Illustrations of phantom limbs are intriguing as they depict an invisible perception. But such illustrations are also important: they provide a form of objectivity to phenomena, which particularly in the past, have often stretched credulity. Acknowledging the paradox of using images to reveal an absent though sensate body part, depictions of phantom limbs are discussed from the neurological perspective, starting with medieval pictures that showed the miraculous restoration of limbs, and which possibly represented pictorial metaphors for a phantom limb. Centuries later, phantom limbs—whether resulting from amputation or deafferentation—became illustrated, and some reasons for their illustration are considered. Although often depicted by others, the most precise and perhaps revealing illustrations of these phantoms have been those made when patients guide the artist, or draw the phantom themselves. In the case of phantom pains, the painful component too is sometimes illustrated, again, as with the miraculous, in metaphorical terms. More recently, depictions of phantoms have also been revealing in studies of some underlying mechanisms of phantom phenomena, notably in demonstrating novel patterns of referred sensations after amputation and attributable to cortical plasticity. Mention is made of photographs of phantom hands visualized using a mirror box, such visualization recalling full circle the miraculous restoration of limbs pictured in the past. The nature of the outline of the phantom is included in a discussion of demarcation of an invisible body part, before concluding that images of phantom limbs provide an invaluable background to understanding and studying these remarkable sensory phenomena.

Keywords: phantom limb; illustration; miracle; perception; deafferentation

Introduction

Images of phantom limbs are enigmatic and intriguing, for they depict missing body parts whose existence is subserved by illusory sensory perceptions for which objective evidence is necessarily unobtainable. Yet these images are invaluable, because they enable the amputee to reveal to others what they experience, and, by making the phantom corporeal, clarify the curious features of the phantom, such as the abnormal posture of limbs or parts of limbs, telescoping of distal structures proximally, and gaps in the phantom limb. The present paper aims to discuss how images contribute to understanding the phenomenology and some underlying mechanisms of phantom limbs.

Medieval miracles and phantoms

How can something be illustrated for which there is no apparent proof of existence? Viewed in this way, images of phantom limbs recall images of any number of other phenomena for which
evidence is absent, with religious images providing perhaps the most compelling examples: no one has seen any of the scenes described in the Bible, or miracles recounted, yet countless images of them have been created. That illustrations of phantom limbs and of religious imagery unexpectedly share features in common is exemplified by those images that illustrate religious legends in which amputations are followed by restoration of limbs.

Such images date at least 600 years, an example being the 15th century Spanish painting illustrating the miracle performed by Saints Cosmas and Damian. In this miracle, the diseased leg of a devout man is amputated and that of a deceased Ethiopian is transplanted in its place, some depictions showing the new leg in the process of being attached to the stump of the amputee’s leg (Fig. 1), whereas others show the attachment to be complete. Such miracles form part of the iconography of the phantom dating from medieval times, and 18 illustrations ranging from the 14th to the 17th century are included in the medical, folkloric and historical accounts of the phantom limb phenomenon collected by Price and Twombly (1978).

That these early depictions indeed illustrate phantom limb phenomena is strongly supported by some of their accompanying commentaries that parallel reports of the sensations sometimes described by amputees with phantom limbs—for example,

‘...during the three days that followed the restoration of the leg, the toes of the restored foot were not yet mobile nor extended but were grown together into a fist and could not be used. In addition, the lower limb itself was without its natural heat and color...’ (Price and Twombly, 1978).

Thus, developing the suggestion that loss and miraculous restoration of body parts constitute a metaphorical or symbolic representation of the phantom limb phenomenon (Price, 1976), the image of a restored limb in place of an amputated one may represent a metaphor for a phantom limb. That a metaphor was employed was hardly surprising, a phantom limb surely being inexplicable and too strange for amputees to report, at least until Ambroise Paré’s brief reference to the phenomenon.

Ambroise Paré, the famous 16th century French military surgeon, is usually recognized as being the first to describe the phantom limb (Paré, 1551), but he did not illustrate the phenomenon, and phantom limbs were subsequently described by numerous authors, including René Descartes, Aaron Lemos, Charles Bell and Silas Weir Mitchell (for historical review see Finger and Hustwit, 2003). Weir Mitchell contributed greatly to the description of the clinical features, and is also noted as having first used the term ‘Phantom Limbs’, the title of his article that appeared in 1871 in Lippincott’s Magazine (Mitchell, 1871). He had previously described the phenomenon in a fictional account for a lay audience, which appeared in The Atlantic Monthly in 1866. In this story, which Weir Mitchell published anonymously, a quadriamputee in the presence of others ‘walked across the room on limbs invisible to them or me’ (cited in Whitaker, 1979). Although Weir Mitchell’s seminal account of 1871 is just seven pages long, it described almost all the features of what he described in terms that again recalled the miraculous as the ‘unseen ghost of the lost part’. He too did not illustrate the phantom limb, and it appears that images of phantom rather than ‘restored’ limbs have emerged perhaps only during the past century.

Why illustrate phantom limbs?

As Halligan has discussed in his thought-provoking review, what is curious is that phantom phenomena were seemingly ignored for centuries, despite their occurrence throughout time immemorial. He goes on to argue that

‘the prevalent common sense assumption of phantom experience as pathological is wrongheaded and largely based on a long-standing and pernicious folk assumption that the physical body is necessary for experience of a body’ (Halligan, 2002).

I suggest that illustration is a powerful tool in correcting this wrongheaded assumption, because illustration serves to validate what are otherwise solely patients’ anecdotal accounts, whether verbal or written. Providing a permanent record, the picture or model bestows validity and objectivity to phenomena that—at least in the past—stretched credulity. Even a few decades ago sufferers often distrusted the reality of their sensations, and disbelief in what was experienced and fear of insanity were not uncommon (Riddoch, 1941). Even in the particularly devastating instances of
severe phantom pain, ‘many amputees are afraid to discuss their phantom pain with their doctors for fear of losing their credibility…’ (Sherman, 1997). But an illustration, however rough, and whether created by the sufferer or someone else on their behalf, reveals and documents the phantom convincingly and for all to ‘see’. Furthermore, illustration provides an invaluable aid when considering possible mechanisms subserving phantom phenomena. Some of these aspects are considered in the observations that follow.

Who draws the pictures?

Although numerous different phantom body parts have been described, including for instance the breast, bladder and rectum (Melzack, 1990), it is mainly phantom limbs that have been illustrated. Thus there are countless pictures of phantom limbs, which are commonly and conventionally shown as dotted outlines, that provide a simple, usually stereotyped diagrammatic representation; double and even triple phantoms—such as those reportedly induced by hypnosis in a patient who had undergone three amputations—have been depicted using such dotted outlines (Fig. 2) (Cedercreutz, 1961). Such diagrams can be striking and revealing, just as in the similarly stylized representation of the phantom hand of an amputee who subsequently underwent the Krukenberg operation; in this procedure the forearm stump of an amputee is split to allow pincer movements of the stump to be achieved. How eloquent is the diagrammatic demonstration that, remarkably, the phantom hand too has become split (Fig. 3)—revealing ‘for the first time that alteration in the structure of the stump causes alteration in that of the phantom hand’ (Kallio, 1950). Typically such explanatory diagrams have been made by others rather than the patients themselves. However, drawing precisely what the amputee actually perceives is different, and two approaches are feasible: patients can describe what is experienced so as to guide the artist, or patients can themselves illustrate the features.

Examples of the first approach, in which others interpret graphically what is described, are not uncommon, and some examples are shown in Fig. 4 (Solonen, 1962). The reader gains an impression, albeit stylized, of the complex phantom phenomena actually experienced by these amputees. A recent and particularly powerful form of visual representation, again involving the patient himself, is the digitally-manipulated and 3D realization of the phantom, an example being the amputee’s phantom hand, perhaps somewhat telescoped but isolated and remote from his stump (Fig. 5). The artist, Alexa Wright, aimed to accurately model the missing part so as to show what the patient perceived in respect of their phantom, and was guided by the patient himself.

The second approach to depicting phantoms, comprising illustrations created by patients themselves, are less common. However, sometimes patients have been encouraged to draw
what their own phantoms feel like. For instance, Haber (1956) interviewed 24 unilateral above-elbow amputees, and at the end ‘each subject made a pencil drawing of his phantom limb’; examples are shown in Fig. 6. These amputees’ drawings illustrate very simply but effectively various phantom phenomena, including phantom limbs that appear telescoped with the hand drawn up into the stump, and others that show extended limbs with or without gaps. These forms of pictures are compelling because, although crude and unembellished, they are personal testaments to what the patients experience, and confirm graphically the repertoire and consistency of the phantom phenomena.

Rarely phantoms that result from deafferentation, rather than loss, have also been illustrated by patients themselves, as in the pictures drawn by a professional sculptor who sustained a spinal cord transection with complete loss of sensation below D8 (Avenarius and Gerstenbrand, 1967). His drawings convincingly reveal the phantom position of his legs (Fig. 7). Another example demonstrating the value of even the very simplest of diagrams is the unusual depiction of a ‘third arm’ in a patient who suffered a stroke resulting in a severe left hemiplegia with sensory loss, hemi-anopia and neglect (Halligan et al., 1993). The patient insisted he had a ‘third arm’ that originated from the top left corner of his torso, but clarification of exactly where the patient himself located his phantom, a term he used himself, was provided when he drew his supernumerary, phantom limb on a body outline drawn by the examiner (Fig. 8).
The use of pictorial analogy to depict phantom pain

Sixty to eighty per cent of patients who have amputation of a body part, particularly a limb, experience various forms of pain, which is severe in 5–10% of patients (Nikolajsen and Jensen, 2001). While in drawings of phantom limbs the memory of the previously intact limb can aid in its illustration, how can phantom pains—sensations that the individual will never have experienced before—be shown? Pain cannot be illustrated, and, just as with verbal descriptions of pain (Schott, 2004), there has to be resort to analogy and metaphor—and examples of such visual metaphors such as crushing and stabbing have often been used to illustrate various forms of pain, including those associated with the phantom limb (Fig. 9) (Solonen, 1962).

Pictures that illustrate mechanisms subserving phantoms

Images discussed above and which illustrate the phenomena associated with phantom limbs are used to convey sensory perceptions. Other forms of image have a different function—namely to illustrate mechanisms subserving the phantom, and reference of sensation following amputation has received particular attention.
over the past two decades. For example, sensory stimuli applied to the cheek are sometimes felt in the phantom hand, and the precise point-to-point topography of these referred sensations has been very usefully illustrated by means of diagrams. These valuable diagrams illustrate an underlying shift in cortical representation of body parts, i.e. the functional remapping attributable to cortical plasticity, which follows loss of a body part. To be easily understood the topographical data depend on illustration, as shown in Fig. 10. Figure 10 shows that focal stimuli applied to the face were referred to individual fingers of the phantom hand, shown with the thumb numbered 1 (Fig. 10A); the topography of finger representations had slightly changed after 6 months (Fig. 10B); and a second map of the fingers was elicited by stimuli applied to the upper arm (Fig. 10C) (Ramachandran and Hirstein, 1998). Diagrams such as these are very revealing, forming the background to the extensive neurophysiological and imaging studies that seek to clarify the mechanisms subserving phantom limb phenomena, especially pain (for review, see Flor et al., 2006).

A related phenomenon, again likely subserved by cortical plasticity, is that revealed by the mirror box (Fig. 11), whereby the missing body part is ‘restored’ by means of the reflection of the opposite, intact limb—an effect sometimes exploited to restore...
the sensation of mobility and to reduce pain in the phantom limb (Ramachandran and Hirstein, 1998). This effect strikingly recalls the observation reported by Weir Mitchell (1965) that ‘if...we substitute for the lost limb an artificial member...the sense of sight will soon refer, in our consciousness, the hand or foot to its old position’. Thus ‘restoration’ to awareness of an absent limb can occur both by means of a mirror and by a prosthesis, and these ‘restorations’ recall the miraculous restorations illustrated in the past. Also notable here is that the photographic image showing the ‘restored’ phantom limb in the mirror in Fig. 11 recalls the picture of the similarly ‘restored’ prosthetic limb painted 600 years ago and shown in Fig. 1.

Another, related way in which illustration contributes to understanding phantom limb phenomena are the diagrams that show the topography of referred sensations in the phantom limb elicited by vibrotactile stimuli applied to the pectoral region (Kew et al., 1997). The diagrams in this PET study, however, do not illustrate phantom limbs; rather, the diagrams depict the cutaneous sites on the intact body from which sensations referred to the phantom were produced. In other studies too, diagrams have been used to demonstrate similar phantom phenomena—for example, the phantom sensations induced following tactile stimulation of distant points in lower limb and breast amputees, and the topographic changes over time of the areas that elicited phantom sensations in a patient with an amputated left index finger (Berlucchi and Aglioti, 1997).

Yet another use of diagrams in studies of phantom limb phenomena are the schematic representations of the position of the phantom arm in patients who underwent local anaesthetic blocks of the upper limb (Melzack and Bromage, 1973). Temporary deafferentation led to the ‘phantom arm’ being felt at the side of the body and bent at the elbow, or above the abdomen or lower chest; the real arm lay flat beside the body, and the number of subjects who reported the phantom arm in each position was appended on the diagrams. Here again the diagrams were made by the experimenters and not the patients, but the diagrams added some objectivity to the patients’ accounts, and enabled the experimenters to conclude that ‘our perceived limbs are, at least in part, images based on central neural activities and are not solely the result of feedback from our real limbs’ (Melzack and Bromage, 1973).

Demarcating the phantom

Illustrations of phantom limbs present a further paradox, because not only are they depicting body parts that are missing, but what is being depicted is not the actual body part but a sensation. It is thus the sensation of a limb that is shown by means of a diagram or a picture, even if not a photograph, which usually consists of an outline, or contour, demarcating the extent of that phantom sensation. Despite its representation, however, we are not aware of such demarcation—an aspect that touches on some concepts...
concerning the body-image (Schilder, 1935; Critchley, 1950; Tessari et al., 2010). Thus, on closing our eyes with our arms held still and outstretched in front of us, we cannot feel the extent of our limbs and where our fingers end. ‘There is a tendency towards the dissolution of the body-image. When we close our eyes and remain as motionless as possible, the body image tends towards dissolution’ (Schilder, 1935), yet phantom limbs are nevertheless pictured, not as vague shapes but as clear-cut outlines. The same empirical consideration applies to Penfield and Boldrey’s homunculi, which too were necessarily drawn with outlines demarcating the extent of the body parts mapped over the cerebral cortex (Schott, 1993). Thus, from the graphic perspective, depictions of both phantom limbs and homunculi similarly incorporate outlines of the extent of imaginary structures. Such considerations touch on the dichotomy between ‘how we perceive our body to be, and how we remember or believe that it is’ (Longo et al., 2010), and illustrations enable us more readily to imagine, though never experience, what a phantom limb feels like to the amputee.

**Conclusion**

Illustrating phantom limbs and other body parts is an intriguing endeavour: it enables the phantom body part resulting from loss or deafferentation to achieve some corporeality and objectivity, albeit not reality. Such illustrations arguably date back several centuries to the miraculous ‘restorations’ of amputated limbs,
and in the past century have ranged from simple drawings to recent computer-generated images of phantom limbs. But if illustrating a phantom limb is at the same time paradoxical by virtue of displaying something not only absent but solely sensory, the mechanisms subserving phantom phenomena are becoming less enigmatic. It is increasingly recognized that the amputee's experiences of these sensory phenomena, often realized through illustration, can contribute to understanding the nature of the body schema and the widespread network of neurons—the neuromatrix (Melzack, 1990)—postulated as being the substrate for ‘the body in mind’ underpinning the phantom (Halligan, 2002).

Many images of phantom limbs have thus not only been poignant and of significance to those who have lost limbs, but have also provided much of importance for those studying these remarkable sensory phenomena.

References

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