This limb is mine but I do not want it: from anatomy to body ownership


The experience that the body is part of the self, and in particular that my body belongs to me in all its parts, in a coherent and continuous way, is a fundamental aspect of consciousness. Moreover, a normal sense of body ownership is critical for our daily interaction with the objects of the outside world. The different processes that are involved in the building up of normal body awareness are far from being clear. A classical distinction, introduced by Head and Holmes (1911), is that between body schema and body image. Body schema is generally regarded as an unconscious, bottom-up, dynamic representation, relying on proprioceptive information and involved in enabling and monitoring motor actions. Body image is considered to be a more conscious, top-down, cognitive representation, mostly used to make perceptual judgments. More recently, the unified concept of body matrix has been introduced that captures functional features like multisensory processes that are relevant for the construction of body awareness (Moseley et al., 2012).

At first glance, the sensation that I have a body, and that I am that body, is so self-evident and immediate that it seems there is nothing to explain about it. The ‘feeling of the same old body always there’ (James, 1890) is part of our identity from the beginning of our conscious life, and appears to be a sensation so intimately tied to all aspects of our mental processes that even when parts of the body are severely affected by either brain damage, as in hemiplegia after a stroke, or by peripheral traumatic injuries, as in limb amputation, patients can still have the experience of a ‘normal’ functioning of their body. In anosognosia for hemiplegia, patients are convinced that their paretic limb can still move, and it has been proved that their altered body awareness is based on normal neural signals that affect the motor behaviour of the good side of the body (Garbarini et al., 2012). Similarly, in amputees, phantom sensation (rephrasing James, the feeling that the same old body is still there) are often observed, indicating the persistence of ‘normal’ body sensory–motor maps despite the
absence of a body part (Franz and Ramachandran, 1998). These two pathological conditions paradoxically show normal functioning of some body representations despite modified body conditions. We may speculate that the construction of body awareness is reached by the contribution of so many different neural networks, implementing both body schema and body image process, to be resistant, within certain limits, to different pathological assaults. The idea of an enduring sense of coherent body awareness is evolutionary plausible and may be the base of the feeling of unity and ownership experienced when we think to ourself.

In this context, the disorder studied by Hilti et al. (2013) in the current issue of Brain is completely counterintuitive. Indeed, xenomelia, previously called apotemnophilia or body integrity identity disorder, is a dramatic condition in which sufferers, who apparently do not have history of brain damage, desire the amputation of healthy limbs. Often the desire for the amputation dates back to childhood, and sometimes it started after exposure to an amputee. It can also be accompanied by a sexual attraction for amputation of own or others’ limbs.

The interpretation of such an astonishing mental status has been controversial. The sexual component, the analogy with gender disorders and the frequent co-occurrence of psychiatric symptoms have favoured for a long time a pure psychological/psycho-dynamic interpretation (De Preester, 2011). However, many subjects have been reported to be ‘sane’ and ‘rational’, without any other psychological problems, with the exception of the emotional strain related to the desire for a different body. On the other hand, some features of the disorder have pointed to the possibility of a neurological origin of xenomelia (Brang et al., 2008). For instance, the limbs most frequently involved are the lower limbs and in particular the ones on the left side, suggesting some sort of hemispheric asymmetry for the anomalous desire. More importantly, both subjective and objective sensory abnormalities have been reported: when asked if the limb ‘felt different in some way’, subjects may say that the limb felt ‘like it was not their own’ and may also report experienced sensations in the limb they want to be amputated less intensely as compared with their other limbs (First, 2004). Moreover, in some cases, xenomelic subjects want the operation because they feel ‘incomplete’ (De Preester, 2011) or ‘over-complete’ (McGeoch et al., 2011) with four limbs, but would feel more complete with three, suggesting a distortion of body image. The subjective experience reported by these subjects is associated with alteration of objective parameters.

Brang et al. (2008) found heightened skin conductance response to pinprick, in two subjects, below the desired line of amputation, while McGeoch et al. (2011) found a selective reduced activation in the right superior parietal lobe in magnetoencephalography scans during tactile stimulation of the affected leg when compared with both subjects’ unaffected legs and that of control subjects. Therefore, different observations point to the possibility that the disorder may be interpreted within a theoretical framework that takes into account possible impairment in body representation. In this respect, the article by Hilti et al. (2013) is a fundamental step for clarifying the nature of the disorder. The principal aim of the study was to investigate whether there are structural abnormalities that may explain xenomelic subjects’ behaviour. The study was carried out in a relatively large sample of subjects (considering that the disorder is rare, 13 xenomelic ‘patients’ constitute an important database) that makes the observations reliable and an important starting point for future research. The results show that, compared with normal subjects, xenomelic patients have alterations in the cortical architecture and, in particular, a reduced cortical thickness and volume in the superior parietal lobule and reduced cortical surface area in the inferior parietal lobule, in the somatosensory areas SI and SII and in the anterior insular cortex and frontal operculum. These observations are enlightening because the areas involved in the disorder are often indicated as crucial in the construction of the feeling of owning a body, therefore suggesting a tight link between xenomelia and an impairment of complex circuits responsible for the integration of fundamental information for the establishment and maintenance of the sense of body ownership.

It is of greatest interest, in this respect, that some of the areas that Hilti et al. (2013) associate to the xenomelic disturbance partially overlap with brain areas found to be damaged in a neuro-psychological disorder, known as somatoparaphrenia, which strikingly parallels xenomelia. In its classic form, patients, after right hemisphere lesions, deny the ownership of their left limbs, a behaviour that can be seen as the extreme consequence of the feeling of strangeness that some xenomelic subjects declare having towards their left limbs. The lesional pattern recently associated with somatoparaphrenia involves a complex and distributed right fronto–temporo–parietal network extending to subcortical structures (Gandola et al., 2012), and to the insula (Karnath et al., 2010). Therefore, the behavioural/anatomical similarities between the two disturbances suggest that impairments in one or more regions identified in the studies reported above and now by Hilti et al. (2013) may affect the construction of a coherent body image, possibly destroying a specific part of it, to an extent that patients either deny the ownership of the affected limbs (as in somatoparaphrenia) or they want to get rid of them because of the stress caused by the distorted representation (as in xenomelia). We are still far from fully understanding the kind of distortion experienced by the patients in these syndromes, but their analogical aspects would suggest a specific and localized alteration of body image so that body representation is somehow ‘missing’ the area of the affected limb (Brang et al., 2008). This might be congenital in xenomelia, and the abnormalities found by Hilti et al. (2013) would, therefore, be the cause, or a facilitating factor, of subjects’ feeling of left limb strangeness (and not the effect, as might be argued), whereas in somatoparaphrenic patients, the firm belief of dis-ownership is acquired as a consequence of a complex, and more severe, lesional pattern (Gandola et al., 2012) that would lead to the misidentification of the affected limb.

For xenomelic patients, one question we can ask is how do they feel after the amputation? There are not many reports on that, and it is not clear whether they experience phantom limb sensations. The hypothesis of the existence of an analogically impaired body image before surgery would actually predict that after amputation, being the body aspect coherent with the body image, patients should not have any phantom limb sensation. This might be a question to be addressed in future research. Another point that may deserve further investigation is related to the ‘motor’ aspect of the limb affected by the amputation desire. Hilti et al.
(2013) note that despite the feeling of strangeness they experience for the affected limb, xenomelic subjects are well aware that they are the agent of the action they perform with that limb, that is they do not show any sign of anarchic hand syndrome (Schaefer et al., 2010). However, although agency might be intact, motor intentionality and motor awareness for the affected limbs might be affected by the sense of dis-ownership. Body schema and body image interact and one might predict reduced motor intentionality and, consequently, reduced motor activation for the limb that might not be represented (or under-represented) in the body image of xenomelic patients. Such findings would further strengthen the interpretation of xenomelia as a disorder imprinted in body representation and especially would be in keeping with the concept of body ‘as source or power to action, i.e. as the variety of motor potentialities that define the horizon of the world in which we live’ (Gallese and Sinigaliga, 2010). In any case, the article by Hilti et al. (2013) demonstrates the hardwired nature of xenomelia, or at least of its main features, and, supporting the validity of using an anatomo-clinical correlation model, represents an important contribution to understanding how an apparent self-evident sensation, like body ownership, is built up in a complex and multidimensional way.

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Anna Berti  
Department of Psychology, University of Turin, Via Po 14, Turin, Italy

Correspondence to: Anna Berti, Department of Psychology, University of Turin, Via Po 14, Turin, Italy  
E-mail: annamaria.berti@unito.it

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