Seeing the body: a new mechanism for acupuncture analgesia?

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ABSTRACT
The use of visual illusions to study how the brain gives rise to a representation of the body has produced surprising results, particularly in relation to modulation of pain. It seems likely that this research has relevance to how we understand acupuncture analgesia. Acupuncture supplies several different kinds of signal to the brain: touch in the preliminary examination for tender areas; needle stimulation, mainly of Aδ fibres; and sometimes visual input from the patient’s sight of the needle insertion. In the light of recent research, all these are likely to modulate pain. There are implications here for clinical practice and for research. Acupuncture may be more effective if patients can see the needles being inserted. The use of non-penetrating stimuli to the skin or minimal needle insertion at non-acupuncture points as control procedures becomes more than ever open to question and this, in turn, has relevance for claims that acupuncture is indistinguishable from placebo.

INTRODUCTION
In 2011 Anna Bulley presented a paper at the Autumn Meeting of the British Medical Acupuncture Society, in which she described her experience using the ‘rubber hand illusion’ in conjunction with acupuncture. In outline, the illusion consists in placing one of a subject’s hands (say, the left) on a table while the other hand is out of sight beneath the table. A screen hides the subject’s left hand from view. A rubber hand and arm are placed on the table in front of the subject, and his or her left hand and the artificial hand are stroked simultaneously with a small brush. This often causes curious perceptual illusions. Subjects may feel as if the rubber hand were their own, or their real hand may seem to be drifting towards the rubber one. In more extreme cases they may feel that they have two left hands, or that the rubber hand is taking on the appearance of their own hand; alternatively, their own hand may feel more ‘rubbery’.¹ The experiment demonstrates the phenomenon of multisensory integration; tactile and visual signals are superimposed, as it were. (In fact, even the sight of a rubber hand may not be necessary to produce the illusion. A recent study finds that the sense of a phantom hand can be projected to a region of empty space.²)

Bulley’s experiment was designed to test whether inserting acupuncture needles into the rubber hand would break the illusion. What she actually found was remarkable: although needling did break the illusion in some cases, in most it produced typical de qi sensations, even in subjects who had not experienced acupuncture previously. This tells us that the de qi phenomenon can occur as part of a visual illusion, without any need for physical stimulation of the subject’s body.

This startling discovery surely has important implications for how we think about acupuncture. Currently acupuncture is believed to produce effects at several different levels.³ These are (1) the local tissues at the site of needle insertion; (2) the spinal cord, segmentally and extrasegmentally; (3) affective and homeostatic mechanisms in the brain; and (4) myofascial trigger points. Perhaps it is time to add a fifth level of mechanism involving the brain: multisensory pain modulation, including visual modulation.

Most of the research on how acupuncture influences the brain has centred on the affective (emotional) component of pain. This is understandable, because the same is true of research on brain processing of pain in general. The limbic and paralimbic areas seem to be particularly important here, especially the anterior cingulate cortex.⁴ Acupuncture has been found to alter activity in these regions and this may account for the clinical
observation that acupuncture may reduce the unpleasantness of pain as well as its intensity.

As well as having a role in the emotional response to pain, the central brain areas are also implicated in the modification of pain by expectation and preconditioning of the ‘reward’ centres in the brain. Wager and colleagues have shown that placebo-induced analgesia is associated with decreased functional magnetic resonance (fMRI) activity in the thalamus, insula and anterior cingulate cortex. These findings may explain why patients receiving acupuncture seem to need to be expecting the treatment and to perceive the needling in a therapeutic context if it is to work (although prior belief in its efficacy is not required).

However, it is not only the central areas that are responsible for modulation of pain by expectation. There can also be localised anaesthesia in response to suggestion. Benedetti and colleagues induced pain by the injection of capsaicin into several body areas simultaneously while applying a placebo cream to just one of these areas. This produced analgesia only in the area to which the cream was applied; the effect was blocked by naloxone. As Benedetti and colleagues state: ‘Most important, this specific effect is mediated by endogenous opioids, indicating that placebo-activated opioids do not act on the entire body but only on the part where expectancy is directed. This suggests that a highly organized and somatotopic network of endogenous opioids links expectation, attention, and body schema.’ (emphasis added).

The importance of this somatotopic organisation is emphasised by Haggard and colleagues in a comprehensive review of human and animal studies. Aδ skin nociceptive fibres from all over the body project to a spatially-organised somatotopic map in the primary somatosensory cortex. Pain mapping of this kind, these authors believe, is important for our understanding of pain-related plasticity and pain modulation by multisensory stimulation, including the recent discovery of cognitive modulation induced by viewing one’s own body.

In what follows, I first outline the main features of this research and then suggest how it may shed light on acupuncture analgesia. I also indicate what it implies for the question of whether, or in what sense, acupuncture can be said to act primarily as a placebo.

**Multisensory pain modulation**

Multisensory pain modulation depends on the idea that the intensity of pain signals varies with the presence or absence of a signal in another modality. One example of this is the gate control system of Melzack and Wall, which is situated in the spinal cord. But the same principle of modulation by touch is now thought to operate at higher levels, including the thalamus and sensory cortex. Something as simple as crossing the arms in front of the body has been shown to reduce the intensity of experimental pain as a result of changes in the somatosensory processing of input. It is not only touch that can modulate pain in this way. For example, caloric stimulation of the vestibule can reduce chronic post-stroke pain (central pain), and this can also work for experimental pain.

All the interactions described so far are between pain perception and internal body sensory systems. However, there are also interactions with input from outside the body—notably visual input. Haggard and colleagues term this ‘visual analgesia.’

**Visual analgesia**

The specific content of what is seen can modulate pain. This has been shown by Longo and colleagues, who used the mirrorbox illusion to modulate pain. In this method a mirror is placed in the subject’s midline in such a way that one hand (say, the left) is reflected in the mirror to appear as the right hand. This produces a transformation of body representation rather similar to that which occurs in the rubber hand illusion. The technique was originally introduced by Ramachandran and colleagues as a treatment for phantom limb pain, but it has also been used in research to allow manipulation of the body representation in healthy people. Longo and colleagues found that viewing the reflection of the hand raised the threshold of experimental pain in healthy subjects, compared with viewing a neutral image. They concluded that their results ‘suggest a novel mechanism of analgesia based on multisensory interactions involving perception of one’s own body’.

The effect is not confined to seeing just the hand. Hänself and colleagues have produced the same result by using virtual reality to project a whole-body image. A mannequin was filmed from behind and projected via a video head-mounted display. Subjects saw either the mannequin’s back as if it were standing in front of them or a neutral object (a large cardboard box). The subjects’ backs and that of the mannequin or box were stroked simultaneously. This produced an illusion of body displacement into the mannequin and also raised the subjects’ pain threshold, compared with viewing the box.

**IMPLICATIONS FOR ACUPUNCTURE**

The research summarised above has implications for our understanding of acupuncture. There is more to this treatment than just the insertion of needles. It usually includes, among other things, a preliminary examination for tenderness, and this touching will presumably alter body representation and consequently pain perception, even before any needles are inserted. This mechanism is independent of any possible inactivation of myofascial trigger points by manual pressure.

As well as touch, acupuncture usually includes a visual element, since patients are often able to see where the needles have been inserted. This will...
presumably contribute visual analgesia to the picture, which is likely to enhance the effectiveness of the treatment and may be important clinically. It also has implications for the design of clinical trials of acupuncture. This is discussed further below.

Two qualifications need to be considered here. One is that the situation of a patient differs from that of the subjects in the visual experiments, who were being induced to identify with an image that was not physically part of their body. Patients, however, are seeing or feeling their own body being touched and needled directly. But the illusion induced in the experiments was mainly a device to isolate visual signalling from tactile signalling. In the clinical setting, patients will often receive tactile and visual signals simultaneously, which if anything would probably enhance the analgesia compared with the experimental situation.

The second qualification is that Bulley’s experiment produced de qi but not analgesia, at least as far as we know, so we cannot extrapolate from it to assume that needling an illusory hand would have therapeutic value. The question largely hinges on how much significance should be attached to de qi. Whether it is important in obtaining a therapeutic result is still undecided.15 16

In fact, the connection between visual input and analgesia, at least for experimental pain, needs further investigation. Some recent research suggests that the pain relief due to visual input as described by Longo and colleagues may not occur with the rubber hand illusion. In these experiments the rubber hand illusion was produced and the subjects’ real hands and the rubber hand were subjected to pain-inducing stimuli, either with an acupuncture needle inserted at LI4, by Chang et al.,17 or thermally, by Mohan et al.18 Both studies found no difference in pain intensity, whether the illusion was being experienced at the time or not. But Mohan and colleagues point out that these results do not exclude a useful role for visual illusion in the treatment of chronic or pathological pain, and there may also be differences when full-body illusions are produced: ‘[Our] finding suggests against the utility of the rubber hand illusion as a therapeutic tool for pain relief in a clinical setting, but leaves open the possibility that illusions involving multisensory representation or spatial conflict may be helpful for central or widespread pain’.

The differences between experimentally induced pain and chronic pain are doubtless important. Changes in cortical representation are now recognised in many kinds of chronic pain, including post-injury pain and chronic back pain.19 20

It is possible that acupuncture can reverse such changes. Phantom limb pain may respond to acupuncture applied to the opposite limb, and there may be accompanying lessening or even disappearance of the phantom sensations.21 22 This suggests that there is a change in cortical mapping due to the treatment in such cases. However, acupuncture is not necessarily effective in all kinds of pain that have been linked with distortion of cortical mapping; for example, severe repetitive strain injury in musicians often fails to respond (personal observation). It is possible that acupuncture can sometimes produce very profound alterations in body representation, at least in patients who have some form of brain pathology. There is an anecdotal report of acupuncture eliciting an ‘out of body’ experience in a patient who had recently begun to experience epilepsy.23 These strange experiences have been linked to a failure to integrate multisensory information from one’s own body at the temporoparietal junction.24 25

Perhaps the most significant aspect of the research referred to here is that it involves consciousness, at least in the case of vision. This is important for the frequently repeated assertion that acupuncture relies on the placebo effect. Such statements beg the question of how the placebo effect is produced. What is often forgotten or overlooked is that it has to be a neurophysiological phenomenon, so ‘placebo’ is simply a placeholder for ‘unknown central mechanism’.26 Hitherto it has been difficult to explain this in any detail but the new evidence for multimodal, especially visual, analgesia, does provide a basis for it by showing that touch and vision can directly influence the way pain is experienced. The criticism of acupuncture as ‘mere placebo’ loses much of its force in the light of this.

Another aspect of the acupuncture-as-placebo controversy concerns the use of non-penetrating skin stimulation as a supposedly neutral stimulus in research. Trials have been performed using cocktail sticks for this purpose,27 28 and a more recent innovation is the development of a sham needle.29 The validity of such techniques has been questioned in view of the recent discovery of tactile C fibres that act on the limbic system to produce feelings of relaxation and well-being,30 but we now have another reason for doubt. All forms of tactile stimulation appear to have an analgesic effect. The same will apply to the use of so-called sham acupuncture with minimal-depth needle insertion, which also stimulates Aδ fibres.

Salih and colleagues have shown that it is possible to produce de qi with real and sham laser stimulation.31 As they remark, ‘[these] results give hints that de qi might be a central phenomenon of awareness and consciousness and that its relevance should be taken into account, even in clinical trials’. Bulley’s report provides further evidence for this hypothesis.

**Suggestions for future research**

The ideas outlined in this paper could be tested in a number of ways. First, the experiment described by Bulley needs to be repeated, preferably with simultaneous brain imaging to investigate what is happening in the somatosensory cortex while de qi is being...
experienced. Second, the whole-body experiment described by Hänsel and colleagues could be performed on patients who have chronic back pain. After producing the illusion in the manner described by the experimenters, acupuncture could be performed on the back of the mannequin to see if this caused a reduction in the patient’s pain. Third, patients who experience chronic pain quite often report alterations in the subjective size of their bodies. For example, they may say they have swelling in different parts of the body, although no swelling is evident to an observer. Presumably, this is due to changes in cortical mapping. It would be interesting to know if acupuncture can reduce the subjective sense of swelling in such cases. Finally, it is possible that the response to acupuncture will be better when patients see themselves while being needled compared with when they do not. This could be tested by comparing the results in the two situations.

CONCLUSIONS
The study of how multisensory modality can modulate pain is an active area of research today and it is likely to provide new ways of understanding how acupuncture works. Applying these insights may suggest ideas for enhancing the effectiveness of acupuncture. Häggard and colleagues make a plea for research in using multisensory modalities, and not just vision, in the treatment of chronic pain. Acupuncture is well suited to provide multimodal pain relief of this kind.

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