penis has survived a lifetime of contrary visual feedback, enculturation and being raised as a girl (Ramachandran, McGeoch 2008, 10).

The hypothesis is supported by important evidences. The descriptions were never vague but highly detailed: the subjects reported the specific length and curvature of the penis (left or right), different from what would have been in the model of their «ideal» penis. Phantom erections also occurred in situations not due to excitement: for example, suddenly in the streets, or in an elevator, on waking up in the morning or even in the middle of the night. When asked if this image had a metaphorical value, like having wings to fly or a multipurpose tail, the answers were all in agreement: the phantom of the penis was a real sensory experience, nothing imaginary. These phenomena, then, are part of a bio-psychic state that occurs as children, and some of them claimed to have «received» the phantom penis before childhood. Finally, they also manifest themselves in the opposite case of males passing through the female gender: as a ghost of the breast similar to the one of mastectomized women. In short, according to the hypothesis of Ramachandran and McGeoch, the gender-specific body image is perceived from the inside because it is *entirely wired in the brain*. Gender image and identity are dissociated in gender dysphoria. But the «new bodies» are nothing more than the natural return to that gender identity marked in the «old brain», probably already in utero (*ibidem*, 6).

It is known, in fact, that in the body the default chromosomal setting for gender is female: this could also apply to the brain. Towards the seventh month of embryonic development, the region that determines sex (SRGene Y on the Y chromosome) produces a cascade of effects that cause differentiation between the two genders. These usually occur simultaneously for both the brain and the body, while their dissociation would lead to gender dysphoria. According to the Ramachandran-McGeoch hypothesis it could happen, that is, that those hormonal factors in a genetically female (XX) subject lead the fetus to virilization of the brain and the consequent wiring of a male body image and gender identity in an individual whose external body morphology remains feminine.

Other aspects of more recent researches seem to be going in this direction. The researchers traced the areas of investigation on genetic factors, not only those mediated by hormonal action, but also those that derive from the expression of the X and Y genes within the non-

gonadal cells and cause sexual differences in their functioning (Ngun *et al.* 2011).

Heritability seems to play a significant role, especially in studies conducted on gender identity tendencies in twins (Van Beijsterveldt *et al.* 2006). In a study conducted on a relevant sample of twin couples (5799) of 3-4 years of age, the inheritance estimates of identity phenomena were much higher in females than in males (Knafo *et al.* 2005). The data was also confirmed in a study explicitly conducted on the heritability of gender dysphoria, also indicating a very high rate (40%) of homozygotes compared to dizygotes (Heylens *et al.* 2012).

Unlike the overall statistical evaluation of the heritability of the dysphoric traits, the search for strong genetic candidates did not give appreciable results. As Klink and Den Heijer write: «Due to the complexity of developing gender identity, it does not seem likely that a single gene will be discovered» (2014, 37). In many non-human animals (certain species of birds and rats) some brain gender differences cannot be attributed to hormonal factors, but to structural ones. Different structures of the human brain also have some gender-dependent differences. For example there are specific brain dimorphisms: in females the caudate nucleus, the hippocampus, the Broca area, the anterior commissure and the right parietal lobe are greater; in the male the anterior hypothalamus 3 (INAH3), the nucleus of the stria terminalis (BSTc) and the amygdala (Goldstein *et al.* 2001).

In addition to neuroanatomical differences, males and females differ in some neurochemical patterns that transmit and process neurosignaling, i.e. the internal signals of the brain to monitor the understanding of one's own cognitive or emotional state (Ngun *et al.* 2011). Some neuropsychologists claim that there are also cognitive gender dimorphisms. For example, men would be more suited to visuospatial tasks such as mental rotation (Voyer *et al.* 1995) or mathematical problem solving (Benbow *et al.* 2000). Women, on the other hand, would show greater verbal, articulatory and mnemonic fluidity (Becker 2008).

Some of these neurocerebral differences seem to correlate with data on gender dysphoria. E.g. in males transiting to the female gender, female dimensions (namely less than the average) were found in BSTc and INAH3. The latter is considered an important marker of early atypical sexual differentiation and, together with the former, they form a network functionally related to gender identity (Klink, Den Heijer 2014). Even these brain dimorphisms gender-dependent are

however influenced by hormonal processes and could therefore constitute a consequence rather than a cause of this type of data.

In short, biological, psychological and sociological determinants intertwine in gender dysphoria which we can fully consider a typical problem of social neuroscience. In fact, all the most recent models tend to look for new techniques at a broader level of the genome (with related ethological comparisons) or of the epigenetic mechanisms. What we can say with certainty is that in all the clinical and existential stories witnessed in the literature, hatred for one's body, which imprisons the individual in the wrong sex, cannot be circumvented and does not allow compromise: it must be changed to all costs with a biochemistry and surgery that will definitively unlock the psychological and cognitive construction of a future all within the opposite sex. This «new brain», as Lili Elbe called it in the correspondence with its surgeon-demiurge, has a very high carnal cost, at the limits of bodily self-denial:

For I do not want to be an artist, but a woman. Hence I must shut all artistic creation out of my life – you will remember I insisted on this during our last conversation – because I cannot continue the work of the virile artist who was Andreas. And in contrast to Andreas, who had to create the works of art from inner compulsion, my own life feels deflected from everything that constitutes art. Do I make myself clear? It is not with my brain, not with my eyes, not with my hands that I want to be creative, but with my heart and with my blood. The fervent longing in my woman's life is to become the mother of a child. Whether this wish can be fulfilled or not, the fact that I can openly acknowledge this desire from the fullness of a pure woman's heart is an infinite happiness for me. The fact that I may experience this happiness justifies everything that has happened to me here in Dresden. And because it is so, dear friend, the Confessions which I have placed in your hands must end on the note that expresses my strongest craving: I want so much to become a mother (Hoyer 1923, 279-280).

Even more than in gender dysphoria, also for Xenomelia a neurocerebral cause has recently been hypothesized. In an initial phase of the studies, the idea of a psychological origin of BIID prevailed, especially linked to sexual paraphilias often associated with Xenomelia. Another thesis that has enjoyed some luck is the one that would like to solve the embarrassing phenomenology of BIID in an entirely cultural phenomenon: «A new way to be mad» (Elliott 2000) due to psychological suffering in contemporary society.

In the idea of those who advanced this hypothesis – in truth not supported by the testimonies of subjects affected by BIID – the xenomelic impairment would become a sign of identity in the monotonous and shapeless crowd and paraplegia an indicator of the difference in a substantially indifferent world. The cultural foundations of BIID, therefore, would play the role of identity marks which should not be less important than biological factors.

In the clinical cases of the scientific literature, however, some constant behaviors can be seen in all xenomelic aspirants which suggest a strong contribution of the neurocerebral component.

The first is the inexorability of the path taken to damage the body. The testimonies we have told before highlight it beyond any reasonable doubt. The full-blown xenomelic cannot live an acceptable existence if he does not eliminate that part of the body that his brain does not recognize. Only under these conditions he will happily survive:

After more than 7 years as an amputee [of the left leg above the knee], I'm still extremely happy and content with my amputation and my stump! I can't imagine NOT being an amputee. I feel as though my body is now in tune with my mind! I do not regret my choice to get an amputation at all [...]. I love waking up and seeing my stump there. My stump is still very erotic and I do not suffer from any pain at all, including no phantom pains (in Noll-Kasten 2013, 53).

The second constant behaviour is the micrometric precision with which the xenomelics indicate the cuts of the amputations, being even able to draw the contours in the leg or arm to be amputated: «I can feel exactly the line where my leg should end and my stump should begin. Sometimes this line hurts or feels numb» (in Blom *et al.* 2012, 2; cfr. First 2004) This happens because brain mapping is decoupled not, generically, with the limb, but with a part that is often well specified.

A third characterizing aspect is a strong imbalance in the distribution of the desire for amputation: most want to eliminate the left limb, few the right one or both. Also this datum could indicate a neurocerebral origin.

The fourth significant circumstance is that the majority of aspirants have proven their amputation desires early in childhood. The earliness of desire can hardly be explained without resorting to an un-

happy outcome of neurodevelopment processes perhaps, even in this case, during embryogenesis.

Finally, there is a lack of symbolism, discursiveness, an absence of narratives that would justify the extreme gesture of the amputation. Unlike those of the «bodies that love themselves», the discourse on the body of the xenomelic appears raw, technical, in all its devastating incomprehensibility. There are no references to distant cultures to evoke, there are no religious, ideal or values motivations, there are not even particular psychological coloring, there is no motivating content if not the gesture itself and the technical description of its possible achievements (Pennisi 2020; Pennisi, Capodici 2020).

The xenomelics do not suffer also of particular mental disorders: generally are not neurotic, depressed, delusional, schizophrenic, paranoid. In fact, they are impressive because of their coldness in dealing with the only problem they care about: getting rid of a part of their body. On the other hand, BIID's *transabled paradox* taught us that the xenomelic does not want to protest against his bodily functions but only with that piece of meat that is unable to perform them.

In this context it is difficult to hypothesize that the cause of xenomelia can be the impression exercised by images of mutilated subjects in individuals that are particularly weak from a psychological point a view. It is true that the power of the images of the body self is a topic that should also be studied experimentally, but it has nothing to do with the irrepressible urge to cut off an arm, a leg, or to be blinded.

But what then does the disturbed manifestations of the mental image of the xenomelic body depend on? Important neuroscientific experiments carried out on a sample of these subjects led Ramachandran, McGeoch and other scholars to propose that these disorders derive from a congenital dysfunction of the upper right parietal lobule and its connection with the insula (Ramachandran, Mc Geoch 2007; Brang, McGeoch, Ramachandran 2008).

This dysfunction would lead to a decoupling of the body image construct in the right parietal lobe from what it is physically. Dysfunction can be detected either through functional brain imaging (magnetoencephalography – MEG) or through the Skin Conductance Response (SCR) which is the measure of continuous variations in the electrical characteristics of the skin, such as, for example, the SCR following the variation of sweating of the human body or, in the case in question, of stimulation with small electric discharges.

The experiments start from a characteristic of the xenomelic disorder that we have already mentioned: the fact that the subject does not generically indicate the limb that he wants to have amputated but precisely traces the line along which he wants the cut to be made. With this in mind, Ramachandran and colleagues tried to measure the Skin Conductance Response (SCR) in xenomelic subjects above and below the desired amputation line on each leg. Four points were measured: both feet and thighs above the designated amputation line. The patients had their eyes closed all the time. Then sensors were applied to randomly probe the four points. The results were surprisingly clear.

Xenomelics who desired an amputation under the right knee exhibited a double difference in SCR between the left and right legs below the amputation line, another double difference through the desired amputation line on the right leg, but no observed difference in normal limb. In xenomelics who desired a double amputation both under the left knee and under the right thigh the differences recorded were greater: there was a triple difference below the amputation line compared to above in both the left and right legs. Of course, nothing similar occurred in the control subjects. According to the researchers, these results prove that Xenomelia derives from the congenital malfunction of the upper right parietal lobule, which receives and integrates inputs from various sensors in the areas and from the insula to form a coherent sense of body image.

Magnetoencephalography (MEG) studies also reinforce this hypothesis. In a McGeoch et Al. study (2009) on xenomelic subjects, there was an absence of activity in the upper right parietal lobe (SPL) when the affected limb was touched, just like in the experiment on skin conductance. The dysfunction in the SPL causes the inability to represent one or more limbs in the deputy locus.

This has the bizarre consequence that, although the sick can feel the affected limb, in reality this is not integrated into his body image and induces the desire for amputation and the feeling of being «incomplete». The specific location of the much-desired amputation, in fact, may depend on the exact position of the modification of the connections between the SPL and the primary and secondary somatosensory cortices or their projections to limbic structures such as the insula. What is singular is that the somatosensory input from the limb is intact while the leg is missing from the body image. An inverted phantom limb.

2.5. THE BODILY IMAGES: COMPLEX MENTAL STATES

Would the mystery then be revealed? It is still early to say. Hilti *et al.* (2013) studies agree with Ramachandran's theses. These studies described structural anomalies in the right parietal cortex and in the right anterior insula of xenomelic subjects, placing them, like Ramachandran himself, at the somatoparaphrenias (Karnath and Baier, 2010). Also Blanke *et al.* (2009) in a study of twenty xenomelics subjected to a long behavioral questionnaire identified abnormal brain mechanisms in the right fronto-parietal cortex.

Not all scholars agree, however, with this neuroscientific approach, also because Xenomelia is a point of escape for the cognitive sciences from which all possible philosophical, neuroscientific, sociological, psychological, and aesthetic interpretations. Peter Brugger, one of the most important BIID researchers, together with Bigna Lenggenhager and Melita J. Giummarra (2013), hypothesizes, in fact, a social neuroscience of the Xenomelia that integrates the neurological, psychological and sociological approaches with the philosophical ones of the body self-awareness. They contest the generality of the reference to the insula which «representing pretty much every thinkable function». They are convinced of a still valid link between sexual paraphrenia and xenomelic damage precisely because the insula not only integrates interoceptive bodily sensations, but is a decisive region for the convergence of somatoesthetic and sexual arousal. They also highlight how several studies on pathological manifestations in the clinical histories of some xenomelics have highlighted the problematic nature of an exclusively neuropathological approach: the transition from a desire to amputate the right leg to the one to amputate the left leg (Kasten, Stirn 2009), e.g., or the sudden reappearance of the need for amputations after the satisfaction of the former (Sorene *et al.* 2006). Finally, they support the ineffectiveness of the flattening of mental or psychic problems over neurocerebral ones, as well as a lack of attention to the phenomena of brain plasticity which, lasting over time during the development of each individual's life, could explain the connection between neurobiology, environment and socio-cultural influences (including the very powerful ones of the telematic space).

More recently Brugger and colleagues (2016) have returned to the assumptions of Ramachandran and McGeoch. Accepting, this time, the thesis of an involvement of the right upper parietal lobe (SPL) and insula, however, they brought new data that enrich both

the neuroscientific and multifactorial framework. Compared to the first framework, they observed in more recent studies that xenomelics show a reduced sensitivity to disgust in relation to images of bodily violations (Bottini *et al.* 2015): which would confirm and expand the thesis of insula dysfunction (but would strengthen also the paraphiliac-sexual component which is always considered constitutive by Brugger). Another constructive observation regards the fact that neurocerebral dysfunctions have been observed only in relation to the desire for limb amputation, but not for those blind or deaf subjects that we have seen to be important xenomelic phenomenologies.

Despite these acknowledgments of the neuroscientific component, Brugger continues to support the centrality of the psychological aspects. E.g. citing the fact that for about half of the xenomelics the desire for amputation was triggered by the sight of an amputee. This would suggest a role of empathic factors that could remount the mirror neuron system's neural prerequisites and their effects on imitative activity.

An intermediate position was recently formulated by Aner, Schmitt and Kasten (2018). They proposed a theory that would bring Xenomelia back to the typology we have here called «bodies that love themselves». According to them what answers the question asked in the chapter of the essay entitled «What is beauty?» is that we would consider «attractive» what depends on those principles developed during evolution and genetically wired in the brain, as they support the conservation of the species. In practice, the authors have developed a theory that human animals show an ideal of beauty rooted in those external biological traits that have brought a greater selective advantage. Among these traits, in addition to the shape of the face, prosperous breasts, youth, thinness and long hair in women who seem more suitable for reproduction, nursing and care of offspring, the importance of the general morphology of the male body also emerges. Women, in fact, react positively to the muscular V-shaped figure of a man with broad shoulders, well-trained legs and a well shaped bottom, because at the dawn of humanity this indicated that the man was a good hunter and could bring enough hunting for his family. These ideals of beauty, however, could be «modifiable by genetic defects as well as result of environmental events or, possibly, also by small pre-, peri- or post-natal brain damage of this beauty area in the brain» (Aner *et al.* 35). Just as men may like large women with small breasts and no

younger women with short hair, women like vigorexic men and transsexuals like individuals who show the attributes of the opposite sex (at birth) to their own, so BIIDs may be attracted to one-legged individuals. This theory, while recognizing that there may be a neural substratum in BIIDs, tends to assimilate this type of disorder to different «aesthetic tastes» that may vary in humans thanks to «micro-change in one of the brain areas in which the main physical features of human beauty are established» (*ibidem*). In essence, all aesthetic criteria of beauty would depend on the neurocerebral parameters that dictate cultural tastes and, conversely, their exceptions. The latter hypotheses approach the opposite positions, but, at the same time, they simplify them to such an extent that the explanations they give are unusable⁴⁴. They resemble a clumsy mix between the origins of neuro-aesthetics (Zeki 1999) and those of the first evolutionist psychology (Barkow *et al.* 1992).

This thesis has been strongly contested by Ramachandran in all the writings that we have reported previously, to the point of ridiculing it («others have proposed that seeing an amputee at a young age has caused this to be somehow “imprinted” onto the sufferer’s psyche as the “ideal body image”. Bizarrely, it has even been suggested that the supposed phallic resemblance of an amputee’s stump is the underlying motivator», Brang *et al.* 2008, 1305).

Notwithstanding the fundamental disagreement, in another essay Ramachandran however resorts to a reconstructive hypothesis involving mirror neurons in the origin of the formation of body self-awareness. The self is not for him a holistic property of the brain but a function of specific sets of interconnected brain circuits. Its main characteristic is recursion, that is, the property of turning within the self, of turning one’s own attention to one’s mental image.

The specific neurocerebral components on which this property would be based have their roots precisely in the mirror neurons which are highly concentrated in the lower parietal lobule of great apes and in humans. With the evolution of the brain in hominids, the lobule divided into two turns – the supramarginal gyrus and the angular gyrus. The first specialized in reflecting on the body pattern that allows to anticipate the actions necessary to avoid damage in the spatial movement. The second in the management of the body image and, probably, in the social and linguistic aspects of the left hemisphere of our cerebral self. Hence the emergence of self-awareness:

I suggest that self awareness is simply using mirror neurons *for looking at myself as if someone else is look at me* [...]. The mirror neuron mechanism – the same algorithm – that originally evolved to help you adopt another’s point of view was turned inward to look at your own self. This, in essence, is the basis of things like *introspection* [...]. Is often tacitly assumed that the uniquely human ability to construct a *theory of other minds* [...] must come after an already pre- existing sense of self. *I am arguing that the exact opposite is true*; the TOM evolved first in response to social needs and then later, as an unexpected bonus, came the ability to introspect on your own thoughts and intentions (Ramachandran 2007).

Of course Ramachandran immediately takes precautions against the naive interpretations of this thesis by declaring that mirror neurons are not sufficient for the emergence of the self, otherwise the self-awareness of the other primates should also be supported. The recursive predisposition of mirror neurons is indeed intertwined in human animals with areas of language (in particular with the Wernicke’s area that allows their understanding) and with part of the frontal lobes.

If these hypotheses were true, one could explain not only the pathology but also the physiology of the body image and its power of self-identification. In this way, an explanatory perspective would emerge that holds together, under the unifying action of ontogenetic development, both the purely biological components of the brain-body and the non-brain body components, as well as the adaptive, psychological, social and cultural components of the environment in which we live. On this point both Brugger and Ramachandran seem to converge:

If correct, our hypothesis will offer both a neurological explanation of, and a potential therapy for, a long neglected, chronic and currently untreatable condition. Additionally, if it is an uncoupling between one’s internal body image and one’s actual physical self that leads to BIID, then a clearer understanding of how this happens could cast light on how the normal brain constructs body image (Ramachandran, Mc Geoch 2007, 252).

The integration of social, psychological, and neurological views of xenomelia will offer a unique way to explore the reciprocal influences between brain, mind, and society in relation to corporeal awareness and the experience of the self (Brugger *et al.* 2013, 5).

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ENDNOTES

¹ The process is to be distinguished from the problem of what esthetic philosophers call «seeing-in». See especially Wollheim (1980; 1987). Wollheim's position that seeing something in a picture comes prior to recognition – that seeing-in is to be distinguished from seeing-as, to use his terms – is consistent with the position taken here; but it differs from it in its dependence on his view of twofoldedness as essential to esthetic experience. See also Levinson, (1998); and K.L. Walton (1990).

² In this case the question is about the sense that what is happening to that body there is in some dilute sense also happening to mine here; in the other it is about the sense that my body is *there*. One phenomenon precedes the other (the latter before the former); suffering makes the difference.

³ I don't add «imaginatively» here, because imagination has its roots in the cortical correlates of bodily feeling (as I shall eventually set out at greater length elsewhere). It cannot be divorced, let alone detached, from its basis in our biology.

⁴ This emerges with some clarity in several studies of out-of-body experiences by Olaf Blanke and his group in Lausanne, as in note 4 below. But see also the important and now well-known discussion in Ehrsson, Spence, Passingham (2004).

⁵ See the study of asomatognosia (the feeling that part of one's body has disappeared from corporeal awareness) by S. Arzy *et al.* (2006).

⁶ Eg. amongst very many others, S. Arzy *et al.*, (2006); Blanke *et al.* (2004); Blanke *et al.* (2002); Schwabe, Blanke (2007); Lenggenhager, Mouthon, Blanke (2009); Lenggenhager *et al.* (2007).

⁷ Ramachandran, Hirstein (1998), 1605 citing Moser (1948) Ramachandran and Hirstein provide further relevant statistics here.

⁸ The term itself was introduced by Silas Weir Mitchell (1871; 1872).

⁹ Brugger *et al.* (2000).

¹⁰ Ramachandran (1993); Ramachandran, Hirstein (1998), 1619. The phenomenon extends beyond limbs to the loss of other parts of the body as well. It occurs not only in the case of external parts of the body (such as removal of the breast and parts of the face) but in internal ones too. Patients experience phantom bowel movements and flatus after removal of the sigmoid colon and rectum, ulcer pains after partial gastrectomy and even phantom erections and ejaculations after removal of the penis in paraplegics. On these see the many citations in Ramachandran, Hirstein (1998), 1605.

¹¹ Sherrington, Brown (1912).

¹² Cf. Pons, Garraghty, Mishkin (1988).

¹³ Ramachandran, Hirstein (1998); Ramachandran, Rogers-Ramachandran (2000), p. 317.

¹⁴ This example of cortical plasticity followed Merzenich *et al.*'s earlier demonstration of how areas representing the fingertip, for example, could substantially increase in size following repeated stimulation or use. See Merzenich *et al.* (1984).

¹⁵ R Ramachandran, Rogers-Ramachandran (2000), pp. 317-318. Here in fact they cite, for example, Ramachandran (1993), *Behavioral and magnetoencephalographic correlates of plasticity in the adult human brain*; and Halligan, Marshall, Wade (1994).

¹⁶ Sherman (1980); Sherman, Sherman, Parker (1984).

¹⁷ Ramachandran, Rogers-Ramachandran (2000), 318.

¹⁸ Ramachandran, Rogers-Ramachandran, Cobb (1995); Ramachandran, Rogers-Ramachandran (1996); Ramachandran, Hirstein (1998), 1620-1622.

¹⁹ Ramachandran, Hirstein (1998), 1622.

²⁰ A few years later, O'Neill *et al.* (of the Dublin Pyschoprosthesis group) constructed Virtual Mirror box using «Augmented Reality Technology», whereby they could create and show a much closer resemblance to the amputees' perception of their own phantoms (which of course do not necessarily correspond to the image of the good arm in the mirror in the non-virtual mirror box). The virtual box can thus allow for phantom limbs to be virtually tailored to visually resemble what the amputee thinks them to be; and the results of viewing this apparently more authentic limb – which will therefore seem to entail a wider variety of possible movements – further enhances the therapeutic value of the visual experience. See K O'Neill *et al.* (2003); Desmond *et al.* (2006).

²¹ Indeed, in terms of the relevance for issues in contemporary art that also have broader significance, Ramachandran's work on phantom limbs has an important resonance for the understanding of the meaning of prosthetic limbs in contemporary art, such, for example, as in the case of the work of Matthew Barney.

²² For the neural substrate of such effects, especially in the insula and the anterior cingulate cortex, see now Ehrsson *et al.* (2007).

²³ To say that physical feeling is transferred from the object of vision to the viewer herself is by no means to claim that the feeling is the same as that experienced – or intended to be conveyed – by the object of sight, whether in life or in a picture. What is conveyed is a physical feeling, though it may not even remotely approximate to the intensity of what is seen in reality or of what is supposed to be felt in representation.

²⁴ Ramachandran, Hirstein (1998), 1622-1623.

²⁵ Botvinick, Cohen (1998).

²⁶ As Alva Noë would claim, in a book that otherwise has much in common with the present one, Noë (2004).

²⁷ Botvinick, Cohen (1998); Ehrsson, Spence, Passingham (2004).

²⁸ *Ibidem*, 875.

²⁹ Ehrsson has in fact insisted that these out-of-body experiences are attributable to multisensory coordination in the parietal region, as also in the work of Blanke and team Ehrsson, Holmes, Passingham (2005).

³⁰ As cited by Spice (1998).

³¹ Passingham *et al.* (2004), Ehrsson *et al.* (2005).

³² Ehrsson, Spence, Passingham (2004). For the role of ventral premotor cortex in particular in the feeling of limb ownership, see now the stroke and lesion study by Zeller *et al.* (2011).

³³ Ehrsson *et al.* (2007), 9828.

³⁴ Ramachandran, Hirstein (1998): 1622-1623. cf. also Botvinick, Cohen (1998), 756.

³⁵ Milner, Goodale (1995), 11.

³⁶ The time is ripe to reclaim a more directed and focused formalism than the arbitrary formalism that pervaded so much of twentieth-century criticism.

³⁷ But not, in Lipps's case quite specifically, the basis for esthetic experience. See most clearly Lipps (1903).

³⁸ For a firmly art historical position on this, see Rosand (2002).

³⁹ As in Arzy *et al.* (2006).

⁴⁰ Downing *et al.* (2001); Peelen, Downing (2005).

⁴¹ Gliga, Dehaene-Lambertz (2005), 1328.

⁴² *Ibidem*; Meeren, van Heijnsbergen, de Gelder (2005).

⁴³ The story became famous thanks to the book *Man in to woman*, by Ernst Ludwig Harthern-Jacobson (under the pseudonym of Niels Hoyer) who rewrote Lili's biography reporting her personal diaries in accordance with her last wishes. The same story was also freely reconstructed in David Ebershoff's novel *The Danish Girl* and Tom Hooper's film of the same name.

⁴⁴ Kasten's theses could be advantageously applicable more to «devotees» and «pretenders» than to «wannabees». In literature, in fact, there are three levels that can, sometimes, also constitute three stages of the relationship with disability: devotion, pretension and aspiration. In the first, disability is pure libido: the devotee feels only an irresistible and exclusive attraction for the bodies of disabled people. The pretenders are not disabled but they learn to act as disabled people in every way: they simulate every behaviour by pretending to be amputees and spending a good part of their time in a wheelchair feeling in this state very strong sexual excitement. In the wannabees, the acclaimed Xenomelics, the fetishist or exhibitionist desire disappears completely or, at most, remains as a faded background. Their problems are no longer sexual in nature but ontological. Unlike the first two, the wannabees really mutilate themselves. Kasten's theses tend, in fact, to shift xenomelia towards paraphilias, i.e. those bodily behaviors of a sexual nature inspired by the libido models typical of devotees and pretenders (cf. Pennisi, 2020, 1.2.4).