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Article *in* The Journal of Alternative and Complementary Medicine · January 2007

DOI: 10.1089/acm.2006.5245 · Source: PubMed

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THE JOURNAL OF ALTERNATIVE AND COMPLEMENTARY MEDICINE
Volume 13, Number 1, 2007, pp. 59–66

DOI: 10.1089/acm.2006.5245

Cortical Dynamics as a Therapeutic Mechanism for Touch Healing

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ABSTRACT

Touch Healing (TH) therapies, defined here as treatments whose primary route of administration is tactile contact and/or active guiding of somatic attention, are ubiquitous across cultures. Despite increasing integration of TH into mainstream medicine through therapies such as Reiki, Therapeutic Touch,™ and somatically focused meditation practices such as Mindfulness-Based Stress Reduction, relatively little is known about potential underlying mechanisms. Here, we present a neuroscientific explanation for the prevalence and effectiveness of TH therapies for relieving chronic pain. We begin with a cross-cultural review of several different types of TH treatments and identify common characteristics, including: light tactile contact and/or a somatosensory attention directed toward the body, a behaviorally relevant context, a relaxed context and repeated treatment sessions. These cardinal features are also key elements of established mechanisms of neural plasticity in somatosensory cortical maps, suggesting that sensory reorganization is a mechanism for the healing observed. Consideration of the potential health benefits of meditation practice specifically suggests that these practices provide training in the regulation of neural and perceptual dynamics that provide ongoing resistance to the development of maladaptive somatic representations. This model provides several direct predictions for investigating ways that TH may induce cortical plasticity and dynamics in pain remediation.

A BRIEF REVIEW OF TOUCH HEALING

Touch Healing (TH) therapy, broadly defined here as medical treatments whose primary route of administration is tactile contact and/or the active guiding of somatic attention, have been observed in contexts ranging from North American Pentecostal and Charismatic Christian rituals (the "laying on of hands" or "anointing of the sick")[1,2] to *qigong* and similar therapies in China and throughout East Asia.[3,4] The treatments can include Light Touch, brushing, tapping, near touch, or self-directed somatosensory attention.[5,6] Practices associated with TH figure prominently in the recent rise of alternative and complementary health practices in the United States and throughout the developed world.[7–9] In this first section, we identify common characteristics of TH therapies as an introduction to discussing how these common features predict a somatosensory plasticity and perceptual learning mechanism in TH.

Many TH therapies are used in the American health care system, with practitioners dispensing treatments in such modalities as Therapeutic Touch (TT), Healing Touch, Reiki, Polarity Therapy, Mindfulness-Based Stress Reduction (MBSR), and *qigong*.[7,10] One example is TT, a TH modality developed in the early 1970s by D. Kunz and D. Krieger, that is currently used by tens of thousands of nurses in the United States.[11] The practitioner typically begins by eliciting a calm "centered" attitude in the patient. He/she then sweeps his/her hands at a distance of 1–2 inches from the body and tells the patient he/she is receiving a powerful energetic touch. Even though the practitioners' hands are kept at a distance, patients frequently describe a "flowing

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feeling" near where they envision the practitioner's hands to be. Another TH therapy, Reiki, parallels TT in many respects.[12,13]

A number of East and South Asian meditative self-healing practices, including forms of Taoist and Buddhist meditation, share similar characteristics with the TH therapies described above. One example is MBSR, a self-healing practice that originates in the Buddhist practice of mindfulness.[14] This treatment is commonly prescribed for pain and anxiety.[15] Practitioners use meditative procedures to enter a calm state and then follow a protocol of directing focused, mindful awareness to specific areas of the body, and to breathing-related sensations. Practitioners' self-reports of bodily feelings as spontaneously arising and changing during practice echo patient descriptions of the spontaneous bodily feeling of "flow" commonly experienced during TT and Reiki.[16]

Multiple ethnographic accounts[2,17,18] describe a similar set of factors active in ritual healing. For example, in a Thai ritual healing ceremony (described in Tambiah[19]), the healer first fosters a relaxed meditative calm in his patients. He or one of his assistants then lightly touches each member of the audience. In the healer's touch, patients report feeling a surging somatosensory sensation that they associate with healing deities said to be evoked by the healer.

This brief overview of TH across cultures suggests several general traits: (1) Light Touch or "implied touch" is engaged; (2) Somatosensory attention is modulated; (3) Stimuli are administered in a behaviorally relevant context, in which the patient anticipates the possibility of healing; and (4) Treatment is delivered to a relaxed recipient. Using taxonomic methods described by Kaptchuk and Eisenberg,[20] we have identified three classes of therapies that, to differing extents, demonstrate the cardinal features of TH described above. In Class 1, *Light Touch* is delivered in a light or superficial manner with the goal of evoking an internal somatosensory response from patients. Class 2, *guided somatosensory attention,* includes meditative practices in which patient-practitioners use a self-healing meditative protocol to modulate their own somatosensory attention. In Class 3, *ritual healing*, the healer administers a touch stimulus with an instruction that imbues the touch with a specific ritual meaning that has high behavioral relevance to the patient (e.g., the touch of a healing "spirit" or presence).

Of the three forms of TH, Class 1 (*Light Touch*) therapies are the most easily characterized and least variable across healing modalities. Class 2 (*guided somatosensory attention*) meditative practices vary greatly, though forms of attentional guidance and relaxation, such as MBSR, have been systematized and studied in a scientific context.[16] Because Class 1 therapies and specific exemplars of Class 2 therapy are more highly standardized and assimilated into current clinical practice in North America, this paper will focus primarily on these practices. By contrast, Class 3 therapies are more varied in setting, presentation, and clinical uses. However, although the remainder of our review does not specifically address Class 3 TH treatments, we believe the processes described here should be evaluated further to determine whether they underlie any therapeutic changes seen in these forms of ritual healing.

EFFICACY OF TH THERAPIES

The efficacy of Class 1 (*Light Touch*) forms of healer-administered TH has been studied in clinical trials for a range of disorders centered around pain and anxiety states,[21] headache,[22] osteoarthritis,[23] carpal tunnel syndrome,[24] pain in patients with cancer,[25] agitation in Alzheimer patients,[26,27] anxiety in patients receiving complex medical procedures,[28] and behavioral reactions in low-birth-weight babies.[29] Overall, these studies offer evidence for the efficacy of Class 1 therapies, although many studies are weakened by low sample sizes and poor study design.[7,10,11] Two recent well-controlled studies of TH for defined pain conditions[23,24] found that both "sham" and "real" Class 1 TH elicited significant pain relief. As we explain below, clinically meaningful improvement in both sham and real Class 1 TH can be explained by the neuroscientific mechanisms described in this paper. Specifically, "sham" as applied in these studies, should induce similar cortical placticity. Evidence for the efficacy of Class 2 (*guided somatosensory attention*) can also be seen in observational and clinical trials performed in a range of pain conditions.[15,30–33]

CORTICAL PLASTICITY IN CHRONIC PAIN

A prevalent form of chronic pain is centrally maintained chronic pain, in which pain continues despite the absence of active local tissue damage. Although centrally maintained chronic pain is not well-understood, it is implicated in common conditions such as low-back pain[34] and fibromyalgia.[35,36] There is broad agreement that centrally maintained pain is associated with some form of cortical dysregulation[37,38] and is especially difficult to treat.[39]

Several brain areas in humans and other mammals contain "maps" of the body surface,[40] and alterations in the functionality of these maps have been implicated in the etiology of chronic pain.[34] The best-studied body map, the primary somatosensory cortex (SI), contains a representation popularly referred to as the "homunculus," in which contiguous areas of the cortical sheet typically receive peripheral input from adjacent body zones.[41] Studies in adult humans and primates show that somatosensory maps can change or remodel throughout adulthood.[42–46] For example, somatotopic hand maps of musicians and Braille readers have specific differences from those of normal controls.[43,47,48]

Cortical plasticity of this type is correlated with, and may be a causal mechanism in, centrally maintained chronic pain.[49–54] Several features characterize alterations in SI representations correlated with chronic pain. The zone of the SI body map that represents the painful peripheral region has an enlarged area of activation. This region also shows map fragmentation, where noncontiguous areas of the body surface come to be represented in adjacent parts of the map. Further, a shift in the relative amount of neural activity evoked by a constant amplitude stimulus, a change in the "gain" of neural responsiveness, can occur.[49–51,54,55] These abnormalities are correlated with pain intensity. The converse has also been observed—when chronic pain intensity subsides, the somatosensory cortical body map becomes more like that of healthy controls.[56] In animal models, conditions that promote plasticity can also induce pain. In a chronic arm pain/repetitive strain injury paradigm, monkeys subjected to postural strain were found to have abnormal cortical maps of the wrist and hands and disordered somatotopic representation of individual fingers.[49]

TOUCH HEALING AND CORTICAL PLASTICITY: A POTENTIAL THERAPEUTIC MECHANISM

The strong link between maladaptive map organization, map plasticity, and chronic pain suggests that the benefit of TH may occur by inducing beneficial reorganization of body maps (which we refer to as "therapeutic plasticity"). Our hypothesis is that TH modalities work to renormalize somatotopic maps. This prediction is supported by the observation that factors facilitating map reorganization are also cardinal features of TH treatments, and that these cardinal features act in opposition to the conditions that initiate and maintain chronic pain. As such, TH treatment can be seen as an optimal method for inducing changes in cortical map representation of the painful body part. We begin with a brief overview of the "cardinal features" of chronic central pain, cortical somatosensory plasticity, and Healing Touch.

Cardinal factors in persistent chronic pain

Repeated sensory input. Repetitive motion, postural strain, and peripheral lesions are common driving factors in the initiation of chronic pain.[49,57–59] With cumulative exposure, these somatic inputs cause changes in central neural structures involved in pain perception, creating a lasting "pain memory" of the associated sensory inputs.[34,59]

Somatosensory attentional modulation. Pain draws patients' attention preferentially toward the pain experience[60] and imposes a constant cognitive load that interferes with the performance of other tasks[61] and with the perception of alternative stimuli.[62]

Behavioral relevance. Painful stimuli are (by definition) behaviorally relevant and salient. As sensory inputs other than the pain decrease in their salience, patients develop the expectation that the pain will continue unabated in the future and disrupt their ability to function.[63] In clinical trials, the expectation of future pain predicts poor outcome.[64]

Stress. Physiologic and psychologic stress are a *sine qua non* of the pain experience. For example, back pain and upper extremity pain are associated with chronic psychologic workplace stress.[65,66] Physiologically, chronic pain has been demonstrated to increase the release of stress hormones such as glucocorticoids.[67]

Cardinal factors in the optimal induction of cortical plasticity

Repeated sensory input. The induction of SI plasticity depends in large part on repeated and selective contact with a body region. In monkeys, for example, tactile stimuli administered over a period of weeks to the finger produce significant long-term reorganization of the finger region of the SI map.[68,69] Similar observations have been made in rodent SI after the selective trimming of all but one or two of the facial whiskers,[70,71] and in humans after repeated stimulation of the fingertips.[42]

Somatosensory attentional modulation. Modulation of somatosensory attention contributes significantly to long-term plastic remodeling in sensory cortical maps. Systematic practice in shifting attention enhances performance on perceptual tasks.[72] In humans and monkeys, shifts in the focus of attention between different peripheral stimuli can also reorganize primary sensory cortical maps on millisecond to second time scales.[73,74]

Behavioral relevance. The context and expectation associated with a stimulus are central to its efficacy in changing the somatosensory cortical body map. In primate studies, if an animal receives two identical competing stimuli, greater map change is evoked by the stimulus that is more behaviorally relevant (e.g., the signal that the monkey expects will be accompanied by a reward).[69,75,76] This favored plasticity context is likely facilitated by the release of neuromodulators such as acetylcholine.[77–79]

Stress. High levels of physiologic stress, or the presence of high concentrations of stress-related hormones, can block long-term potentiation, a hallmark of central nervous system plasticity.[80] The association between stress and chronic pain, in settings where chronic pain emerges from behavioral maladaptive processes, suggests that stress may play a physiologic role in preventing map renormalization, thereby "locking in" maladaptive plasticity. Pain experienced in the midst of chronic stress may be imprinted on the central nervous system as a long-standing, maladaptive alteration in central processing.[81,82] The converse is also true: relaxation facilitates perceptual learning[83] and cortical remodeling processes.[84]

Cardinal factors of TH treatment

The TH cortical plasticity model described here is related to Class 1 TH therapies such as TT and Reiki. It may also explain the prevalent use of Class 2 meditative practices such as MBSR as therapies for chronic pain.[31,32]

Class 1 (Light Touch) and repeated sensory input. Class 1 TH therapies typically include repeated administration of real or implicit tactile contact applied to specific skin regions. Tactile stimuli are presented in body regions remote from the overrepresented, painful part. Such contact is usually administered with Light Touch, and tactile stimuli are repeated within a session and across multiple days. Such repeated activation of body representations through peripheral input and/or internally generated tactile imagery[85,86] may induce therapeutic plasticity.

Class 1 (Light Touch) and somatosensory attentional modulation. Many Class 1 TH modalities described above use an "implied touch" stimulus, in which the practitioner places his/her hand near, but not directly on, the body, as some aspect of their treatment. Although some have questioned the efficacy and legitimacy of such "implied touch" procedures,[8,87] our TH cortical plasticity model suggests that "implied touch" stimuli may serve the function of guiding subjects' somatosensory attention, and this process may engage at least a subset of the transformative mechanisms that contribute to tactile-induced plasticity. In the case of chronic pain, the use of an "implied touch" stimulus to guide somatosensory attention away from the chronic pain site may increase treatment efficacy.

Class 2 (MBSR) and somatosensory attentional modulation. The cardinal difference between Class 1 and Class 2 therapies is that, in the case of the latter, the somatosensory attentional practices used in many meditative traditions such as mindfulness meditation or *qigong* do not involve an actual TH stimulus. Instead, Class 2 therapies typically teach a daily self-healing regimen that involves systematic shifting of somatosensory attention across the body. In MBSR, practitioners are taught, iteratively, to cultivate meditative awareness of bodily sensations and specific body processes (e.g., breathing). This practice of MBSR's focused awareness of bodily sensations follows directly from early forms of Buddhist mindfulness meditation (e.g., the Body Contemplation practices described in the Four Foundations of Mindfulness[88]). By repeatedly practicing somatosensory attentional focus, we hypothesize that practitioners learn to more optimally control cortical, and more generally, neural dynamics, allowing them to regulate the throughput of information in these representations. This learned control may provide a self-regulatory mechanism for preventing the formation of, and/or renormalizing maladaptive cortical maps that emerge in chronic pain. Learning control of attention could allow practitioners to better "gate" sensory signals in contexts that might lead to a negative alteration of the map, such as repetitive and possibly painful behaviors. Although it is an open question as to how and whether shifts in focused somatosensory attention to distinct body regions can serve as a surrogate for actual tactile contact, and how control over these dynamics may gate sensory information, preliminary findings that short-term attentional shifts effect changes in cortical plasticity[73,74] suggest that attentional shifts could initiate changes in cortical dynamics that bring about long-term remodeling in cortical maps.

Class 1 (Light Touch) and behavioral relevance. Class 1 practitioners frequently claim that touch stimuli are imbued with a potentiating "energy" or vibrational power. Healers and recipients within this community also frequently hold that the positive expectancy elicited by a belief in a therapy's healing power contributes to positive outcomes.[89] According to our TH cortical plasticity model, patients who believe such claims may endow TH with greater behavioral relevance (e.g., through enhanced neuromodulator release). This increased behavioral relevance may facilitate therapeutic cortical remodeling of body maps and, through this mechanism, elicit pain relief.

Class 2 (MBSR) and behavioral relevance. Like the other TH examples described above, MBSR provides practitioners with a nonspecific positive therapeutic expectancy. In addition, by increasing the relevance of neutral sensations (e.g., sensations related to breathing), MBSR may facilitate a behavioral context in which negative chronic pain–related sensations are accorded decreased salience. As this decreased salience is repeatedly reinforced through practice, mindful patients report being able to disengage from negative schemas that may be actively contributing to chronic pain.[14,90]

Class 1 (Light Touch) and relaxation. Class 1 therapies are nearly always described as relaxing and often include an explicit relaxation instruction prior to onset. Patients are typically placed supine, in a quiet room, and asked to lie in as calm and relaxed a state as possible. According to our proposed framework, relaxation may be critical to the efficacy of TH therapies because it may relieve the blockade that psychologic stress and stress hormones create against plasticity.[13,91,92]

Class 2 (MBSR) and relaxation. MBSR uses basic Buddhist philosophic principles that prescribe a "calm mind" as a necessary precondition for attaining benefit from meditation.[93] The stress reduction training that is an essential component of this practice may also be a form of training in the self-regulation of plasticity, allowing subjects to persistently maintain "healthy" map structure.

The alignment of optimal cortical remodeling of somatotopic maps with factors common to Class 1 and Class 2 TH therapies suggests a mechanism by which TH therapies elicit relief of chronic pain. Below we consider the broader significance of our therapeutic plasticity model and its relevance for further research in TH and other complementary and alternative medicine modalities.

APPLICATIONS OF THE MODEL: AVENUES FOR FUTURE RESEARCH

This model provides a framework for investigating ways that TH might induce cortical plasticity and pain remediation. We propose that TH optimizes cortical plasticity by enhancing and guiding attentional focus to nonpainful representations, reducing stress and providing high behavioral relevance in the context of repeated tactile stimulation. Further, these practices may provide training in the self-regulation of neural dynamics and perception, helping to prevent the establishment of maladaptive patterns. Future investigations will allow explicit tests of whether varying specific components of the model produces hypothesized differences in outcome.

The model also explains randomized trial outcomes in which both sham and real Class 1 TH appeared to provide meaningful pain relief.[23,24] Sham TH that does not control for the potentially positive effects of somatosensory attentional modulation, or a behaviorally relevant context, may elicit "active" processes that engage mechanisms that are operative in real TH. Our model thus suggests the importance in future trials of rigorously controlling for factors (e.g., behavioral relevance and somatosensory attention) traditionally regarded as epiphenomenal.

Additionally, although current research is limited, several studies suggest that this model may also be applicable, in a modified form, to emotional disorders. Classic accounts of emotional psychology (e.g., the James-Lange theory) suggest that emotions are rooted in the interoceptive perception of ongoing body states.[94,95] Building on this earlier theory, recent studies have found that somatosensory cortical body maps may be an important component of the neural architecture of emotional processing.[96] Use of TH treatments such as Reiki or TT is increasing for affective disorders,[7,13,97] whereas recent randomized controlled trials support the use of a Class 2 mindfulness-based therapy for prevention of depression relapse.[98,99] Taken together with the prevalence of comorbidity of depression with chronic pain,[100,101] these studies suggest that further investigation of emotional processing as it relates to our model of therapeutic somatosensory cortical plasticity is warranted.

CONCLUSION

Our model has the potential to bring order to what has previously been a poorly defined group of therapies. Using a theory-driven taxonomy, we describe characteristics of TH therapies common to a range of modalities across cultures. These shared characteristics, which include repeated sensory input, somatosensory attentional modulation, behavioral relevance, and relaxation, suggest a single class of mechanisms may underlie the diverse modes of TH.

ACKNOWLEDGMENTS

This work was supported in part by National Institutes of Health grant 1K01AT003459-01 (C.K.) and the fund for interfaculty collaboration, Harvard University, Office of the Provost (R.W.).

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