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# Mechanisms of acupuncture

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ABSTRACT

A lack of scientific studies to prove or disprove the claimed effects of acupuncture has led to its rejection by many of the western scientific community. Now that many effects of acupuncture can be explained in terms of endogenous physiological mechanisms, and that these effects are reported as similar or sometimes superior to established treatments with a very low incidence of side effects, the integration of acupuncture with conventional medicine may be possible. Some of these aspects will be presented in this condensed overview.

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## 1. Introduction

A lack of scientific studies to prove or disprove the claimed effects of acupuncture has led to its rejection by many of the western scientific community. Now that many effects of acupuncture can be explained in terms of endogenous physiological mechanisms, and that these effects are reported as similar or sometimes superior to established treatments with a very low incidence of side effects, the integration of acupuncture with conventional medicine may be possible.

The effects of acupuncture are likely to derive from physiological and/or psychological mechanisms, and the needle stimulation could represent the artificial activation of systems that evolved as natural biological effects in functional situations [1,6].

Acupuncture and some other forms of sensory stimulation elicit similar effects in man and other mammals, suggesting that they bring about fundamental physiological changes. Acupuncture stimulation, eliciting *deqi*, excites receptors and or nerve fibers in the stimulated tissue, which are similarly physiologically activated by strong muscle contractions [1,6]. The effects on certain organ functions are also similar to those obtained by prolonged exercise. On the other hand, light superficial needling excites cutaneous touch receptors that are activated physiologically by stroking that in turn results in a limbic modulation with a suggested role in wellbeing and social bonding [6,4].

The effects of acupuncture in pain cannot be explained by a single mechanism, and pain itself is not entirely a straightforward physiological entity, but a phenomenon that arises from a multitude of varying neuroplastic changes as part of adaptive or sometimes maladaptive reactions [7].

The effects of acupuncture may be attributed to

1. Peripheral effects (release of adenosine and nitric oxide, NO, by axonal and dorsal root reflexes).
2. Spinal effects (modulation of sympathetic tone and motor reflexes)
3. Modulation of endogenous descending pain inhibitory and facilitatory systems
4. Change in the functional connectivity of the brain. Activation or deactivation of:
   a. limbic structures involved in stress/illness responses
   b. the hypothalamus-pituitary-adrenal, HPA, axis
   c. the prefrontal and frontal cortices.
5. Restoration of the default mode state.
6. Modulation of parasympathetic activity.
7. Activation of the reward and mirror systems
8. Modulation of activation of the immune system
9. Expectation, attention, conditioning and extinction of conditioned responses

Clinical trials suggest that variability in treatment outcome following acupuncture may also to a significant degree be attributed to the therapist and the patientís interaction with the therapist. The importance of therapeutic alliance in predicting treatment success is well established. Acupuncture is part of a healing ritual allowing for a therapeutic alliance between the acupuncturist and the patient. Possibly this may be attributed to the ability to mediate empathy and/or consolation.

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## 2. Background

The human biological system has evolved over a very long period of time, but is still adapted to a hunter-gatherer lifestyle where persistence in physical activity was of fundamental importance for survival. In modern society, psychosocial stress is high and motor activity frequently minimal, and the resulting emotional tension cannot be transformed into physical exercise in accordance with inherited biological needs. Instead, the stress-induced changes remain and can cause long-lasting disturbances in muscle tone and autonomous activity, resulting in various types of pain and functional diseases. A contributing factor to health disturbances is probably limited physical exercise with insufficient afferent input for an optimal performance. Changes in function of biological systems occur as a result of somatic afferent stimulation whether from normal physical exercise, electrical stimulation of afferent nerve fibers or stimulation via acupuncture needles. The direction of change seems to be towards an optimal physiological performance of different functions. The details of the underlying mechanisms are largely unknown, but most likely homeostatic and allostatic mechanisms are involved.

### 2.1. Pain

The definition of pain has provided a powerful conceptual anchor for scientific and health care professional advances in understanding the nature and treatment of acute and chronic pain. Recently, a review of the definition of pain was proposed:

*Pain is a distressing experience associated with actual or potential tissue damage with sensory, emotional, cognitive, and social components* [2]. By taking this definition into account assessments of a treatment becomes more complex and requires a deep understanding of its use in a clinical context.

### 2.2. Pain and acupuncture

In recent years, many studies have explored the effects of acupuncture in pain. Some patients may experience amelioration of their suffering which is paralleled by changes in biological functions whereas others "only" report a subjective relief i.e. the changes seen during and after a treatment are highly dependent on the individual and the pathophysiological mechanisms involved. This could account for some of the reasons why variable results of pain alleviation in response to acupuncture have been reported. Also, age and gender related variations in perceived pain have been discussed. Furthermore, factors such as operationalisation of the outcome variable and the statistical method used for evaluation could also be sources of variability. When pain is regarded as subjective, the produced data should be treated as ordinal. A rank-based method, taking the non-metric qualities of the ordinal data into account as well as the variability at the group and the individual level, may therefore be recommended. When using such an approach evaluating changes in electrical sensory thresholds and electrical pain thresholds after low frequency electro-acupuncture separately in healthy women and men, it was found that results were divergent between women and men, i.e. unchanged sensory threshold after acupuncture at the group level in women while changed in men. The assessed pain threshold after acupuncture on the other hand was changed towards higher levels in women and unchanged in men suggesting that evaluation of sensory and pain threshold responses to acupuncture should be analysed separately in women and men [5].

### 2.3. Pain, acupuncture and traditional Chinese medicine

The paradigm of Traditional Chinses Medicine, TCM, with its balancing of energy may, in its way, explain the origins of diseases and disturbed organ functions, but is seen from a western perspective a philosophical rather than biological approach. In many of the original studies regarding acupuncture and pain the underlying mechanisms, e.g. of pain relief, were often discussed relative to traditional TCM or to the location of the pain (for example low back pain, headache and knee pain) but surprisingly few penetrating discussions have dealt with the pathophysiological background of the actual pain condition.

### 2.4. Pain classification

In contrast to symptomatic and/or diagnosis-based pain treatments, mechanism-based treatments are more likely to succeed. Pain can be an adaptive sensation, an early warning to protect the body from tissue injury (Nociceptive pain). By the introduction of hypersensitivity to normally innocuous stimuli, pain may also aid in repair after tissue damage (Inflammatory pain). Pain can also be maladaptive, reflecting pathological function of the nervous system (Neuropathic pain or Dysfunctional/Long lasting pain) [10].

Multiple molecular and cellular mechanisms operate alone and in combination within the peripheral and central nervous systems to produce the different forms of pain. Elucidation of these mechanisms (including for example; peripheral and central sensitization, neuroplasticity following nerve injury, contribution of activity in the sympathetic nervous system and dysfunction of the pain modulatory systems (disinhibition and central facilitation) as well as cognitive and affective factors) is key to the development of acupuncture techniques that specifically target or modulate underlying causes rather than just symptoms.

It has been suggested that "an evidence-based approach to pain management is not always possible or beneficial to the individual patient. In the face of inconclusive evidence, a theory-based approach may help determine if the therapeutic effect of a given sensory stimulation has the possibility of being a useful clinical tool in the context of modifying a particular patient's mechanism of pain generation." Further studies on mechanism-based classification and such classification-based treatments are essential [8].

### 2.5. Physiological mechanisms of acupuncture

#### 2.5.1. Overview

Effects of acupuncture therapy occur at multiple levels in the nervous system, both in the peripheral tissue, at segmental (spinal) and central levels [6].

#### 2.5.2. Peripheral mechanisms

Insertion and manual or electrical stimulation of needles in skin and muscle activates A-alpha, −beta, −delta and C-fibers. In particular, activation of A-delta and C-fibers may be essential for modulating pain and autonomic nervous system activity. Manual and electrical stimulation (electroacupuncture, EA) causes release of neuropeptides including calcitonin gene-related, peptide (CGRP) and vasoactive intestinal polypeptide (VIP) from peripheral nerve terminals and other vasodilatory mediators from the tissue around the needle (including adenosine and nitrous oxide) into the area, increasing blood flow. Low-frequency (2 Hz pulse trains) EA also increases skeletal muscle glucose uptake. In insulin-resistant rats peripheral insulin sensitivity is improved by low-frequency EA for 4–5 weeks with three treatments per week and normalized by five treatments per week.

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