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Neuroimaging Somatosensory and Therapeutic Alliance Mechanisms Supporting Acupuncture

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ABSTRACT

Acupuncture consists of multiple components, and neuroimaging studies are beginning to tease apart potential brain-based mechanisms supporting this nonpharmacologic intervention. Brain imaging in patient populations is important for the acupuncture neuroimaging field, and recent studies have incorporated neuroimaging into a clinical trial framework for improved ecological validity in extending results to be more relevant for clinical practice. For instance, functional magnetic resonance imaging (fMRI) research with patients suffering from carpal tunnel syndrome has suggested cortical plasticity as a mechanism supporting acupuncture analgesia. In turn, the patient–acupuncturist relationship is another important aspect of acupuncture analgesia, and recent hyperscan fMRI research has begun to explore brain-based mechanisms underlying therapeutic alliance between patient and clinician, and how this might impact acupuncture analgesia. Ultimately, neuroimaging has shown great promise in the past several decades in opening a window into brain function to better appreciate the mechanisms supporting acupuncture. As acupuncture likely operates via multiple distinct mechanisms of action, teasing apart the constituent aspects of acupuncture therapy in humans will be an important goal for current and future neuroimaging research studies.

Keywords: brain, acupuncture, fMRI, pain, analgesia, nonpharmacologic

INTRODUCTION

Acupuncture consists of multiple components, and neuroimaging studies are beginning to tease apart potential brain-based mechanisms supporting this nonpharmacologic intervention. Brain imaging in patient populations is important for the acupuncture neuroimaging field, and recent studies have incorporated neuroimaging into a clinical trial framework for improved ecological validity in extending results to be more relevant for clinical practice.

SUMMARY CONCLUSION

Neuroimaging has shown great promise in the past several decades in opening a window into brain function to better appreciate the many mechanisms supporting acupuncture. As acupuncture likely operates via multiple distinct mechanisms of action, teasing apart the constituent aspects of acupuncture therapy, in humans, will be an important goal for current and future neuroimaging research studies.

Acupuncture consists of at least 3 components: (1) Traditional Chinese Medicine rituals of history taking, palpation, diagnosis, and formation of therapeutic alliance; (2) relaxation response imparted when acupuncture needles are left in place and the patient relaxes; and (3) somatosensory stimulation imparted to the needle, which can be mechanical, thermal, and/or electrical.

Multiple brain imaging studies have assessed somatosensation as an important component of acupuncture. For instance, our group used functional magnetic resonance imaging (fMRI) and diffusion tensor imaging to explore

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potential mechanisms of acupuncture in treating carpal tunnel syndrome (CTS). CTS provides a very expedient model for chronic neuropathic pain because, as opposed to many other functional chronic pain disorders, CTS includes both subjective measures (such as patient-reported outcomes) and objective/functional measures (i.e., nerve conduction latency, which measures CTS-associated reduced velocity of impulses across the wrist). Our study also assessed cortical brain mapping as measured by functional MRI.[1] Eligible CTS patients were randomized to 3 different intervention arms: (1) verum local electroacupuncture (EA) that included stimulation using low-frequency electrical pulses applied to needles placed local to the more affected hand; (2) verum distal EA, for which needles were placed at distal body sites, near the ankle on the opposite side of the body relative to the more affected hand; and (3) sham EA using nonpenetrating placebo needles applied both local and distal to the more affected hand.

Our analyses found that while all 3 interventions reduced patient-rated symptom severity, for neurophysiologic outcomes—that is, nerve conduction studies and cortical organization in the brain—verum acupuncture (i.e., both local and distal arms combined) was found to be superior to sham acupuncture. Moreover, there was a clinical consequence to post-therapy cortical reorganization in the brain, as brain reorganization immediately after the multiweek verum acupuncture protocol predicted sustained improvements in symptom severity at 3-month follow-up. In other words, patients who improved the most in brain organization metrics after acupuncture therapy also reported more sustained improvements in symptom severity 3 months after the end of active treatment. Indeed, our understating of the neuroscience of somatosensory processing suggests that somatosensory aspects of acupuncture are also reflected in somatotopy of the primary somatosensory cortex (S1), where, for instance, different S1 subregions would be distinctly targeted by local versus distal acupuncture electrostimulation. Thus, for CTS, acupuncture at local versus distal sites may improve median nerve function by direct physiologic response to the needle at the local lesion at the wrist (local only), or by modulating vascular parameters at the wrist via central autonomic network connections from needle stimulation-targeted brain regions such as S1. Ultimately the specific role of S1 in acupoint specificity needs to be evaluated by further research.

With regard to the ritual component of acupuncture, the patient–clinician relationship and therapeutic alliance can significantly influence how a patient responds to therapy and perceives pain. It has been shown that therapeutic alliance between a patient and his or her clinician significantly influences clinical outcomes for both integrative and conventional biomedical therapies including spinal manipulation and exercise.[2] Previous research has even shown that the effect size of these context/nonspecific effects can be greater than those of specific effects of an intervention, for example, psychotherapy.[3] Interestingly, interaction style can be experimentally controlled and the style of a therapeutic intervention can indeed influence clinical outcomes.[4] For instance, acupuncturists trained to deliver acupuncture with an ''augmented'' interaction style were found to improve irritable bowel syndrome outcomes compared with a ''limited'' style of acupuncture delivery. However, understanding the brain circuitry supporting such social interactions requires methods that capture synchronous data from 2 persons interacting in an ecologically valid context.

Our recent research targeted this important aspect of acupuncture therapy. Hyperscanning involves synchronous neuroimaging of more than 1 individual and has been used to demonstrate brain concordance between individuals in a variety of settings. In our study, fMRI hyperscanning was used to assess brain-to-brain communication between patients and acupuncturists, wherein we simultaneously recorded brain fMRI data from patient–acupuncturist dyads who interacted via audio/video transfer (where the patient and acupuncturist could see each other) during clinician-initiated EA treatment of evoked (pressure cuff) pain in fibromyalgia patients.[5] The study involved 2 dyad groups: 1 that did and the other that did not receive the usual acupuncture clinical intake before hyperscanning. Patients rated the intensity of the pain experienced, while the clinician rated the intensity of pain they thought the patient had experienced (as assessed by facial expression response), with and without EA stimulation. Both patients and acupuncturists also completed a questionnaire to assess the therapeutic alliance between them during their interaction.

We found that both patients and clinicians reported stronger therapeutic alliance when dyads experienced a clinical intake before hyperscanning. Patients' pain significantly decreased during acupuncture treatment compared with no treatment, which corresponded with, and was correlated to, lower vicarious pain ratings by acupuncturists—that is, the clinicians were able to sense a relatively higher or lower pain experience in the patient. Video analysis found that mirroring of facial expressions between patient and acupuncturist was linked with better therapeutic alliance and greater analgesia following EA. We then hypothesized that concordant fMRI activity in a social mirror neuron system in the brain between acupuncturist and patient also plays a critical role in the patient's perception of therapeutic alliance and, ultimately, analgesia. We found that both patients and clinicians demonstrated fMRI response to pain and treatment in brain areas known to support social mirroring, such as the temporoparietal junction (TPJ), ventrolateral prefrontal cortex, and anterior insula. We then assessed trial-to-trial variability in activation between patients and acupuncturists (i.e., dynamic brain concordance), and found that concordance in social mirroring areas, specifically TPJ, was greater for dyads who experienced a clinical intake before hyperscanning and was correlated with patients' reported analgesia during acupuncture stimulation.[5] Thus, increased patient–clinician concordance in TPJ may support socially facilitated analgesia for therapies such as acupuncture. Interestingly, as TPJ activity has been closely linked in meta-analyses with ''theory of mind'' processing,[6] these studies suggest that acupuncturist training in ''theory of mind'' may be as important as empathy training for building therapeutic alliance—a topic of further research.

In summary, neuroimaging has shown great promise in the past several decades in opening a window into brain function to better appreciate the many mechanisms supporting acupuncture. As acupuncture likely operates via multiple distinct mechanisms of action, teasing apart the constituent aspects of acupuncture therapy, in humans, will be an important goal for current and future neuroimaging research studies.

AUTHOR DISCLOSURE STATEMENT

No competing financial interests exist.

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