

# Survey of the Physiological Impact of Acupuncture on the Central Nervous System (CNS)

This paper surveys the physiological impact of acupuncture on the central nervous system. It is not exhaustively comprehensive but is intended to provide a broad overview of such impact.

The approach taken is one which reflects the anatomical organisation of the central nervous system. Structures and functional regions are considered along a caudal/ rostral axis. This creates a sense of hierarchy, which is consistent with the various papers on the model, and reflects normal neuroanatomy and physiology.

## Spinal Cord

Pain and temperature sensations are carried rostrally from the dorsal horn of the spinal cord almost entirely in the spinothalamic tract. This tract includes three main fibre groups - spinoreticular, spinomesencephalic, and spinothalamic (Kandel et al., 1991).

While initially it was thought the gate control theory of Melzack and Wall (1965) might explain much of the analgesic impact of acupuncture, this has proven not to be so, even in its modified form (Melzack, 1973). However it did instigate much debate and research into possible neurohumeral mechanisms which might explain a more complete array of acupuncture's effects.

Acupuncture sensations are carried, at least partly, in A-beta and A-delta fibres, and the anterolateral funiculus is the main afferent pathway carrying acupuncture analgesia (Han, 1984).

As discussed below there are many sites rostral to the spinal cord which have been found to contribute to the effects of acupuncture, particularly to acupuncture analgesia. These are discussed under the headings Brainstem, Diencephalon, Limbic System and Deep Grey, and Cerebral Cortex. The End Note to this paper, and the diagrams which precede it, give a summarised overview.

Descending fibres from the nucleus raphe magnus in the pons synapse in the substantia gelatinosa of the dorsal horn along much of the length of the spinal cord (Fields and Anderson, 1978). These fibres are mainly serotonergic and inhibit or modulate nociceptive information as it enters the dorsal horn (Chung and Dickenson, 1980; Dickenson et al., 1979; Yaksh and Rudy, 1979; Yaksh and Tyce, 1979; Rivot et al., 1979; Oliveras et al., 1977; Carpenter, 1991).

The periaqueductal grey innervates the nucleus raphe magnus in the brainstem, and so exerts an indirect influence on the dorsal horn via this nucleus (Carpenter, 1991).

The neurotransmitter, Substance P, has an excitatory impact on primary afferent neurones in the dorsal horn. It therefore opposes the effects of acupuncture analgesia (Otsuka and Konishi, 1979; Oehme et al., 1980). Cholecystokinin (CCK-8), found in the dorsal root ganglia, has also been found to be antagonistic to acupuncture analgesia (Abrams and Recht, 1982).

Cyclic AMP (cAMP) appears to oppose acupuncture analgesia in the spinal cord (Han et al., 1980).

## Brainstem

Several regions of the brainstem have been implicated in explaining the impact of acupuncture. These include the raphe nuclei, the locus coeruleus, and the periaqueductal grey matter (PAG), (Bensoussan, 1991; Han et al., 1986).

### Raphe Nuclei

The raphe nuclei consist of several cell groups which lie in or close to the mid-line of the medulla, pons and midbrain (Carpenter, 1991). These constitute the median column of the reticular formation (Conn, 1995). The neurones of many raphe nuclei synthesise serotonin (5-hydroxytryptamine, 5-HT), and probably use this as a neurotransmitter (Conn, 1995). Many contain cholecystokinin (CCK) (Carpenter, 1991).

Serotonergic neurones of the raphe nuclei of the medulla and caudal pons - raphe magnus, raphe pallidus and raphe obscuris - project to the spinal cord in the dorsolateral funiculus and terminate in laminae I and II of the dorsal horn (Carpenter, 1991).

Neurones of the raphe magnus have an inhibitory effect on nociceptive neurones in the caudal spinal trigeminal nucleus and in the spinal dorsal horn. Serotonin (5-HT) appears to be the dominant neurotransmitter, acting on nociceptive interneurons and spinothalamic tract neurones (Carpenter, 1991). Enkephalin has also been shown to be present (Carpenter, 1991).

Electrical stimulation of the periaqueductal grey produces analgesic effects in these regions due to its connections with raphe nuclei in the medulla (Carpenter, 1991).

Acupuncture has been shown to activate the raphe magnus (Zhu and Shi, 1984). It is suggested this response is partly mediated by opiate-like substances released from the periaqueductal grey (PAG). Increased activity in raphe magnus neurones has been found to be blocked by naloxone, implying endogenous opiates are involved (Bensoussan, 1991).

Evidence for the role of serotonin (5-HT) in acupuncture analgesia was provided by Han et al. (1979, 1980), when the serotonin precursor 5-hydroxytryptophan (5-HTP) was found to increase the analgesic effect of acupuncture when injected intrathecally and intraventrically in rats. Further, when the reabsorption of serotonin was blocked using clomipramine, increased levels of analgesia resulted (Han et al., 1980).

Prevention of serotonin synthesis by injecting parachlorophenylalanine into rats and rabbits has been found to attenuate acupuncture analgesia (Han, 1980), but not abolish it, implying other transmitters are also involved (Bensoussan, 1991).

Electro-acupuncture has been found to raise the level of platelet serotonin in chronic pain patients (Mao et al., 1980).

Considering the role of serotonin further, it has been found that depression is associated with low levels of central and platelet serotonin, (Sarai and Kayano, 1968; Sternbach et al., 1976; Patterson, 1986), as is increased risk of suicide (van Praag, 1983). The serotonin precursor 5-hydroxytryptophan (5-HTP) has been found to alleviate insomnia (Schmidt, 1978).

Bensoussan (1991) suggests ... "that serotonin in the central nervous system may be one of the most important neurochemical agents mediating acupuncture analgesia" and is "capable of exerting profound physiological responses".

### **Locus Coeruleus**

The locus coeruleus is a compact collection of blue-black pigmented cells in the rostral pons, ventrolateral to the periventricular grey of the fourth ventricle (Conn, 1995; Carpenter, 1991). It intermingles partly with cells of the mesencephalic nucleus of the trigeminal nerve (CN V). Ventrolaterally is the nucleus sub-coeruleus (Carpenter, 1991).

Many locus coeruleus cells contain noradrenaline as a neurotransmitter (Conn, 1995; Carpenter, 1991).

The locus coeruleus projects fibres widely to parts of the telencephalon, diencephalon, midbrain, pons, medulla, cerebellum and spinal cord. There are two prominent ascending groups, one to the thalamus, hippocampus, amygdala and all areas of the cerebral cortex, the other to the periaqueductal grey and hypothalamus (Conn, 1995).

Noradrenergic fibres are distributed widely in the cerebral cortex and hippocampal formation, while those projecting to the thalamus distribute to particular groups, including the lateral geniculate body (Carpenter, 1991).

More than 10% of locus coeruleus cells innervate both the cerebellar and cerebral cortex (Carpenter, 1991). Noradrenergic fibres project to the superior and inferior colliculus, reticular formation and cerebellar cortex.

Caudally projecting fibres of the locus coeruleus and sub-coeruleus project to the spinal cord, innervating parts of the anterior and intermediolateral grey matter (Carpenter, 1991), but these fibres do not terminate directly on intermediolateral cells in thoracolumbar spinal segments.

The A5 group of noradrenergic neurones is considered to provide most of the input to the intermediolateral cell column of the spinal cord, which in turn gives rise to preganglionic sympathetic fibres (Carpenter, 1991). The A5 cell group projects to regions which do not receive projections from locus coeruleus (Carpenter, 1991) and sends collaterals to the dorsal motor nucleus of the vagus, nucleus solitarius and nucleus ambiguus.

The locus coeruleus projects noradrenergic fibres to the raphe magnus, nucleus habenula, and periaqueductal grey (Bensoussan, 1991). Cao et al. (1983) found that electroacupuncture on humans and conscious rabbits decreased noradrenalin in plasma and CSF, and this was accompanied by an increase in pain threshold. They suggest inhibition of sympathetic activity may play a role in acupuncture analgesia.

CSF content of noradrenalin has been found to have a negative correlation with the effectiveness of acupuncture anaesthesia. A precursor to noradrenalin, dihydroxyphenylserine (DOPS), has been injected intraventricularly into rats. This was found to have an antagonistic effect to acupuncture analgesia (Peking Medical College, 1979).

Chemical lesion of noradrenalin axon terminals in the dorsal raphe nucleus has been found to augment the effect of acupuncture analgesia (Dun et al., 1979). Microinjection of a noradrenaline agonist (clonidine-M) into the periaqueductal grey of rabbits and cats is antagonistic to acupuncture analgesia (Zhou et al., 1979).

On the other hand, noradrenalin content in the dorsal horn of the spinal cord has been found to increase with acupuncture stimulation (Cao, 1983, 1984). In these regions it is thought to augment the analgesic response (Bensoussan, 1991).

Bensoussan (1991) suggests that the central effect of electroacupuncture (at some acupuncture points) is to increase both the synthesis and release of noradrenalin, which on balance suppresses acupuncture analgesia

### **Periaqueductal Grey**

The periaqueductal grey (PAG) surrounds the cerebral aqueduct in the midbrain. It contains several groups of nuclei which are closely packed and relatively small. At the level of the inferior colliculus the rostral locus coeruleus and the mesencephalic nucleus of the trigeminal (CN V) occupy its lateral regions. The medial region contains the dorsal raphe nucleus (Carpenter, 1991), and lateral to this are the dorsal tegmental nuclei.

The PAG receives input from the hypothalamus, brainstem reticular formation, raphe nuclei, locus coeruleus, and spinal cord. Its efferent projections commonly have reciprocal destinations (Carpenter, 1991).

Carpenter (1991) suggests this region is functionally heterogeneous with possible involvement in central analgesic mechanisms, vocalization, control of reproductive behaviour, aggressive behaviour, and upward gaze mechanisms. Ventrolateral PAG regions are thought to participate in (stimulation produced) analgesia. Microinjections of morphine into the PAG in rats and mice produce marked analgesia (Carpenter, 1991).

Acupuncture analgesia has been found to be antagonised by naloxone (Takeshige et al., 1980; Mayer et al., 1977; Pomeranz and Chiu, 1976, Yang and Kok, 1979). These researchers concluded that opiate-like substances released by the dorsal PAG play a significant role in acupuncture analgesia.

Together with the nucleus accumbens, amygdala, habenula, and dorsal horn of the spinal cord, the PAG has a significant presence of opioid receptors (Hokfelt et al., 1976; Kuhar et al., 1973; Simantov et al., 1977; He and Dong, 1983). It is therefore thought to play an important role in acupuncture analgesia (Bensoussan, 1991).

Electrical stimulation, and morphine injection into the periaqueductal grey, stimulates descending serotonergic pathways which inhibit nociceptive neurones of the dorsal horn via the nucleus raphe magnus (Reynolds, 1969; Mayer et al., 1971; Carstens et al., 1979; Bennet and Mayer, 1979; Oliveras et al., 1977).

Opioid peptides found to be present in the PAG include beta-endorphins, enkephalin and dynorphin (Bensoussan, 1991). Beta-endorphin has been found to have potent anti-nociceptive properties (Loh et al., 1976; Feldberg and Smyth, 1976; Han, 1984).

The presence of endogenous opiates in the brain is closely correlated with acupuncture analgesia (Han et al., 1980). This is also true of opiates in plasma (Xu et al., 1979).

While recognising the role of endorphins and other opioid-like substances in acupuncture analgesia, Bensoussan (1991) does not believe these on their own are the complete explanation. It has also been shown that a particular subclass of opioid receptor may mediate the acupuncture analgesia response (Pasternak, 1981).

The functions of serotonin and opiate-like substances (in rats) have been found to be closely interrelated (Han, 1980, Han et al., 1986). Acupuncture analgesia has excellent results when serotonin content is high and opiate activity levels are also high. When only one factor is high, the result is more likely to be moderate analgesia. If both factors are blocked or low, poor analgesia results (Han et al., 1986; Liang, 1979).

Blockage of opiate receptors with naloxone not only obstructs the activity of endogenous opioids, but leads to increased turnover of serotonin. Further, a decrease in serotonin content leads to an increase in opiate activity (Han et al., 1986).

## **Diencephalon**

Three areas of the diencephalon (thalamus, habenula, and hypothalamus) are implicated in acupuncture analgesia (Bensoussan, 1991; Han et al., 1986b).

### **Thalamus**

The thalamus is a major sensory relay centre. All sensory modalities project fibres to the thalamus, including pain and temperature via the spinothalamic tract (Carpenter, 1991; Conn, 1995; Kandel et al., 1991).

Acupuncture carried out on rabbits, cats and rats has been shown to inhibit pain responses in the nucleus parafascicularis and nucleus centralis lateralis of the thalamus (Chang, 1973; Xu et al., 1984a; He and Wang, 1984; Zhao et al., 1986). Endogenous opioid peptides and receptors participated in the mediation of these nociceptive responses (He and Wang, 1984).

Bensoussan (1991) suggests ascending serotonergic fibres from the raphe dorsalis nucleus are likely to contribute to the analgesic effects of acupuncture in the thalamus.

The neurotransmitter glutamic acid has been identified in the thalamus. Glutamic acid has been found to have a role in acupuncture analgesia (Zhu, 1984; Wang et al., 1987; Xu et al., 1984b).

### **Habenula**

The habenula is part of the epithalamus. It consists of a small medial nucleus, lateral to which is a slightly larger nucleus. These nuclei receive fibres from the septal nuclei, lateral (preoptic) hypothalamus, and anterior thalamic nucleus, via the stria medularis. The habenula projects fibres to the interpeduncular nucleus and raphe nuclei of the midbrain (Carpenter, 1991).

The habenula is a site of convergence for limbic pathways. Opioids have been identified in these nuclei (Fan et al., 1979). However there is evidence that the habenula inhibits the analgesic responses of the PAG, thalamus, and raphe nuclei during electroacupuncture analgesia (Wang et al., 1987; Xu et al., 1984; Fang et al., 1984). The neurotransmitter released is gamma aminobutyric acid (GABA).

During electroacupuncture the habenula also stimulates the locus coeruleus which inhibits the raphe nuclei (Han, 1984).

### **Hypothalamus**

Neurons containing beta-endorphins have been identified in the arcuate nucleus of the hypothalamus (Yin et al., 1984; Finley et al., 1981; Gao and Gu, 1984a,b). Fibres from this nucleus project to the PAG and locus coeruleus.

Electroacupuncture on rats has been shown to stimulate neurons of the arcuate nucleus, which resulted in attenuation of noxious stimuli (Yin et al., 1984).

Increased levels of acetylcholine (ACh) in the hypothalamus have been positively correlated with the analgesic and regulatory effect of acupuncture in the hypothalamus (Tang et al., 1979; Wang et al., 1979). Inhibiting synthesis of ACh has resulted in attenuation of acupuncture analgesia, while accumulation of ACh has potentiated the effects of acupuncture analgesia (Ren et al., 1979; Guan et al., 1986).

### **Limbic System and Deep Grey of Forebrain**

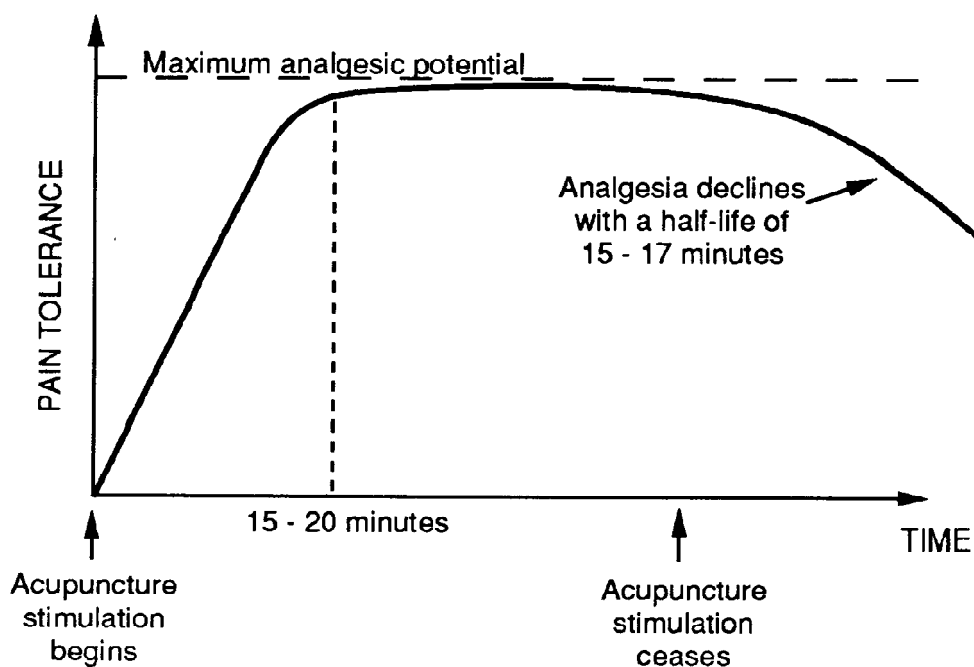
Three structures in these regions are identified as playing a role in the impact of acupuncture - the nuclei accumbens, amygdala and caudate (Bensoussan, 1991; Han et al., 1986b).

#### **Nucleus Accumbens**

The nucleus accumbens is developmentally related to the caudate nucleus and putamen, and so may be considered part of the basal ganglia. It is a rostroventral extension of these nuclei, and projects fibres to the substantia nigra and globus pallidus (Carpenter, 1991). It also has a descending opioid pathway to the raphe nuclei (Bensoussan, 1991). The nucleus accumbens receives substantial dopaminergic input, and has serotonergic input from the PAG and the raphe dorsalis. It plays a role in attention evoking mechanisms (Kandel et al., 1991).

Serotonergic stimulation of the nucleus accumbens leads to release of met-enkephalins from its raphe pathway. This inhibits pain signals and supports analgesia. Pathways between the nucleus accumbens, PAG and raphe dorsalis have been referred to as the 'mesolimbic loop of analgesia' (Han, 1984). It may be positive feedback in this loop which might explain the long lasting effects of acupuncture analgesia (Bensoussan, 1991).

The following diagram, Figure 1, is reproduced from Bensoussan (1991) and illustrates the typical effect of acupuncture analgesia on pain tolerance (e.g. refer to Andersson and Holmgren, 1975).



**Fig. 2.1** Pattern of growth and decline of acupuncture induced analgesia (not drawn to scale).

**Figure 1** Reproduced from Bensoussan (1991), p.27

Descending fibres from the nucleus accumbens have been shown to inhibit the habenula (Fan et al., 1979). The effect of this is to attenuate the inhibitory impact of the habenula on its own caudal connections (Wang et al., 1984), and thereby enhance the effects of acupuncture analgesia.

### **Amygdala**

The amygdaloid nucleus is a mass of grey matter situated deep in the dorsomedial temporal lobe (Carpenter, 1991). It has a prominent role in the limbic system. The amygdala is divided into two main nuclear groups:

- 1) the corticomedial nuclear group, which includes a central nucleus.
- 2) the basolateral nuclear group, which is the largest group in humans.

Caudally the amygdaloid complex is in contact with the tail of the caudate nucleus.

Direct afferent connections to the corticomedial group include the lateral olfactory tract, but almost all parts of the amygdala receive direct or indirect olfactory input (Carpenter, 1991).

Many afferent and efferent connections are reciprocal.

Fibres from the rostral hypothalamus pass to all amygdaloid nuclei except the central nucleus. These are mainly from the ipsilateral lateral hypothalamic area. The ventromedial hypothalamic area projects mainly to medial regions of the amygdala (Carpenter, 1991).

There are a small number of projections from the paraventricular thalamus, and the lateral parabrachial nucleus of the pons and midbrain projects ipsilaterally to the central amygdaloid

nucleus (Carpenter, 1991). The lateral parabrachial nucleus receives ipsilateral projections from the nucleus solitarius (Loewy, 1990).

Both serotonin and enkephalins have been found in the amygdala, and both have been found to facilitate electroacupuncture analgesia (Xu et al., 1984). The role of the amygdala in the modulation of pain by acupuncture has been confirmed (Sun et al., 1984), who suggest the raphe nuclei act as relay nuclei for the acupuncture stimulus. However Zhang (1980) found no significant change in endorphin levels in the amygdala during acupuncture analgesia.

### **Caudate Nucleus**

The caudate nucleus is an elongated C shaped mass of deep grey matter (Carpenter, 1991). It is related to the lateral ventricle throughout its length. The head of the caudate and the putamen are largely separated by the anterior limb of the internal capsule, but are continuous rostroventrally as the nucleus accumbens (Carpenter, 1991).

Electrical stimulation has been shown to provide relief from chronic intractable pain caused by advanced tumors (Chen et al., 1982). When the cholinergic blocker, scopolamine, was injected into the caudate nucleus, acupuncture analgesia was blocked (He et al., 1979, 1981; Xu et al., 1983), indicating acetylcholine (Ach) facilitates acupuncture analgesia in the caudate nucleus.

An increase in the concentration of dopamine in the caudate nucleus due to electroacupuncture stimulation has been found to block the analgesic effects of acetylcholine, whereas injection of dopamine into the substantia nigra serves to increase this effect (Sun et al., 1984). Dopamine produced in the substantia nigra is an inhibitory neurotransmitter in the striatum (Conn, 1995).

When metoclopramide, a drug which has both anticholinesterase and antidopamine properties, was injected into rabbits prior to electroacupuncture, the pain threshold was both raised and prolonged upon stimulation (Xu et al., 1983).

It has been suggested the overall effect of dopamine in the brain is to attenuate acupuncture analgesia (Xu, 1978; Xu et al., 1984).

### **Cerebral Cortex**

The cerebral cortex has been shown to participate in the central nervous system's transmission and integration of pain signals (Delgado, 1955; Berkley and Palmer, 1974; Xu et al., 1986; Chen et al., 1986).

Fibres projecting from the cortex to more caudal structures, such as the caudate nucleus, thalamus, periaqueductal grey, reticular formation, raphe nuclei, and spinal cord may participate in the modulation and integration of nociception and pain (Kuypers and Lawrence, 1967; Brown et al., 1977; Yeziarski et al., 1983; Oka, 1980; Royce, 1983; Kunzle, 1977; Soto-Moyano and Hernandez, 1981).

Fibres projecting from the somatosensory cortex to the centromedian nucleus of the thalamus participate in producing and maintaining the effects of acupuncture analgesia (Lin and Wu, 1984a,b). Acupuncture appears to initiate the descending impulses.

The response of somatosensory area I to noxious stimuli has been inhibited by electroacupuncture, and this inhibition has itself been significantly attenuated by intravenous injection of naloxone (Dong et al, 1984), implying the involvement of opioid-like substances. Electroacupuncture has been shown to inhibit cerebral potentials evoked by noxious stimuli (Xia et al., 1984).

## Conclusion & Discussion

The following three diagrams, Figures 2, 3, and 4, are reproduced from Bensoussan (1991). They survey and summarise many of the connections in the brainstem, diencephalon and forebrain which are activated by acupuncture, and some of the important neurotransmitters and neuromodulators which participate in acupuncture's effects.

Although TCM may appear to the casual observer to be relatively unintrusive, acupuncture may have a substantial effect due to its impact in many (homeostatic) regions of the central nervous system. There is a veritable symphony of neurohumeral effects brought on by acupuncture stimulation.

When related to the model, these diagrams mainly provide a general overview of the effects of acupuncture within tier two, and between tiers two and three.

It should be emphasised however, that while the impact of acupuncture on the central nervous system is now well recognised in general terms, particularly relating to analgesia, a very considerable amount of juxtapositional research and investigation is still required into such areas as:

- the precision of the impact deriving from individual Points and Meridians
  - the various types of Meridians and categories of acupuncture points
  - the nature of the Zang Fu in juxtapositional terms
  - the nature of Wu Xing interactions
  - pulse and tongue diagnosis
  - the nature of the relationship between the Jing Luo, the Zang Fu, and the Wu Xing
  - the nature of Qi and other fundamental substances
- and so on.

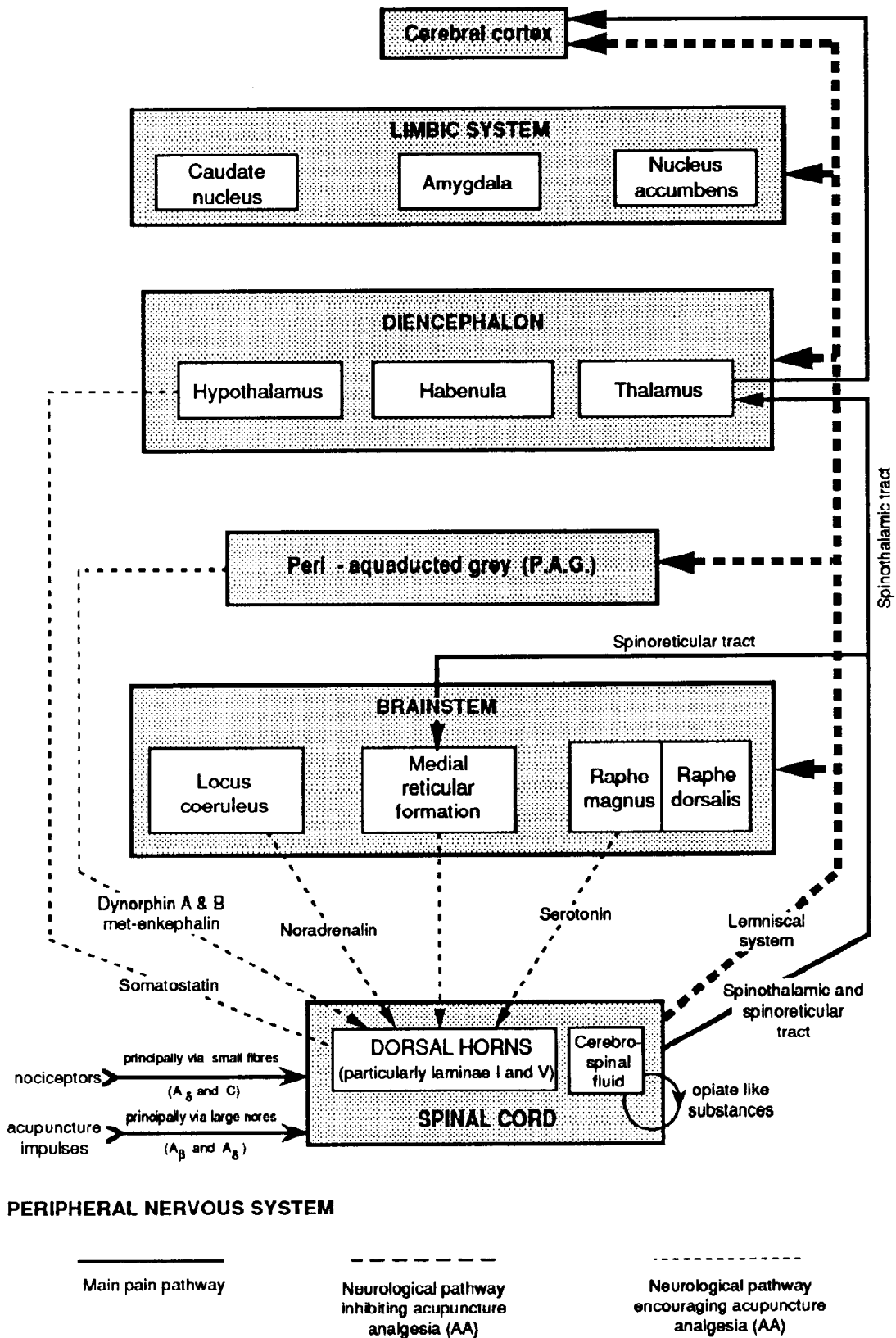


Fig. 5.3 Some of the neurological connections between the brainstem, the spinal cord and peripheral nerves that are activated by acupuncture.

Figure 2 Reproduced from Bensoussan (1991), p. 106

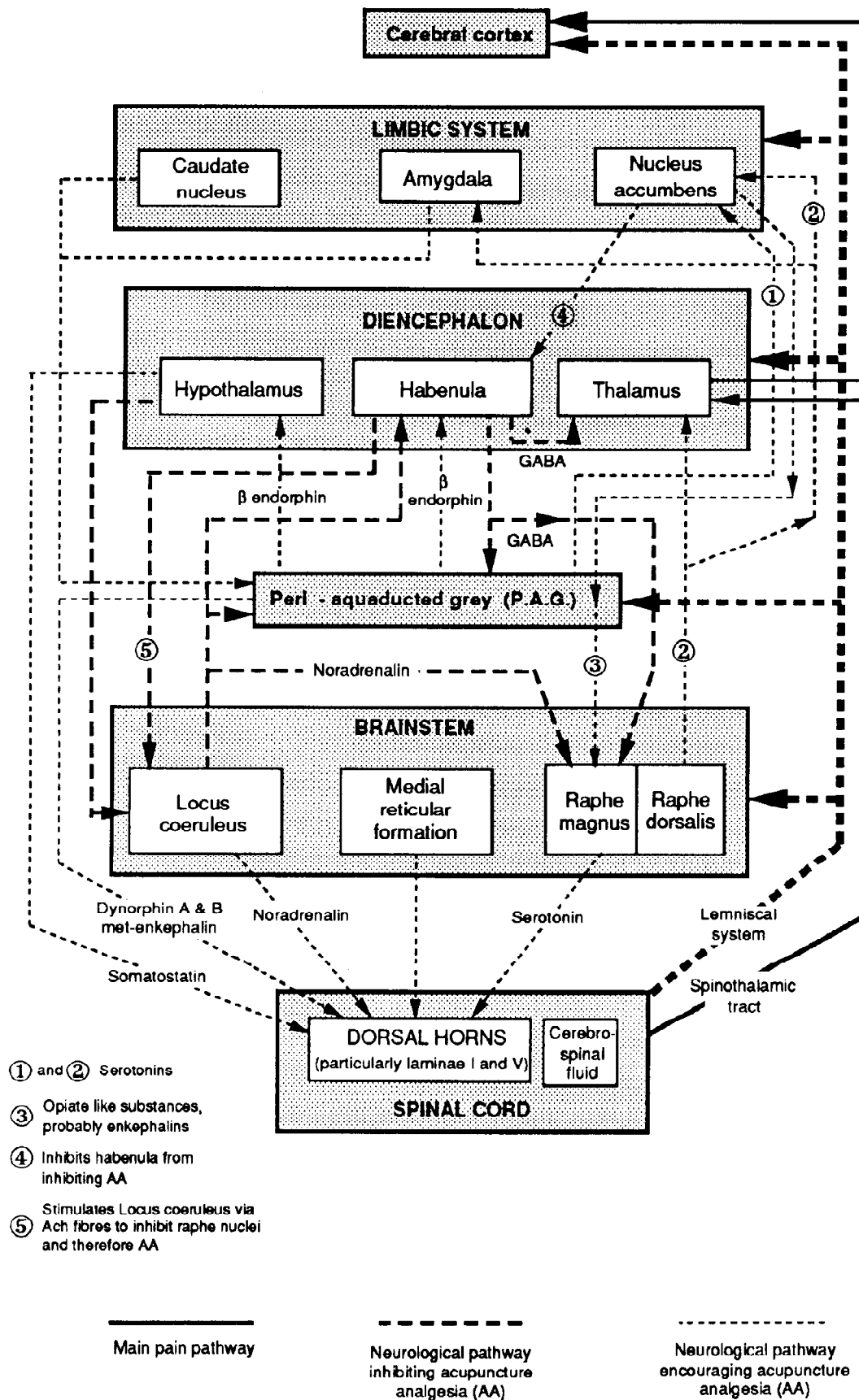


Fig. 5.4 Some of the neurological connections between the brainstem and the diencephalon that are activated by acupuncture.

Figure 3 Reproduced from Bensoussan (1991), p. 111

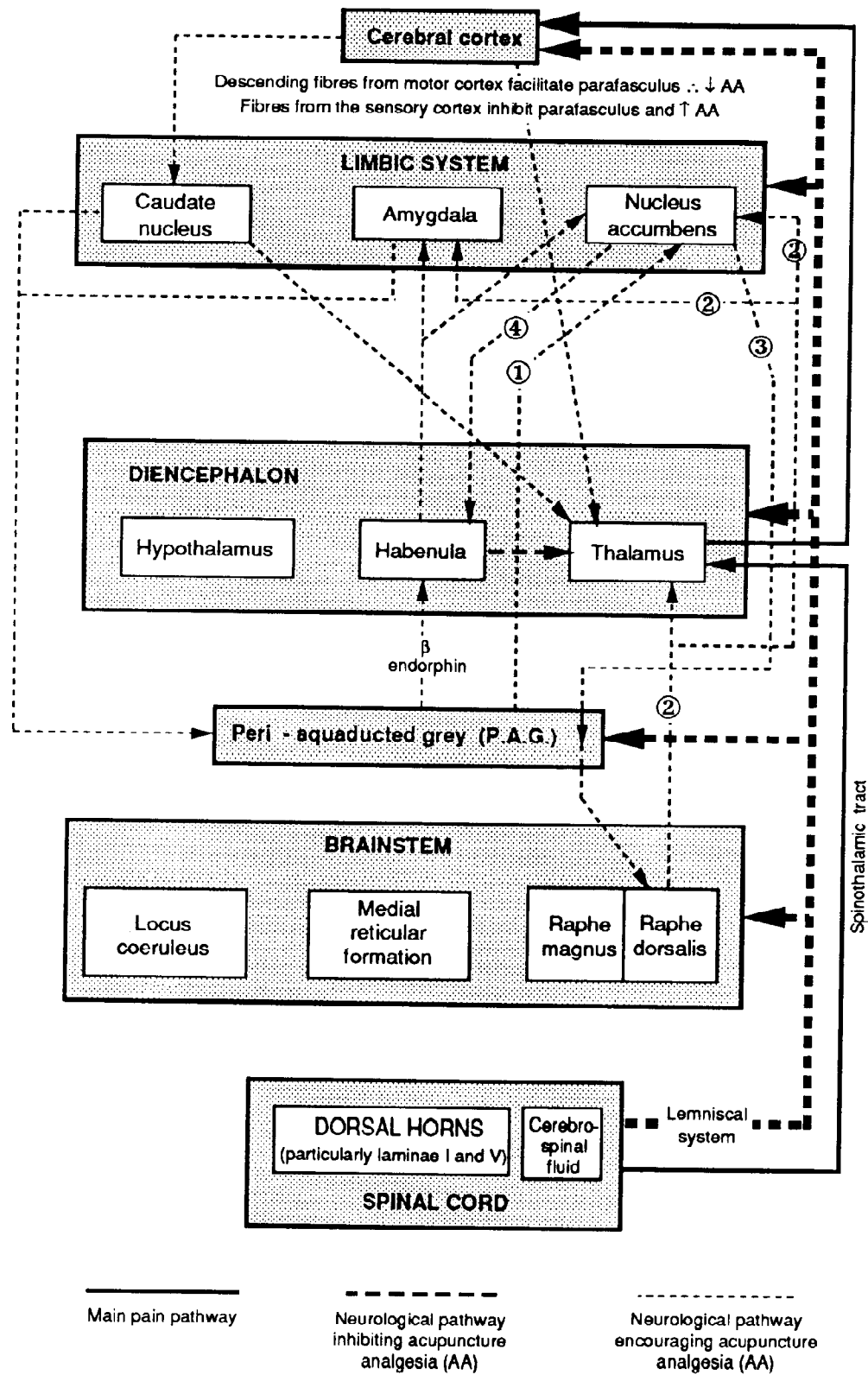


Fig. 5.5 Neurological connections activated or enhanced by acupuncture between the limbic system, diencephalon and cerebral cortex.

Figure 4 Reproduced from Bensoussan (1991), p. 118

## End Note

The following is an extract from Han et al. (1986b). It complements and summarises much of the subject matter of this paper dealing with acupuncture analgesia.

(The following diagram, Figure 5) ... "is intended to bring together the morphological and the functional, the electrophysiological and the neurochemical materials in a simple diagram so as to have a general idea of the present status of research in this field.

Signals of noxious stimulation travelling along afferent nerve fibers enter the CNS at the dorsal horn of the spinal cord, and probably release substance P there and bring the neurons of layer I and V to excitation. They may arouse motor reflexes at the spinal level, and may also be transmitted along the specific and nonspecific pain conducting pathways to higher centers; among them, the N. parafascicularis and centro-lateralis of the thalamus may occupy a strategic position in integration of pain-related messages. When the messages arrive at the cerebral cortex, they give rise to pain sensation and conscious perception.

After acupuncture signals (such as those arising from manual needling, electroacupuncture, mechanical pressing over the points of acupuncture or appropriate transcutaneous electrical stimulation) enter the CNS from the peripheral nerves, they may inhibit the transmission of pain signals at the spinal level (gate control mechanism). But what is more important is that they are carried along the anterolateral funiculus to the brain, and then through the mediation of certain nuclei exert a modulatory action on the transmission and perception of pain. For example:

(1) They may excite the raphe nuclei and inhibit the transmission of pain signals via ascending and descending serotonergic fibers.

(2) They may activate N. magno-cellularis (gigantocellularis) which imparts a descending inhibitory influence ... upon the dorsal horn.

(3) They may activate the PAG, which in turn excites raphe nuclei and N. magno-cellularis (gigantocellularis).

(4) The signal after reaching N. magno-cellularis (gigantocellularis) may be transmitted to centro-median nucleus and then through a long tortuous neuronal circuit (including probably the caudate nucleus) inhibits the parafascicular nucleus of the thalamus.

(5) Efferent fibers from the caudate nucleus may inhibit the parafascicular nucleus and may also excite the raphe nuclei. Within the caudate nucleus, the cholinergic mechanism might play an important role.

(6) After the acupuncture signals arrive at the cerebral cortex, they may impart a descending inhibition upon the parafascicular nucleus, and may also exert an analgesic effect through the mediation of the caudate nucleus and other subcortical structures.

(7) Opiate-like-substances (OLS) take effect at N. accumbens, amygdaloid nucleus, habenula and PAG, and may also exert their influence on the dorsal horn of the spinal cord by presynaptic inhibition to suppress the liberation of substance P, thus blocking the transmission of pain signals.

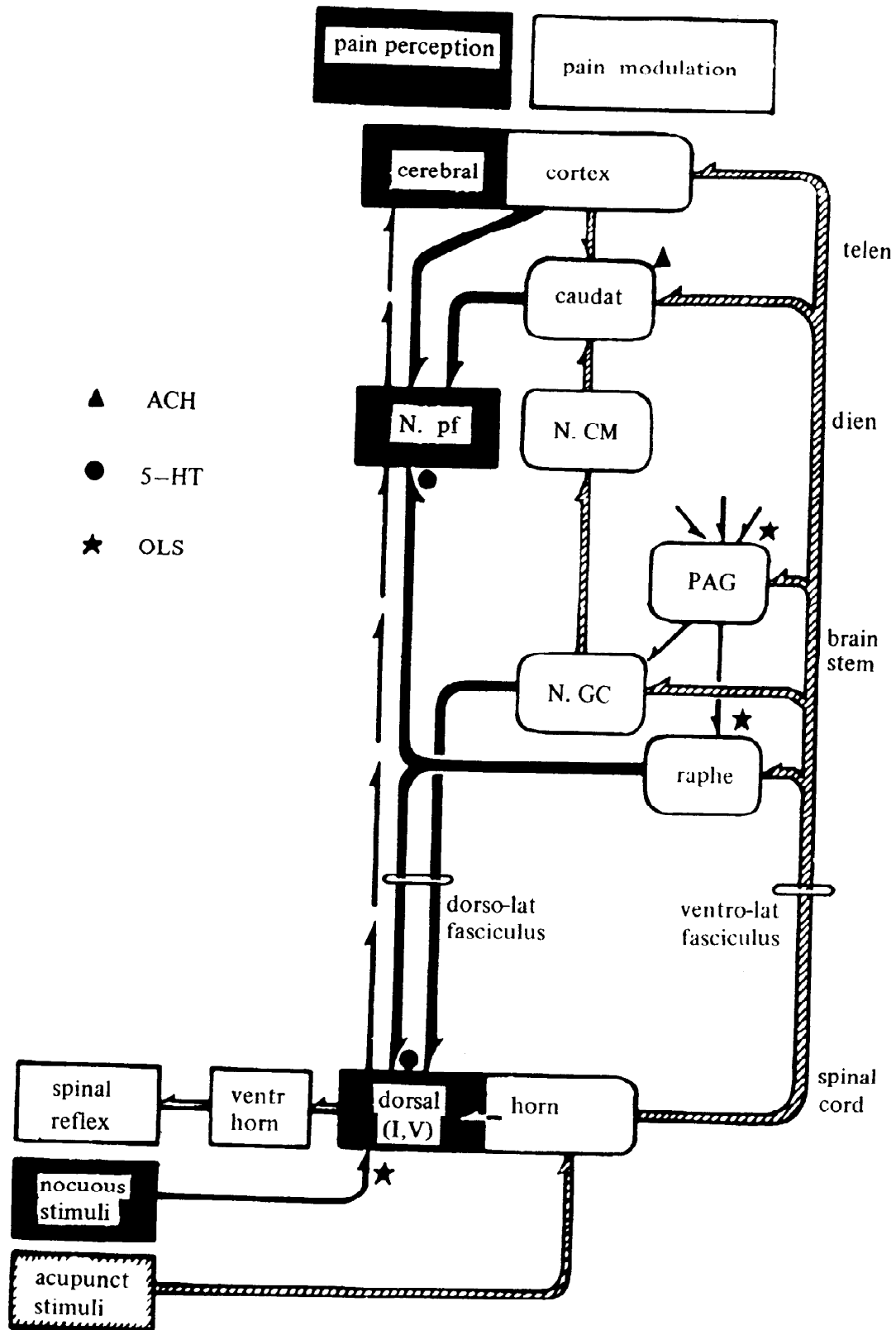


Fig. 3 Central neural pathways and related neurotransmitters in relevant to acupuncture analgesia.

Figure 5 Reproduced from Han et al. (1986b) p. 253

(8) NE antagonizes AA at habenula, PAG, etc., and may also impart descending influences augmenting AA (not shown in the figure).

This simple sketch is by no means comprehensive and in fact it is almost impossible to include everything here. As shown in the sketch, the analgesic effect of acupuncture is the result of mobilization of a complex pain-modulating system in the CNS. The details of the system, which is now still in its rudimentary form, await further clarification."