Phantom Limb Pain: An Energy/Trauma Model

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Phantom limb pain (PLP) is a form of chronic neuropathic pain that responds poorly to treatment interventions derived from the neuroanatomic understanding of pain and analgesia. Several new psychological and behavioral treatments that have proven more effective have been explained by invoking neural plasticity as their mechanism of action. Other novel treatments that are based on an "energy medicine" model also appear to be quite effective, especially when addressing the psychological trauma of the amputation itself, a factor that is generally overlooked in the standard surgical approach to limb amputation. A speculative trauma/energy model for the etiology of PLP is proposed. This model is developed in some detail, and its utility in explaining several anomalous aspects of PLP, as well as the clinical efficacy of energy therapies, is outlined. This model is proposed as a step in the development of simple and effective energy/trauma treatment protocols for this widespread and largely treatment-resistant disorder.

Key words: phantom pain, trauma, energy psychology, PTSD, chronic pain, EFT

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INTRODUCTION

Phantom limb pain (PLP) is a poorly understood form of chronic pain in which patients perceive pain sensations that seem to come from a limb that has been amputated. PLP was first recognized in the 1600s by French surgeon Ambroise Paré as a common sequela of blunderbuss wounds[1] and was well-characterized during the American Civil War by military surgeon Silas Weir Mitchell.[2] PLP has been described by novelists ranging from Herman Melville (in *Moby Dick*, Captain Ahab noted that "a dismasted man never loses the feeling of his old spar, but it will be still be pricking him at times")[3] to Stephen King (the protagonist in *Duma Key* drew artistic, if malevolent, inspiration from his phantom limb sensations)[4] and JK Rowling (the hero of her pseudonymous novel *The Cuckoo's Calling* "could still feel the missing foot…he could flex the vanished toes if he wanted to.").[5] Yet, despite its lengthy history, PLP is often resistant to standard medical and neurosurgical treatments for pain. Over 150,000 amputations occur annually in America due to accident, injury, or surgical necessity, and over 60% of amputees report phantom pain of "bothersome" or worse intensity, with 87% of these having symptoms persisting more than two years after the amputation.[6] The pain is intense and often leads to depression and suicide, while the related but benign phantom sensations are so realistic that patients will often attempt to walk on their phantom leg or reach for objects with the phantom hand. The need for a simple and effective treatment for this disorder is now more important than ever, given its increased incidence in US combat veterans in Iraq and Afghanistan who have suffered limb loss from improvised explosive devices (IEDs), as well as in local civilian populations exposed to IEDs and dormant land mines from earlier wars.

The leading medical model to explain PLP sees the pain as being generated by aberrant peripheral afferent nociceptive signaling originating from a neuroma at the amputation stump and persisting due to central sensitization. In this process, repeated afferent pain sensations become centrally generated even in the absence of significant peripheral input. This model predicts that intervention at various central and peripheral levels of the neuraxis should be analgesic, yet medications [opiates, anti-convulsants, selective serotonin reuptake inhibitors (SSRIs), and tricyclics], nerve blocks (of the sensory nerves and of the autonomic ganglia), and surgical ablations do not prevent the persistence of PLP in a majority of patients.[7] With the advent of functional brain imaging, a neural plasticity model of PLP has emerged in which cortical re-patterning is felt to generate anomalous pain sensations as part of the central nervous system's attempt to reestablish homeostasis after the elimination of the previous sources of afferent input; the somatosensory cortex that maps to the missing limb is reprogrammed and re-patterned by input from adjacent sensory zones.[8] Once again, however, treatments derived from the neuroplasticity model have also been disappointingly ineffective.[9]

Therefore, other models to explain and treat PLP should be sought. For example, in the mind/body approach to medicine, the role of stress and emotions is felt to be crucial in sustaining many illnesses, including chronic pain. In fact, cognitive–behavioral approaches to the management of chronic pain have become the mainstay of multidisciplinary

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pain treatment centers in recent years.[10] Therapies based on enhancing the mind/body connection—biofeedback, hypnosis, and meditation—have been somewhat helpful in teaching patients to better manage their PLP by increasing functional activity and decreasing utilization of healthcare services, but they have not been curative.[7]

Hence, an alternative paradigm may be needed to adequately explain and treat PLP, one that includes components missing even from a combined biomedical plus mind/body Western allopathic approach. To this end, it is important to note that many healing systems around the world incorporate a therapeutic dimension known as "subtle energy." This invisible vital force is called "qi" in Traditional Chinese Medicine (TCM), "prana" in the yoga practices of Ayurveda, and "ruach" in Jewish mysticism. But despite rising awareness of the efficacy of many forms of so-called "energy medicine," Western allopathic medicine has remained mechanistic in its approach and has resisted the notion of an innate vital force, elan vital, or healing energy. Paradoxically, the concept of homeostatic balance itself is well accepted by allopathic medicine, but it is felt to result from biochemical or physiologic processes rather than from the action of any invisible energies. In fact, since the furor generated by Franz Mesmer's work with "Animal Magnetism" over 200 years ago, Western medicine has been loath to invoke any of the invisible energies described in TCM and Ayurveda which purportedly bring about internal harmony, balance, and health.

However, recent advances in the field of biomagnetism suggest that these ancient forces may have a physical correlate in the human electromagnetic field (EMF). Though this relationship between subtle energy and electromagnetism is speculative, the connections are tight: for example, the Motoyama device used by many acupuncturists to assess activity in the meridians is detecting changes in electrical charge that arise in response to the input of a weak electrical pulse. The flow of prana/qi can be seen either as an exact equivalent to EMF changes or as a more subtle underlying cause of EMF changes. So, these energetic fluxes, whether at the level of EMF or of subtler energies, may help to explain many of the vagaries of PLP's etiology, diagnosis, and management.

In particular, "invisible energies" might help to explain such anomalous features of PLP as the vividness and accuracy of the phantom sensations and the rapid efficacy of energy-based modalities. Hence, it is becoming increasingly important to investigate links between the worlds of PLP, energy medicine, and biomagnetism. In fact, PLP may serve as an ideal bridge or crossover point between the Western medical model and the Eastern energy-based perspective. What follows, then, is a speculative, observational, and phenomenological attempt to develop an energy-based model for PLP that is built on an emerging body of clinical and experimental evidence.

OTHER EXPLANATORY MODELS

Moving beyond mechanistic and mind/body models for PLP, we will now consider two additional perspectives to enhance our understanding of PLP: the post-traumatic stress disorder (PTSD) literature and the realm of energy medicine.

Trauma and PLP

An extensive literature documents the connections between PTSD and chronic pain. Retrospective studies have shown significant correlations between traumatic life events and various types of chronic pain. For example, meta-analysis shows that chronic pelvic pain and related gynecological problems are associated with a high incidence of childhood sexual abuse.[11] A high correlation exists between the diagnosis of chronic pain and the incidence of childhood abuse of a sexual, physical, or emotional nature, with a 50% incidence of abuse in patients on an inpatient pain management unit, compared to a 20% incidence in controls.[12] The mechanism for this trauma/pain connection is presumed to be a priming of the limbic system by the trauma's early and sustained activation of the hypothalamic–pituitary–adrenal axis, creating a central sensitization that leads to a future propensity for somaticized stimulus perception.[13]

Research in a pain/trauma connection specific to PLP is preliminary. A survey of 75 amputees whose injuries were sustained during the Northern Ireland "troubles" showed a 67% incidence of PTSD; however, no comparison group was studied.[14] Another study found low rates of PTSD by Diagnostic and Statistical Manual of Mental Disorders (Fourth Edition) (DSM-IV) criteria in patients on an inpatient amputee rehabilitation service.[15] However, those patients were not assessed for degree of PTSD intensity via a scaled instrument. The diagnosis of PTSD was judged to be either present or absent, in accordance with the non-parametric assessment instrument used. PLP was relatively uncommon, and it is possible that those less frequent cases were associated with mild or moderate traumatic symptomatology, but not full-blown PTSD.

Individual case reports[16] show a strong connection between PLP and PTSD. One survivor of the Tiananmen Square shootings has described how his amputation pain flares up in a sort of somatic flashback whenever he hears fireworks[17]; survivors of the 2005 London bombing also reported pain flashbacks.[18] Similarly, individual reports highlight the importance of psychodynamic factors like loss and grief about the amputated limb itself in sustaining or resolving PLP.[19] Unreported case studies from this author's clinical experience support the possibility that unresolved emotional wounds from the original amputation may be a key factor in the maintenance of this disorder. PLP patients commonly report persistent emotional distress when remembering the trauma, no matter how long ago it happened: the sense of helplessness experienced during a motor vehicle accident, or the shock of awakening from surgery to discover that an unanticipated amputation had been performed, or the fear elicited by remembering how the original injury occurred.

This type of psychological trauma is typically not addressed by acute care surgeons or by physical therapists and occupational therapists during post-amputation rehabilitation with the new prosthetic limb. No studies have assessed the impact of standard psychotherapy like cognitive behavioral therapy (CBT) on post-amputation psychological trauma or PLP. However, several novel energy-based forms of psychotherapy collectively called Energy Psychology (EP) appear to be

particularly effective in treating PTSD, suggesting the potential value of an integrated energy/trauma approach to PLP.

Energy Dynamics of PTSD and PLP

Albert Einstein demonstrated that energy and matter are interconvertible: $e = mc^2$. Matter is theorized to be energy in a more condensed or precipitated state. Similarly, in the view of energy dynamics that developed from the meditative and mystical traditions, the physical body is only the most dense of several interpenetrating bodies that are all composed of the same underlying subtle energy of consciousness. These hypothesized energetic layers (called "sheaths" in Ayurveda) expand outward from the physical core of flesh and blood into layers of increasing vibrational frequency and decreasing density, much as the substance H_2O transforms from ice to water to steam as its thermal energy level increases. The energetic layers that are less dense than the physical body include the distribution network of the acupuncture meridians, the emotional (or astral) body, the mental body of "thoughtforms," and the highest energetic level of Spirit (whose individualized expression is known as the Soul). These outer layers comprise the energy field, or aura, and their frequency signatures are set by a vertical axis of energy centers called chakras.[20,21] While there is clearly a bi-directional causal link between energy fields and the human body, these energy structures (chakras, meridians, and sheaths) can be conceived of as the pre-existing templates from which the biological organism is created, much as iron filings align into a geometric pattern in accordance with the invisible lines of force that comprise the underlying magnetic field.

Energy's key role in health and illness is acknowledged by Traditional Chinese Medicine, which believes that an impaired flow of qi leads to low energy and disease, while the free flow of qi leads to abundant energy and radiant health. This insight allows us to begin to address the philosophical conundrum of the relationship between mind and body—i.e., which comes first, which is causal, how do they interact, etc.? Energy becomes the "missing link," the previously overlooked connection between mind and body, as described in the martial arts adage "Blood (i.e., physiology) follows the qi, and mind directs the qi." In other words, thoughts, beliefs, and emotions regulate the flow, or resistance to flow, of this life energy; the body responds in kind. Symptoms arise whenever and wherever there are imbalances in the distribution of this vital force within the subtle energy structures of the body. Thus, energy imbalances can affect both mind and body, causing both psychological and physical symptoms. And since energy is seen as prior to or causative of the physical body, energy imbalances should be detectable even before the symptomatic changes in physiology arise.

The symptom of pain is conceived of as a blockage in the free flow of subtle energy. A useful heuristic metaphor depicts this blockage as a sort of "friction" or resistance to flow that is perceived by the patient as discomfort. These energy blocks can be manually detected by skilled practitioners, and these so-called "energy cysts"[22] can be caused by injury, poor nutrition, extreme weather, and emotional distress. Psychological trauma is theorized to be caused by (or correlated with) a pattern of stuck energy, "frozen" in the acupuncture meridians until it is "released" by the appropriate therapy. If the symptoms of traumatic energy disruption are primarily psychological in nature, the patient manifests the anxiety symptoms of post-traumatic stress disorder (PTSD). When the symptoms are more physical in nature, the energy blockages are somatically experienced as chronic pain. In either case, emotions that are too viscerally intense to be tolerable (i.e., a knot in the stomach) may be more amenable to psychotherapeutic resolution only after their experiential intensity can first be dissipated by an energetic intervention.

With respect to PLP, if the energetic block is maintained by psychological resistance to re-experiencing the emotionally traumatic memory, then energetically defusing the memory should also defuse the pain. In the same way, the lines of force of a magnet's EMF are still present and active, if invisible, even when the iron filings are removed from the sheet of paper. The phantom limb of PLP can be thought of as the usually invisible energy template underlying the physical structure of the arm, but which is now unveiled by removing the cells of the denser physical limb (the cells being analogous to the iron filings in the magnet metaphor). The phantom sensations associated with PLP feel as real as they did pre-injury, not because they are generated centrally by the brain as sensory memories, but because the phantom sensations are presumably being generated peripherally by the blocked energy in the phantom limb itself (whether this occurs at the level of EMF or subtle energy).

In this vein, direct and accurate sensory perception of energy fields has been demonstrated in the laboratory.[23] In one vivid example of energetically mediated peripheral sensory perception, an amputee was able to identify various objects placed "in" his phantom hand; accurate peripheral sensory perception appeared to be mediated by the phantom limb, since no neurologic structures were in contact with the objects to be identified.[24] Similarly, a well-known paraplegic yoga teacher has described the same phantom sensations in his paralyzed limbs that amputees feel in their phantom limbs[25]; because of this subject's complete spinal cord transections, these sensations are clearly mediated non-neurologically, perhaps via the same energetic sensitivity mentioned earlier. These validated sensory experiences are not compatible with paradigm of scientific materialism—that sensory experience can only be mediated by nerves. Nonetheless, this form of information transfer appears to be non-physically based through a parallel system that may involve electromagnetic fields, subtle energy flows, or an as-yet undetermined mechanism.

SYNTHESIS AND HYPOTHESIS

The energy/trauma model holds that in PTSD, intense emotions have not yet been psychologically processed and released, regardless of whether the amputation resulted from a violent and painful accidental injury (e.g., via combat or motor vehicle accident), or a planned and painless surgical amputation (i.e., if issues of self-image or shame remain unresolved). This neo-Freudian view of catharsis and healing

parallels Freud's own theory of subtle energy, which he called "libido." There are three primary assumptions: that PTSD is an energy blockage, that chronic pain is a somatically focused variant of PTSD, and that PLP is a form of PTSD occurring in patients who have not fully resolved the emotional trauma of their amputation. Several testable hypotheses emerge from this speculative energy/trauma model of PLP:

(1) Energy-based therapies will prove to be particularly effective treatments for PLP.
(2) Anxiety and other non-pain symptoms of PTSD should also respond to appropriate energy therapies. For example, overt anxiety symptoms and milder signs of trauma (as measured on graded trauma indices like the Impact of Events Scale) should respond to Emotional Freedom Techniques (EFT) and energy psychology.
(3) Because alterations in the human biomagnetic field are theorized to underlie PLP, they are potentially detectable by appropriate instrumentation that measures EMFs.

Let us now examine the extent to which current research data supports these three hypotheses.

ENERGY-BASED THERAPIES: PRELIMINARY DATA

Several novel therapies have shown effectiveness in PLP in case reports and pilot studies but are not yet supported by randomized controlled studies. Three therapies are explicitly energy-based (acupuncture, Energy Psychology, and Therapeutic Touch), while four are not explicitly energetic in nature [graded motor imagery, mirror box therapy, Farabloc, and eye movement desensitization and reprocessing (EMDR)]. However, the lack of an established mechanism of action for these latter four therapies provides the impetus for exploring possible energetic processes mediating the impact of all of these therapies on PLP. These treatments are described in brief here.

Acupuncture

Reports in the English acupuncture literature on the use of acupuncture for PLP go back 40 years, but all are case studies. One randomized clinical trial (RCT) sponsored by the World Health Organization is now being conducted in Israel; it features subject recruitment prior to scheduled amputation surgery and prompt post-operative acupuncture treatment.[26] A scalp acupuncture protocol[27] has also been shown to be effective for PLP, sometimes within minutes. Acupuncture protocols generally insert needles into the intact pain-free limb; the activation of mirror neurons is presumed to enable the contralateral side to benefit.

Related approaches utilize needle stimulation or laser phototherapy treatment of the phantom limb itself; to the observer, it appears as though the needles or laser light are directed at empty space. In one report,[28] acupressure to the invisible phantom meridians of an amputated foot resolved both the PLP and the PTSD of a Vietnam veteran who had lost his limb in combat. The success of these treatments may be an indication that external energy fields mediate PLP and are being directly activated in treatment. Alternatively, a robust placebo response may have been elicited by the dramatic and unexpected therapeutic focus on apparently empty space. In other words, this seemingly bizarre intervention may have unintentionally functioned as an indirect hypnotic induction procedure that elicited a robust placebo response. By mobilizing a strong attentional focus in the patient and following it with suggestions for healing, this protocol may have elicited a non-specific self-healing response rather than a specific pattern of energy rebalancing.

Therapeutic Touch

Therapeutic Touch (TT) is a non-contact energy balancing system developed by and for nurses over 40 years ago. The diagnostic phase of TT involves manual assessment of the patient's purported energy field, as the nurse/therapist uses the palms of her hands to detect non-thermal sensations that are often described as a sort of magnetic repulsion emanating from the surface of the patient's body.[29] In one controlled study that reached statistical significance, these subjective perceptions were shown to be reliably accurate.[23] Typically, sensations like tingling or heat are felt over symptomatic regions, especially when pain is the primary symptom. Treatment consists of slow manual sweeps of the external field to "smooth out" presumed obstructions in the field. In several cases treated by the author,[30] and as described anecdotally in TT circles, the therapist can manually experience subtle tactile sensations in the region of the absent phantom limb that are identical to those felt around the intact physical body of the patient. Interestingly, during TT, the patient may report that his phantom limb feels like it is being touched. This experience dovetails with the widespread belief among amputees that the phantom limb is an intact (if invisible) structure that occupies physical space and can be impacted by adjacent structures.

Case report. Joe was a 35-year-old cargo loader whose leg had been crushed in a work injury, necessitating an above-the-knee amputation five years before he presented to our clinic. His chronic phantom pain was only marginally responsive to medications and cognitive–behavioral therapy, so I offered him a trial of TT, about which he knew nothing. I felt the familiar energy "presence" or magnetic push against my hands around his body during the assessment phase, but to my surprise, I also felt it in the region of his missing leg. And at the same moment that I was noticing this field effect around his missing leg, Joe (whose eyes had been closed) reported that he was feeling my hand touching his phantom. As I continued sweeping the field around his phantom leg, he reported that the pain sensations seemed to be draining out the bottom of his phantom foot. Surprisingly, he asked me to stop the treatment before the pain could be completely alleviated, saying that he feared becoming pain-free because this would feel as though his leg was in fact missing. In other words, his pain served the psychological function of defending him against the emotional impact of fully acknowledging his traumatic loss.[30]

Energy Psychology (EP)

Acupressure, or acupuncture without needles (known as shiatsu in Japan), forms the basis for a novel approach to psychotherapy called Energy Psychology (EP). Based on the Traditional Chinese Medicine (TCM) belief that different acupuncture meridians mediate different emotional qualities, this technique combines cognitive reframing and imaginal exposure with somatic stimulation of acupoints in order to release "blockages" theorized to be held in the meridians following stressful events. When an upsetting memory is intentionally reviewed in a state of self-acceptance at the same time that the acupressure stimulation sequence is applied, rapid release of negative emotions has been reported. Several variants of EP have emerged, the best known of which is Emotional Freedom Techniques (EFT). Controlled studies of EFT have shown a rapid, statistically significant, and clinically significant reduction in PTSD symptoms in combat veterans,[31] while resolution of a variety of pain symptoms and syndromes has been reported anecdotally[32] and in larger scales studies (e.g., for fibromyalgia[33]).

Case report. Jean was a 62-year-old woman with an eight-year history of PLP, which began when she fell down a flight of stairs at home and injured her right leg; she developed vascular complications, which necessitated amputation. During her one session of EFT, as we began to desensitize the emotions surrounding her memory of the fall, she spontaneously remembered a childhood accident in which she fell into a small tidal pool while wading by the ocean, slightly injuring her right leg. Both accidents were marked by an unpleasant feeling of disorientation and helplessness during free-fall, and with EFT desensitization, she was able to dissipate this unpleasant subjective sensation. She was pleased to note that the PLP also disappeared completely (she was not seen in subsequent follow-up visits).

Eye Movement Desensitization and Reprocessing (EMDR)

EMDR is a 30-year-old form of psychotherapy that has been shown in randomized controlled studies to be effective for a wide range of psychological symptoms, including PTSD.[34] In EMDR, the patient is guided through a remembering of the traumatic events while focusing attention on the rhythmic horizontal movement of the therapist's finger back and forth across his field of view; he is encouraged to allow affect to surface and be released, after which positive cognitions are installed to ensure ongoing mastery of the traumatic memory.[35] One uncontrolled study[36] describes its benefits in five patients with PLP. In another,[37] a decrease in pain-related memories led to a decrease in PLP. The mechanism of action of EMDR has been explored from a neuro-functional perspective and is theorized to involve interhemispheric stimulation that facilitates a rapid reprocessing and re-consolidation of memories, similar to that seen with REM sleep. Structural MRI shows an increase in hippocampal volume after EMDR treatment of PTSD,[38] which is especially significant because hippocampal shrinkage is one of the hallmarks of PTSD.

Mirror Boxes

Another new therapy for PLP shows great promise, although its mechanism of action is again uncertain. Mirror box therapy (MBT) utilizes a longitudinally aligned mirror arranged so that the patient perceives a reflection of his own intact limb in the space where his stump and phantom limb lie. By moving the intact limb (e.g., by opening and closing the physical hand and fingers), the mirror creates an illusion of an intact and functional limb. The resultant sense of bodily integrity is quite compelling, with patients often reporting rapid shifts in their pain experience within one to two sessions with the mirrors. Functional MRI studies have shown long-term cortical reorganization of somatosensory brain maps with MBT for PLP.[39]

Graded Motor Imagery

Graded motor imagery (GMI) is a series of cognitive desensitization exercises that focus attention on the painful region from an increasingly direct internal perspective or point of view. The protocol has several phases: laterality training (awareness of the side of the body where the deficits originate), followed by focusing from a distance on the affected body region, and finally a proprioceptive "re-inhabiting" of the affected area in a series of explicit motor imagery exercises.[40] In effect, GMI reframes the PLP patient's phantom sensations as real rather than hallucinatory, and works directly with them until they become kinesthetically accepted, precise, and compelling. Physiological studies have shown that both MBT and GMI depend in part on the system of mirror neurons that are active not only during the execution of a particular task but also during the observation of that task being performed by another person.[41] This finding provides further support for the idea that imagined movements share the same cortical pathways as executed motor tasks.[42] Like MBT, GMI has also been used with other neuropathic pain conditions, including complex regional pain syndrome (CRPS).[43]

Farabloc

A linen fabric sheathing layered with ultrathin steel thread (Farabloc^{TM}) worn over the amputation stump has been shown to be moderately helpful in alleviating PLP.[44] The authors acknowledge that current etiologic theories cannot explain their results, but the electromagnetically non-conductive nature of the sheath suggests that EMF factors may be involved. According to the authors, the sheath may "protect the nerve endings through the shielding effect of its wire mesh," thereby blocking the potentially nociceptive influence of disruptive external EMFs. External magnetic fields have been shown to impact nerve function directly, as when externally applied pulsed magnetic fields are used to modulate brain function in the treatment of depression with repetitive transcranial magnetic stimulation (rTMS).[45] Similarly, the TT practitioners described above may have been detecting subtle sensory feedback generated by perturbations in this biomagnetic field.[23]

ENERGETIC ASPECTS OF NON-ENERGY-BASED THERAPIES

It may seem incongruous that several of the therapies discussed in a review of energetic aspects of PLP do not involve subtle energies in their accepted mechanisms of action, either explicitly or implicitly. Yet subtle energy dynamics may underlie the efficacy of EMDR, mirror box therapy, and GMI, much as they are presumed to do with acupuncture, TT, and EP. Although neural plasticity and mirror neurons have been invoked as the causal mechanisms of both GMI and MBT,[46,39] the reduction of pain sensations with GMI and MBT is too rapid (sometimes within minutes to hours) for nerve regrowth and cortical reorganization to have occurred; hence, these neural factors are unlikely to be the primary causal mechanism.

However, because energy shifts are believed to occur instantly (as is often reported anecdotally by medical intuitives), energy fluctuations may in fact be the "prime mover" in these four non-energetic therapies. In other words, these putative energy shifts (and the changes in EMF that are hypothesized to accompany these shifts) can occur much more rapidly than rewiring neural circuitry or processing physical signals like neurotransmitters and hormones, because electromagnetic signaling within the nervous system is the most rapid method of information transfer. Again, since energy release and pain relief can happen so rapidly, any neuroplastic re-patterning after MBT or GMI would only be a slower secondary result of the energy shift, rather than the primary cause of the pain relief. One can speculate that this cortical re-mapping might be directed by mechanisms similar to those operating in rTMS and other electromagnetic therapies.

The possible role of energy in these non-energy-based treatments becomes clear when we remember the previously mentioned martial arts adage "blood follows the qi, and mind directs the qi" (or colloquially, "energy flows where attention goes"). Chronic pain patients in general avoid "tuning in" to painful body parts because the resultant sensory (and presumably energetic) activation is intense and uncomfortable. However, this avoidance of attentional contact also prevents the flow of new healing energy into that region. So while paying attention to pain with an attitude of fear and worry will exacerbate the discomfort, mindful and compassionate attention to pain is not stressful, and can be an effective therapeutic intervention in and of itself.[47] Therefore, let us now examine each "non-energetic" therapy in turn to assess the possible role of subtle energies in their mechanisms of action and in the phenomenology of the PLP experience.

GMI

GMI enables the patient's attentional—and therefore energetic—reconnection to the painful region to develop so gradually that no acute pain sensations are triggered, because no rapid unmodulated energetic or emotional shifts occur. The patient thus becomes comfortable relating to that body part (with PLP, the phantom limb; with CRPS, the painful limb or region itself) by a gradual process of energetic desensitization. The affect is never of overwhelming intensity because the "energy cysts" or energy blocks are slowly and steadily drained and released in the context of non-reactive neutral attention, thereby avoiding the need for emotional abreaction.

Mirror Box Therapy

Similarly, patients undergoing MBT describe subjective experiences that can be re-conceptualized as energetic shifts. The initial impact of seeing an apparently intact physical limb in place of the invisible phantom limb, and the sense of watching this limb appear to move volitionally, is psychologically disorienting. The unsettling quality of this experience has led a significant number of patients to discontinue MBT treatment, reporting confusion, dizziness, and irritation.[48] In one MBT demonstration, several physically intact energy medicine practitioners who self-describe as being sensitive to their own internal energy flows placed one arm in a mirror box. When they moved their physical hand, they experienced a clear (and unsettling) sensation of energetic movement into the region of empty space where their reflected limb appeared to be (J. Wesley, personal communication, 2013). From the PTSD/energy perspective, one can speculate that for PLP patients, the sight of a physically intact body could be a cathartic and emotionally positive experience of wholeness and bodily integrity, an experience that allows the patients to release any energetic blockages that were previously associated with the amputation. In clinical practice, MBT is often preceded by a course of GMI, which may initiate gradual energy releases that facilitate a more complete response to the MBT.

EMDR

An energy-based mechanism of action for EMDR has been proposed,[49] based on the fact that a similar pattern of repetitive horizontal eye movements is part of an established training protocol in some branches of energy medicine meant to develop intuitive perception. This exercise is felt to strengthen the so-called "third eye," an energy center located between the physical eyes that is supposed to regulate psychic vision (clairvoyance). The trance-like state of altered consciousness that follows from these repetitive eye movements is one of being a neutral "witness" to the emerging emotional material. This perspective can allow emotionally laden material to be processed and released without the typical reactive psychological response. In psychic training, an open "third eye" allows for clear sight without emotional contamination.[20] In psychoanalytic terms, these eye movements allow cathexis to be withdrawn from emotionally conflicted material, leading to its easier dissolution and release without the need for abreaction.

Farabloc

According to the so-called inductive chain model of energetic interactions,[50] fluctuations in subtle energy flow can induce changes in adjacent EMFs. Because the Farabloc mesh shields the stump from external EMFs, it may thereby be preventing the induced electromagnetic component of the phantom limb's energy field from impacting the peripheral nervous system (remembering that external EMF changes in rTMS can trigger axonal activity and neurologically based subjective

perceptions). The Farabloc shielding may prevent peripheral energy field blockages from being perceived by a similar inductive chain of interactions from qi, to EMF, to neuron. This model may also explain how TT practitioners can perceive sensations that apparently arise at this qi/EMF interface, and which can generate clear and reliable sensory impressions.

DETECTION OF THE HUMAN ENERGY FIELD

Perhaps the most provocative aspect of this trauma/energy proposal is the notion that an invisible energetic and electromagnetic phantom limb exists in "empty" space, independently of any biologic structures. The phantom should therefore be detectable using appropriately sensitive electronic instrumentation. The pursuit of reliable images of the human "aura" (or its EMF equivalent) has been fraught with controversy for years and has been the Holy Grail of energy medicine practitioners. One source of confusion is the presumed equivalence of the human "energy" field (the "aura") and the human EMF. The existence of a human EMF is well accepted in the arena of bioelectromagnetism in which it is understood to originate from the electrical activity generated by the nerve impulses and muscle contractions of the human organism. But, the question remains whether these EMFs are in fact identical to "vital energy," or whether EMFs are the physical imprint or condensation of an even-more-subtle life energy that originates in the quantum domain.[51] It is beyond the scope of this article to further elucidate this distinction, which is discussed in more detail elsewhere.[52] For the purposes of this discussion, we will assume that any subtle energy field around and within living organisms will have an accompanying EMF that should be detectable by appropriately sensitive electronic equipment. Several energy detection technologies have in fact been applied to PLP, with mixed results.

Kirlian Photography

This technique for measuring electrostatic corona discharge patterns at the periphery of living tissue became widely known in the 1970s. The size of the glowing haloes surrounding palm prints and leaf outlines is presumed to indicate the relative strength of the underlying EMF and hence of the more subtle energy field. Kirlian's relevance to phantom limbs was suggested by the so-called "phantom leaf effect," in which intact electrostatic fields were shown to persist around the tip of a leaf even after the tip itself had been cut away.[53,54] This effect proves that the Kirlian field is not generated by the biological structure (the leaf tip or the amputated limb) and differs from any charge gradient that is set up by the associated biochemical and electrical processes which undergird the physiology of the leaf or the limb. Rather, this Kirlian electromagnetic/energetic field exists independently of, and prior to, those superimposed physical structures (Figure 1).

However, the phantom leaf effect is notoriously difficult to reproduce, even though sources of physical artifact are readily controlled for (e.g., temperature and humidity). Kirlian photography's suitability for imaging phantom limbs is further limited by the requirement that the object being imaged be thin enough to fit into the 1-cm space between the two recording electrode plates. Attempts by the author to image phantom fingers using a low-sensitivity Kirlian unit have not been successful, possibly because the discharge voltage of this Kirlian unit was so large that it overrode any EMF that might have been associated with the amputated finger.

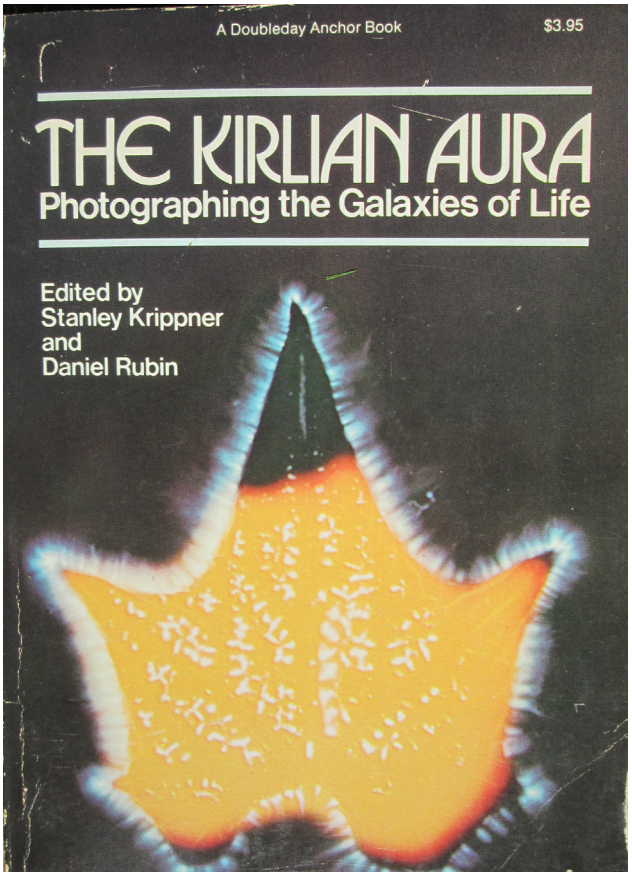

Figure 1. The Phantom Leaf Effect.

Polycontrast Interference Photography (PIP)

Developed by British researcher Harry Oldfield as a technique to image the entire human biofield, this method relies on the Moiré patterns produced by optical phase contrast filters recording light reflected off the human body.[21] Oldfield believed that such interference effects could also be detected in phantom limbs, by virtue of their energetic nature. However, when a series of amputation survivors underwent PIP imaging at a leading biofield research center, no evidence was seen of a phantom biofield extending in space beyond the edge of the amputation stump (Streeter T, Leskowitz E. *Centre for Biofield Research*. ⟨www.biofieldresearch.com⟩, 2009 [Unpublished pilot study–data available on request]) (Figure 2).

Gas Discharge Visualization (GDV)

This adaptation of Kirlian photography is used by holistic physicians as a non-invasive tool to assess the status of their patients' energy field. Measuring the electrostatic fields around

Figure 2. PIP image of below-knee amputee.

each of the subject's 10 fingers (where each of the major acupuncture meridians terminate), allows a calculation of the activity pattern in each meridian. A computer program then extrapolates the activity of each of these meridians into a full-scale mockup of the body's entire biofield, showing areas of energetic weakness or blockage. In essence, GDV builds on the techniques of Electroacupuncture According to Voll (the EAV, described in Ref. 55) and the skin impedance measurements pioneered by Motoyama (described in Ref. 56) to reconstruct an image of the body's entire electromagnetic field. Despite growing evidence of its diagnostic accuracy, GDV suffers from a structural limitation that precludes its use in the direct detection of phantom limbs: all GDV recordings must be taken from the subject's fingertips. Hence, upper limb amputees cannot even be assessed with this device. Furthermore, GDV could generate direct images of a phantom field, but only computerized extrapolations of the field that are derived from the individual electrophysiologic data points. One recent field test of GDV did not detect the phantom limb of an above-the-knee amputee without PLP (Leskowitz E. Reported at: The Association for Comprehensive Energy Psychology Annual Conference, June 2014, Phoenix AZ [Unpublished data]).

Indicator of Geophysical Anomalies (IGA)

The IGA device is a hand-held Gauss meter that measures ambient magnetic field strength at multiple points in the region being studied and has been used commercially in salvage operations to detect ferromagnetic metals at demolition sites.[57] When the developing engineers realized that these meters could also detect human limbs found in post-earthquake rubble, they adapted the IGA to measure EMFs surrounding the human body. Though the IGA has not been used regularly in clinical situations, several respected researchers in the field of biomagnetism have acknowledged this product's potential usefulness for phantom limb detection (K. Maret, personal communication, 1999) (J. Oschman, personal communications, 2003, 2004). Due to lack of funding, this line of research has not been pursued.

SUMMARY

Phantom limb pain was first described several 100 years ago, but the effectiveness of biomedically based and neuroanatomically derived treatments has not improved significantly in the past 150 years, suggesting that other etiologies should be explored. This article proposes that PLP may be more accurately conceptualized as an energetic sequela of emotional trauma and is a form of PTSD best treated via energy-based therapies.

Based on preliminary clinical findings and a modest body of supportive research data, an energy-based model of PLP is proposed which can be readily tested by controlled studies. Further, several behavioral therapies for PLP are described (mirror box therapy, graded motor imagery, and EMDR) whose mechanisms of action are not well understood within the standard biomedical conceptual framework but whose energetic undercurrents may trigger the neuroanatomic and neuroplastic changes which are currently being investigated by modern brain researchers.

The incidence and prevalence of phantom pain are increasing as a result of IED- and landmine-induced combat and civilian injuries. Hence, the public health need for an effective and easy-to-implement clinical intervention for PLP is great, with Energy Psychology tools showing particular promise. Despite preliminary research that supports speculation about the energetic basis of phantom limbs, no detection device has yet confirmed the existence of the independently existing subtle energetic phantom limb or its electromagnetic correlates whose existence is postulated in this article. It is hoped that further research along the lines suggested here may lead to a better understanding of the etiology of this disorder and the development of effective treatment protocols.

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