The Neurophysiology of Acupuncture

Possible Mechanisms and Outcomes

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Acupuncture Channels

Primary Afferent Fibers

Small Fiber Neurogenic Inflammatory Cycle

Tissue Inflammation

+ Neuropeptides

- Histamine
- Bradykinin
- Prostaglandins

Sensitized Primary Afferent Fibers

Spinal Cord
Central Sensitization - Somatic
Central Sensitization - Visceral

Large Fiber Touch

Small Fiber

Gate-Control Theory

Raphe-spinal Tract

Dorsal horn

ENK Neuron

To spinothalamic tract
Large Fiber Touch

Small Fiber

Raphe-spinal Tract

Dorsal horn

ENK Neuron

To spinothalamic tract

Loss of Inhibition on the Segment

Neuropathic Pain
Viscerosomatic Integration - The Viscerotome

Epaxial muscle mass
Intermuscular septum
Hypaxial muscle mass

Somatic input
Visceral input
Cross-Sensitization in the Dorsal Horn

Skin (Cutaneous Afferents)

Joint (Deep Somatic Afferents)

Heart (Visceral Afferents)

Thalamus

Cross-Sensitization in the Dorsal Horn
Viscerosomatic Integration & Acupuncture Points

Reciprocal Sensitization

Viscerosomatic Receptive Fields

Primary Afferent Fibers
Central Processes

Tract of Lissauer
Viscerosomatic Integration of Acupuncture Points

Bidirectional Communication

Referred Pain
Pancreaticosomatic Reflexes

- Stimulation of the pancreatic duct with trypsin
- Enhance EMG activity in the acromiotorapezius muscle of the back

Referred Gall Bladder Pain

Trophic Changes

- Increased thickness of the subcutaneous tissue
- Firmness not related to edema
- Decreased thickness in the associated muscle layers
- Muscle atrophy
- Degree of change related to duration of painful episodes

Referred Uterine Pain
Referred Pain From The Uterus

• Rats pretreated with Evans Blue vital dye
• Subjected to noxious uterine stimulation
• Extravasation of dye over the low abdomen and back, sacral and perineal region

Cross-sensitization of Pelvic Organs

Spinal cord as an integrator of afferent fibers

Control of Spinal Cord Activity

Ascending Nociceptive Pathways

Brainstem-Subcortical Thalamocortical

Descending Spinal Control Systems

Endogenous Pain Control
Raphe-spinal system
Noradrenergic-spinal system

Diffuse Noxious Inhibitory Control
Spino-Reticulospinal Loop
Naloxone Sensitive
Cingulate Gyrus, Medial Prefrontal Lobe, & Amygdala
Dorsolateral Prefrontal Cortex
Pain Neuromatrix

Somatic Sensory Cortex

Anterior Cingulate Cortex

Prefrontal Cortex

Discrimination Localization

Mood Affect

Cognition Experience

Posterior Cingulate Cortex

Sensory Behavior

Cerebral Pain Matrix

Anticipation Integration

Past Experiences

Insular Cortex

Amygdala

Nociception
Pain Neuromatrix

- Somatic Sensory Cortex
- Anterior Cingulate Cortex
- Prefrontal Cortex
- Posterior Cingulate Cortex
- Sensory Behavior
- Cerebral Pain Matrix
- Anticipation Integration
- Past Experiences
- Amygdala
- Nociception
- Mood Affect
- Cognition Experience
Pain Connectome

(A) Pain Connectome

(i) Salience network
Sustained activation during attention to pain

(ii) Default mode network
Suppressed when attending to pain but not when mind wandering away

(iii) Antinociceptive system
Increased functional connectivity during mind wandering away from pain

(B) Pain Connectome

(B) Pain Connectome

Rest (no pain) | Attend to pain | MW from pain

Network engagement

DMN | SN | DMN, AS
AS, SN | AS | SN

(C) Pain Connectome

High IAP individual
Connectivity strength/flexibility

Low IAP (MW) individual

Kucyi A, Davis KD. 2015. The dynamic pain connectome. Trends Neurosci 38: 86-95
Acupuncture Can Influence Cerebral Cortical Activity


Following acupuncture needle stimulation, activation in the sensorimotor cortical network, including the **insula, thalamus, anterior cingulate cortex, and primary and secondary somatosensory cortices**, and deactivation in the limbic-paralimbic neocortical network, including the **medial prefrontal cortex, caudate, amygdala, posterior cingulate cortex, and parahippocampus**, were detected and assessed...
TNA and SNA+MS induced DMN-insula activity and extensive DMN activity compared to SNA, despite comparable levels of de qi sensation. The TNA and SNA+MS groups exhibited a delayed and enhanced modulation of the DMN, which was not observed followed SNA and TENS. Furthermore, TNA increased precuneus activity and increased the DMNrelated activity of the cuneus and left insula, while SNA+MS increased activity in the right insula.
Research Article

Acupuncture Reversible Effects on Altered Default Mode Network of Chronic Migraine Accompanied with Clinical Symptom Relief

The Neurophysiology of Acupuncture

Cerebral Cortex ➔

Brainstem ➔

Spinal Cord ➔

Peripheral Nerve ➔