ACUPUNCTURE: AN INVESTIGATION INTO THE HISTORY, MECHANISMS OF APPLICATION, NEUROLOGICAL INVOLVEMENT AND VALIDITY

by

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Abstract

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The ultimate goal of this thesis is to investigate possible neurological involvement of acupuncture. In order to present a broad background of acupuncture, a thorough investigation into both its philosophical and practical aspects precedes any relationship to structures and pathways within the central and autonomic nervous systems.

The neurological involvement of acupuncture is approached by the author in two different ways: 1) From existing theories and experimentation; and 2) By hypothetical conclusions (reached by the author) based upon both previous investigation by "experts" in the field and interpretation of various interrelated structures and pathways within the central and autonomic nervous systems. In order to achieve a "broad based" conclusion as to neurological involvement, the most recent experimentation and investigation is coupled with both personal interviews and mailed responses from some of the leading authorities on acupuncture in the world.

By incorporating the above approaches, the author concludes the investigation by proposing a "total mechanism" theory, encompassing a neurological pathway from the acupuncture insertion point to the "target" area or organ which is affected (usually anesthetised). It is emphasized that acupuncture is an "explainable" method of treatment despite its unscientific philosophy.
In addition, practical applications (exemplified by case histories) emphasize the importance of acupuncture as an adjunct to "Western Medicine" and recent (1974) experimentation is cited as proof that knowledge of neurological involvement is essential for the expansion of "clinical acupuncture."
Preface

This paper's major purpose is to satisfy the question: "Why does acupuncture work? and how?" In responding to that question, a thorough investigation of the history of acupuncture, location of points and theories of possible neurological involvement were considered the logical means of approaching the subject. Such was, indeed, the basic approach of this author.

The ultimate goal of this paper (a logical unveiling of neurological involvement) was achieved to the satisfaction of this author's "requirements" and includes a complete "total mechanism" theory which encompasses neurological involvement at virtually every conceivable related location within both the central nervous system and autonomic nervous system.

It should be noted that during the investigation which led to the final conclusions, various additional research was carried on—and this research served to re-enforce the specific concepts of the "total mechanism" theory.

Finally, this author would like to personally thank both Dr. Doney and Dr. Spence for their invaluable assistance in the compilation of this thesis. In addition, appreciation for "personal" information is extended to Mrs. Mark, Chen, Fox, Katz, Spring and Wall.
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I. History of Early Chinese Medicine
   A. Investigation of the Philosophical Foundations in The Yellow Emperor's Classic of Internal Medicine

The Yellow Emperor's Classic of Internal Medicine (Huang Ti Nei Ching Su Wen) served as the original philosophical basis for acupuncture.

It is not known for certain whether Huang Ti (The Yellow Emperor) was indeed its author; but it seems logical that an emperor would be preoccupied with other matters:

To state that Huang Ti was the real author of the Su Wen is open to serious doubt. The emperor has to attend to the affairs of state; how is it possible for him to sit all day long and discuss problems of medicine with his minister (1)?

Additional sources also reflect the uncertainty of the author:

Historical researchers proved that this work was not composed by Huang Ti during his alleged reign of 2696-2598 (doubt is even indicated about his existence) but was a later production written about 1,000 B.C. (2).

In addition, the fact remains that the entire edition was updated to its present form by Wong Ping in 62 A.D. and later revised during the decade of 1069-1073 by Kao Pao-heng and Lin I. This and the above information must consequently be taken into consideration when we explore the philosophical foundations of the work. It must further be realized that the many authorships and revisions could result in contradictions. With this in mind, an analysis of the work now follows.

Dialogue between Huang Ti and his minister constitutes the format in which the philosophy is expounded. This allows for a greater flexibility in approach; including the presentation of prevailing Chinese ethics and religious beliefs. A holistic view of nature and the universe is presented. All aspects of life are incorporated into one out of two basic divisions (Yin and Yang). And as will be explained, a perfect balance (Tao) must be established between the two in order for true harmony to ex-
3. Investigation of the theories in The Yellow Emperor's Classic of Internal Medicine; Including the Investigation of Medicine and Philosophy

1. The Theory of Tao

Lao-Tzu (Sixth Century B.C.) first enunciated this theory and became the "Father of Taoism" although he did not create the word "Tao" or give it a specific meaning, his area of concern was universalism. But it appears that the doctrine of Tao emerged from this approach. It is "the key to the mysterious intermingling of 'heaven and earth'". Tao means the way and the method of maintaining the harmony between the world and the beyond; that is, by shaping earthly conduct to correspond completely with the demands of the other world (3)."

The perfect balance or harmony discussed above is the basic foundation of the theory of Tao. The approach to Taoism is universal in concept. The "right way" could be attained only by emulating the course of the universe and completely adjusting to it. And the universe is best approached through nature:

The concept and principle of the Tao are described as a natural law (by Lao Tzu) applicable to all (4).

In a very real sense, the principle of Tao is almost religious in concept. In fact, the term "tao" literally means "the way." And this religious-like approach is subdivided from "the Tao of Heaven to the Tao of the Earth and the Tao of Man, one fitting into the other as an invisible entity (1)."

The concern of this report is naturally the "Tao of Man." This theory involves a holistic approach to the human body. The ultimate goal of this approach is the achievement of perpetual youth via the maintenance of a youthful body.
The Tao is rarely discussed alone but generally in conjunction with the two component parts of the universe, the Yin and the Yang. All things in Nature—including Man—are in a sense two, and each is possessed of the qualities of Yang and Yin in varying proportions... Yang and Yin are universal opposed forces in Nature. The idea of Yang is associated with light, the sun, strength... Yin is associated with darkness, the moon, weakness... To be sound in mind and body and to lead the good life a perfect balance of the two must be achieved (2).

So, essentially Yin and Yang are on opposite ends of the spectrum of the Universe; and are its two primogenial elements. Yang represents the positive and Yin the negative side. However, "positive" does not mean "good" and "negative" does not mean bad. They were, in fact, conceived of as one entity and both together are ever-present in an effort to form the "perfect union" of Tao. The fact that the two are united to form the universe is best illustrated in the following quote from Chapter 6 of the Nei Ching:

Yang ascends to Heaven. Yin descends to Earth. Hence the Universe (Heaven and Earth) represents motion and rest, controlled by the wisdom of nature. Nature grants the power to beget and to grow, to harvest and to store, to finish and to begin anew.

And we see that since the "wisdom of nature" controls the Universe, it can be applied very readily to the human body.

Yin and Yang occupy specific regions within the human body. There are three parts of Yin and three parts of Yang. The treatment of a specific disease or a specific organ was dependent on its location within a specific part of Yin or Yang. Consequently, knowledge of these subdivisions was strategically necessary for both diagnosis and treatment. The various regions are enunciated in Chapter 20 of the Nei Ching.
Yang
The Great Yang
The Lesser Yang
The "Sunlight"

Yin
The Great Yin
The Lesser Yin
The Absolute Yin

Each region or subdivision includes a specific organ and, in turn, works in conjunction with another region. This relationship is illustrated in Chapter 22 of the Nei Ching:

- The Absolute Yin includes the Liver
- The Lesser Yang includes the Gall Bladder

- The Lesser Yin includes the Heart
- The Great Yang includes the Small Intestines

- The Great Yin includes the Spleen
- The "Sunlight" includes the Stomach

- The Great Yin includes the Lungs
- The "Sunlight" includes the Lower Intestines

- The Lesser Yin includes the Kidneys
- The "Sunlight" includes the Bladder

Therefore, the affinity of Yin and Yang to each other was considered the very crux of good health. Perfect harmony did not exist if either element of Yin or Yang was in excess. This resulted in either disease or death.

The Yin and Yang in addition to exerting their dual power, were broken down into 5 primordial elements or components: water, fire, metal, wood, and earth. Consequently, the number 5 became significant for virtually every relationship within the human body. The following example is from Chapter 23 of the Nei Ching:

The Controls Exerted by the Viscera:
1. The heart controls the pulse.
2. The lungs control the skin.
3. The liver controls the muscles.
4. The Spleen controls the flesh.
5. The Kidneys control the bones.

A vast number of additional relationships are present in the Nei Ching, all illustrating groupings of 5. This may be due in part to the organiza-
tion of the "five viscera": the Heart, Spleen, Lungs, Liver and Kidneys (which will be dealt with shortly). Or perhaps there is no justifiable reason other than the existence of the primordial 5 elements. In any event the number 5 is almost religious in context; similar to the Trinity of Christianity.

C. Anatomical and Physiological Concepts

Man has five "viscera" and six "bowels" according to the Nei Ching. The "viscera" consist of the Heart, Lung, Liver, Spleen and Kidneys. The six "bowels" which are involved with elimination are the Gall Bladder, Stomach, Lower Intestines, The Kidneys, Small Intestines and Three Foci ("Burning Spaces"). The use of 6 bowels as opposed to 5 is the first divergence from that "magical" number. However, the sixth bowel or "Three Burning Spaces" are considered "a link between the Universe and Man, and are subdivided into Upper, Middle and Lower parts controlling corresponding regions of the body (1)." Consequently, we see a segmentation of influence. The viscera and bowels occupy specific roles within the body; comparable to figures within a Kingdom with the heart acting as the highest official.

Numbers played additional roles in early anatomical relationships. Man is divided into three hundred and sixty five parts for the days of the year. Twelve main vessels (or ducts) correspond to the months of the year. And four main arteries correspond to the four seasons.

In addition, there is a very fine dividing line between the anatomical and physiological concepts of the Nei Ching. Instead of termed by their structure and location, organs are described for their function. The continuous interaction of Yin and Yang dominates any theories on structure. In addition, all organs are classified as either Yin or Yang in
function.

D. Therapeutic Concepts

The application of the number five in the Nei Ching continues with the five methods of treatment as stated in Chapter 25:

The first method cures the spirit; the second gives knowledge on how to nourish the body; the third teaches the true effects of medicines; the fourth explains acupuncture and the use of the small and large needle; the fifth gives instruction on how to examine and to treat the bowels and the viscera, the blood and the breath.

The first method indicates the closeness of Chinese religious and medical thinking. Those who disobeyed the "laws of heaven and earth" suffered by being ill; as if they were the guilty party. Consequently, the ancient Chinese followed a very simple mode of life and diseases were few. And those who became ill were considered evil and beyond help. As a result, the ancients did not treat those already affected but were most interested in what we presently call "preventive medicine."

But, the frequency of illnesses increased and the second method of treatment, that of dietetics, came into being. The five flavors were distinctly involved in the treatment process. Each flavor allegedly had a healing effect on certain target organs and consequently upon the parts of the body affected by the organs. Five kinds of nourishment were also specified (in Chapter 14 of the Nei Ching):

1. Medicines, which attack the evil influences; consisting of roots, stalks, the topmost branches of Thyme, herbs in general, and soups, clear liquids, lees of wine.
2. The Five grains, which act as nourishment. They are wheat, glutinous millet, rice, and beans.
3. The Five tree-fruits, which are peaches, plums, apricots, chestnuts and dates.
4. The Five domestic animals which contribute additional nutritional benefit. They are fowl, sheep, beef, horses and pigs.
5. The Five vegetables, which complete nourishment.
They are mallows, coarse greens, scallions, onions, and leeks.

Those Five flavors treat not only the internal organs but also the parts of the body connected with each particular organ.

The true effect of medicines serves to counter-balance the injurious effects which sickness brings to the body. The aim of the medicines is to bring about an equal balance between the opposing forces of Yin and Yang. This is the very crux of acupuncture and moxibustion. In addition, it was the duty of the physiciaian to criticize and correct any faults in the patient's mode of life. These faults represented themselves as imbalances in bowel habits, malfunctions in internal organs and (endocrine) glands, "tired blood" (undoubtedly anemia), and abnormalcy in breathing and the quality of the breath.

E. Introduction To Acupuncture and Moxibustion (the application of burnt Artemisia Vulgaris leaves to specific points-forming a blister)

Acupuncture involves the insertion of various types of needles; and each one has a definite function. The needles are inserted at specific points (determined by their tissue quality) which are distributed all over the body along twelve channels or main ducts. These channels are what might be designated as the "outside" control of the blood vessels which are themselves "internal" and which more intimately connect the organs and viscera. "The channels are supposed to be deeply set in the muscles and not in direct connection with the blood vessels (6)." Fixed relationships exist between organs of the body and these organs are connected by the channels (which were subsequently called meridians). Three hundred and sixty five acupuncture points initially existed on the original meridians; but this increased as more meridians were discovered. The acupunc-
ture points are all at strategic locations on the meridians. Each point, if inserted with the correct acupuncture needle, has the effect of either anesthetizing a specific location or correcting an imbalance in either Yin or Yang for a target organ.

Moxa, or moxibustion has similar goals to acupuncture. Its practice consists of the application to the skin of combustible cones of powdered leaves of Artemisia Vulgaris. They are placed on particular spots, ignited and are extinguished, forming a blister. The chart for moxibustion is very similar to the one for acupuncture and its goal is also to alleviate illnesses by bringing about a balance between Yin and Yang. It is very highly recommended in all diseases which are caused by an excess of Yin.\(^7\).

II. The Principles and Applications Surrounding Acupuncture
   A. The Acupuncture Points
      1. The Mu Points

      These are situated in the vicinity of the diseased part but do not belong to the meridian that encompasses the organ. They are considered "alarm points" and are located on the front of the trunk, but not within the extremities. When a Mu point is stimulated, the effect is virtually instantaneous. Every meridian has Mu points with the exception of the one controlling the circulation.

      2. The Ching Points

      These points are located at the beginning and end of the meridians and serve to bring about a harmony within the entire body.

      3. The Points of Tonification and Sedation

      They are considered to be the most important points in the body and serve to bring about a state of Tào or balance by reducing the effect of organs that are over-producing. The points are arranged in order of
effectiveness and are paired with organs which exist in what is considered an "energy cycle;" and which, in turn comprise the "five elements." These elements serve to unite those organs whose functioning is in complete opposition to each other. Consequently, one organ serves the purpose of Yin while the other that of Yang. The chart below exemplifies this relationship, including the correct sequence of the energy cycle.

<table>
<thead>
<tr>
<th>Fire Element</th>
<th>Yin-Heart</th>
<th>Yang-Small Intestine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Earth Element</td>
<td>Yin-Spleen</td>
<td>Yang-Stomach</td>
</tr>
<tr>
<td>Metal Element</td>
<td>Yin-Lungs</td>
<td>Yang-Large Intestine</td>
</tr>
<tr>
<td>Water Element</td>
<td>Yin-Kidneys</td>
<td>Yang-Bladder</td>
</tr>
<tr>
<td>Wood Element</td>
<td>Yin-Liver</td>
<td>Yang-Gall Bladder (4)</td>
</tr>
</tbody>
</table>

In addition, the rule of "mother and son" was applied whereby an illness caused by an excessive function was treated by the application of tranquilizing treatment to the organ next in sequence in the "energy cycle." Thus, both the organ itself and its "son" were treated. For example, a hyperfunctional problem was treated by means of sedation of the affected organ and, at the same time, by applying tranquilizing treatment to the organ next in sequence in the "energy cycle." Thus, both the organ itself and its "son" were treated. For example, in the event of a hyperfunctional disorder of the "pulmonary tract", the "son" as well as the points of the lung meridian, have to be given sedation. Since the lungs belong to the Yin group of the metal element, and this is followed by the water element, the Ho point (which is linked to the water element) must be tranquilized as well.

If, on the other hand, a disorder of the pulmonary tract occurs as the result of hypofunction, then not only must the functioning of the pulmonary tract (which belongs to the metal element) be stimulated, but also the "mother." In preceding order this is the Yu point of the earth element.
It is appropriate to now note that although we have repeatedly seen "the naming of the points according to the elements (it) is only of secondary importance and actually serves merely to make practical implementation more easy to grasp (4)."

4. The Lo or "Passage Points"

These points, like those of tonification and sedation, serve to bring about harmony within the body. They balance the "energy" between the meridians. Referring once again to the chart of the elements, a balance is brought about by the function of corresponding organs of the same element. The Lo point of the meridian of the organ which is overfunctioning is stimulated in order to accomplish this.

5. The Yu Points

They are located on the bladder meridian which runs along both sides of the spinal column. "The points should be regarded as being segment dependent, and they may well be connected with the innervation of the spinal cord segments (7)." The Yu points have a sedative ability similar to the points of Tonification and Sedation; and like both the points of Tonification and Sedation and the Lo points, have an equalizing influence.

6. The Points Corresponding to the Five Elements

Each of the five elements corresponds to specific points which are as follows:

The Ching points (wood element), the Yung points (Fire element), the Yuan and Yu points (earth element), the Ching points—written in Chinese with characters different from the one above—(metal element), and the Ho points (water element). All these are located along the meridians which are linked with the Yin organs. The following points are found on the Yang organs and their associated meridians: The Ching points (metal element), the Yung points (water element), the Yu and Yuan points (wood element), the Ching points (fire element), and the Ho points (earth element) (8).
These "are located near the points of tonification and sedation and strengthen their effect. Similar effects can also be achieved by means of the so-called "Nao" or 'reunion points.' These points link the 12 main meridians with other meridians (7).

7. The "Special Points"

The "special points" are normally utilized in the event of special illnesses such as circulatory disorders or malfunctioning of the vagus nerve. (In the latter event these points would serve either for tonification or sedation of the nerve). They affect the interplay or synergy of all organs. Consequently, they have a direct effect on the Autonomic Nervous System.

B. The Main Meridians

1. The Lung Meridian (Refer to Fig. 1, pg. I)

This meridian runs along the arms and obtains its energy from the liver meridian which is Yin in character and is associated with the wood element. As a result, it transmits energy to the large intestine meridian, which is Yang in character and belongs to the metal element. The lung meridian itself belongs to the metal element and it runs in a "centrifugal" direction. It starts near the armpit between the second and third ribs, runs along the inside of the upper and lower arm and ends on the inside of the thumb. In all, this meridian encompasses 22 points (including both sides of the body).

It is possible to measure changes in the electropotential values along this meridian in cases of abnormal disorders of the respiratory system, such as branchial catarrh, inflammation of the lungs, asthmatic complaints, and angina, and also as a result of secondary phenomena due to heart diseases and certain nose and eye ailments (9).

2. The Heart Meridian (Refer to Fig. 2, pg. II)
Like the lung meridian, it is Yin in character and is in association with the fire element. It allegedly obtains its energy from the spleen meridian (which is also Yin in character but is part of the earth element) and transfers energy to the small intestine meridian (which is Yang in nature and is associated with the fire element). The heart meridian also runs in a "centrifugal" direction; starting at a point beneath the chest muscles (pectoralis major and minor) at the level of the third rib, running along the inside of the upper and lower arms and ending on the inside of the top portion of the little finger, near the nail fold corner.

The heart meridian includes 18 points (9 on each side). Fluctuating electropotential values indicate heart disease and circulatory disorders. Secondary phenomena, such as diseases of the small intestine, larynx, and eyes, are also registered. The measured values on this meridian are often irregular during the change of life (climacteric) (8).

3. The "Controller of the Heart" Meridian (Refer to Fig. 3, pg. III)

This meridian is also Yin in character and belongs to the water element. It crosses the arm after starting between the nipple and the armpit, between the third and fourth ribs; and it ends on the inside of the upper section of the index finger, comprising 18 points (9 on each side). There is no linkage to any particular organ, but the meridian encompasses a functional cycle which affects the peripheral circulation, the blood count and the nourishment of the Yin organs.

4. The Small Intestine Meridian (Refer to Fig. 4, pg. IV)

The above is a Yang group of meridians which is associated with the fire element. It receives energy from the heart meridian, which is Yin in character, but also belongs to the fire element. Its function is to transmit energy to the bladder meridian, which is Yang in nature and is connected with the water element. It runs in a "centripetal" direction to the
trunk, begins above the end of the nail of the little finger, continues along the ulna on the dorsal side of the forearm, over the upper arm to the shoulder joint, across the neck and lower jawbone to the outer corner of the eye and ends in front of the ear. It encompasses 36 points (18 on each side).

The meridian reflects the healthy or disturbed state of the small intestine. Functional disorders of the stomach and heart can also be measured by means of it. Irregularities in the "energy cycle" of the meridian also occur in cases of neurasthenia, psychoses, Parkinsonism, and epilepsy (9).

5. The "Triple Warmer" Meridian (Refer to Fig. 5, pg. V)

This meridian belongs to the fire element and is Yang in character. It receives its energy from the circulation meridian which also belongs to the fire element but is Yin in character. It transmits energy to the gall bladder meridian, which belongs to the wood element and is Yang in nature. It runs in a "centripetal" direction, with its starting point above the nail of the ring finger. The meridian continues along the dorsal side of the arm across the shoulder to the clavicle, rises from there to the temple bone; circles the ear; continues down to the lower jawbone and ends at the outer lateral corner of the eye, comprising 46 points (23 on each side).

This meridian is also not linked to any definite organs. The "triple warmer" consists of three sections: The lower, central, and upper "warmers." The upper one controls respiration, the central one regulates the complex functions of digestion and ingestion, while the lower one affects the urogenital system, sexual potency, and chemical state of the whole organism. The "triple warmer" represents a controlling functional cycle which, by virtue of its opposing actions, counterbalances the function of the "controller of the heart." Any disturbances of its function-
ing may be accompanied by "disorders of the respiratory passages, together with convulsions, deafness and neuralgia (4)."

6. The Large Intestine Meridian (Refer to Fig. 6, pg. VI)

This meridian belongs to the metal element, receiving its energy from the lung meridian, which also belongs to the metal element. It is Yin in character and transmits energy to the stomach meridian, which is Yang in character and belongs to the earth element. It is also "centripetal" in direction, starting on the outer side of the top section of the index finger, near the nail root.

From there it runs along the outer ventral side of the arm to the clavicle. It touches the upper cervical vertebrae, turns there, and goes back to the clavicle, though more in the vicinity of the breastbone. It then runs via the lower jawbone and the corner of the mouth to the opposite nasolabial fold, where it ends. This meridian links 20 points on the body (40 in all, counting both sides). Appreciable changes in this meridian mainly reflect diseases of the large intestine, but also secondary ailments affecting the teeth and gums, asthmatic complaints, and various skin diseases (8).

7. Spleen Meridian (Refer to fig. 7, pg. VII)

The spleen meridian is Yin in character and is associated with the earth element. It receives its energy from the stomach meridian which belongs to the earth element but is Yang in character, and transmits it to the heart meridian which is associated with the fire element and is Yin in character.

The starting point of this meridian is on the outside of the upper section of the big toe, whence it runs along the inside of the leg, touching the area of the navel, thence obliquely past the nipple until it ends in the vicinity of the second intercostal space. It runs in a 'centripetal' direction and includes 42 points (21 on each side) (8).

8. The Kidney Meridian (Refer to fig. 8, pg. VIII)
This meridian is Yin in character and is associated with the water element. It receives its energy from the bladder meridian, which also belongs to the circulation meridian, which is Yin in character and belongs to the fire element. The kidney meridian runs in a "centripetal" direction; beginning on the sole of the front part of the foot, running along the inside of the lower leg and the thigh up to the area of the bladder, continuing past the navel and breastbone and ending on the sternal side of the clavicle. It comprises 54 points (27 on each side). The points on the meridian are used to alleviate kidney and heart irregularities of circulation; as well as neurasthenic and epileptic conditions.

9. The Liver Meridian (Refer to Fig. 9, pg. IX)

The liver meridian begins in the legs. It is Yin in character and is associated with the wood element. It receives its energy from the gall bladder meridian, which likewise belongs to the wood element but is Yang in character. Its energy is transmitted to the lung meridian, which is Yin in character and belongs to the metal element.

This meridian travels in a "centripetal" direction, starting between the big and second toes, running along the inside of the lower leg and thigh, past the groin and bladder, touching the 11th and 12th ribs and ending near the nipple. It consists of 14 points and reflects disorders such as jaundice, symptoms of fatigue, liver swelling, intestinal disorders, emaciation, allergies, headaches and arthralgia.

10. The Bladder Meridian (Refer to Fig. 10, pg. X)

This meridian also begins in the leg area, is Yang in character, and is associated with the water element. It receives its energy from the small intestine meridian, which is Yang in nature and is associated with the fire element. It transmits energy to the kidney meridian, which is
Yin in character and belongs to the water element.

It starts at the inner corner of the eye, continues across the sagittal suture of the cranium, divides into two strands at the neck and continues in parallel lines down the back, touching the coccyx area. One strand reaches the heel via the dorsal center of the leg and ends on the lower section of the little toe. The other strand ends in the hollow of the knee. This meridian runs in a "centrifugal" pattern and encompasses 134 points (67 on each side).

Appreciable changes in this meridian may denote painful, convulsive conditions, headaches, neuralgia, rheumatic pains, sciatica and lumbago, and secondary effects such as metabolic disorders of the cells, eczema and disturbances in the water content of the body. (9).

11. The Gall Bladder Meridian (Refer to Fig. 11, pg. XI)

The gall bladder meridian is Yang in character and is associated with the wood element. It receives its energy from the "triple warmer" meridian, which is also Yang in character but associated with the fire element. It transmits energy to the liver meridian, which is Yin in character and associated with the wood element. This meridian runs in a "centrifugal" direction. It begins at the outer corner of the eye, runs across the temples and the occipital zone to the central part of the trapezius muscle and continues past the shoulder joint to the top of the pelvis and along the outside of the leg to the lower section of the fourth toe. This meridian consists of 88 points (44 points on each side) and any changes within it reflect the following disorders: migraine, convulsive conditions of the sense organs, and particularly, pains in the lower limbs and neuralgia.

12. The Stomach Meridian (Refer to Fig. 12, pg. XII)

This meridian is Yang in character and is connected with the earth
element. It receives its energy from the large intestine meridian, which is also yang in character but belongs to the metal element; and transmits energy to the spleen meridian, which is yin in character and associated with the earth element.

The stomach meridian runs in a "centrifugal" direction; beginning at the nasolabial fold, running along the lower jawbone to the temple area and returning to the lower jawbone. From there it runs past the clavicle, nipple and navel to the vicinity of the hip. Then, it continues along the front of the thigh and lower leg and it ends on the top section of the second toe. It connects 90 points (45 on each side).

Disorders of the stomach and digestive tract, secondary convulsive conditions of the facial muscles (tics) and painful conditions of the cervical muscles are relieved by employment of specific points of this meridian.

C. The Eight Special Meridians

Each of the twelve meridians previously described has particular points on the body which can either be stimulated or tranquilized. However, the special meridians do not have any of these points. There are eight special meridians:

1. The Tu-mai Meridian (Governing Vessel)
2. The Jen-mai Meridian (Vessel of Conception)—See Fig. 13, pg. XIII
3. The Ch'ung-mai Meridian (Vessel of the Uninhibitor)
4. The Tai-mai Meridian (Belt Vessel)
5. The Yin-chiao-mai Meridian (Vessel of the Yin Exciter)
6. The Yang-chiao-mai Meridian (Vessel of the Yang Exciter)
7. The Yin-wei-mai Meridian (Vessel of the Yin Keeper)
8. The Yang-wei-mai Meridian (Vessel of the Yang Keeper)

The Tu-mai, Tai-mai, and Yang-Chiao-mai meridians are yang vessels; the Jen-mai, Ch'ung-mai, Yin-chiao-mai, and Yin-wei-mai meridians are yin in character. The old doctors explained the significance of the special meridians by stating that if the twelve main meridians could be regarded as rivers, then eight special merid-
ians could be compared to lakes or seas. Doctors who have engaged in historical research have also mentioned that old books contain widely differing ideas as to the significance of the special meridians (8).

All eight special "vessels" exercise a regulating function in the event of a blockage in the main meridians. They also "play a special part in the treatment of chronic diseases, vegetative conditions of fatigue, metabolic disorders, and psychic strain (7)." The first two of the eight special meridians, the Tu-mai and Jen-mai were originally considered to be main meridians. Consequently, they will be discussed in detail.

The Tu-mai meridian is Yang in character and runs along the spinal column from the mouth (above the incisors) to the anal region. It links 28 points. The Jen-mai meridian is Yin in character and runs along the center line from the chest to the abdomen. Its initial point is in the gum region of the upper jawbone and its concluding point is in the anal region. This meridian links 24 points including some important Mu (alarm) points which react on the bladder, small intestine, stomach, heart and lung meridians.

As has been indicated, the Tu-mai meridian is Yang in character while the Jen-mai meridian is Yin. In addition, they both run along the center of the body; influencing the same organs and/or locations in the body. As a result, they perfectly illustrate the Yin-Yang principle of working in concord to bring about functional harmony; which in their case concerns normal body growth and development.

D. The Subsidiary Meridians

The subsidiary meridians serve to "connect" the main meridians via "Lo links."

If we regard the main meridians as rivers within the -
'macrocosmic and microcosmic' framework of the universe, then we can grade those Lo links as tributaries or brooks, some of which flow into other 'rivers' and thus form transverse links between the 'rivers.' If, by a similar analogy, we regard the main meridians as 'highways,' then the Lo links can be taken as 'byways' (7).

Consequently, there are definite subsidiary meridians incorporating the initial point on a main meridian, the Lo-link and the reception point on a second main meridian. The following are extents of the subsidiary meridians; incorporating the Lo links:

1. Bladder Meridian (Yang) and Kidney Meridian (Yin)
2. Gall Bladder Meridian (Yang) and Liver Meridian (Yin)
3. Stomach Meridian (Yang) and Spleen Meridian (Yin)
4. Small Intestine Meridian (Yang) and Heart Meridian (Yin)
5. 'Triple Warmer' Meridian (Yang) and Circulation Meridian (Yin)
6. Large Intestine Meridian (Yang) and Lung Meridian (Yin) (10)

E. The Muscular Meridians (Refer to Fig. 14, pg. XIV)

There are 12 muscular meridians which affect the functions of the skin and muscles and are included in each of the 12 main meridians. Changes in the muscular meridians reflect skin ailments (such as rashes or eczema), muscular cramps and rheumatic pains.

F. The Pulse—Its Importance and Detection Methods

Determination of the relative health of any particular organ is accomplished by examination of the 'pulse.'

Chinese medicine constructed an entire diagnostic system by means of feeling the pulse on the arteria radialis. This method is based on the idea that by merely feeling the pulse, a doctor can determine not only the condition of the heart and the aortic values, but also whether the internal organs referred to as Tsang and Fu are in good or bad order. The pulse is taken (read) on the arteria radialis of both forearms, the doctor placing three fingers on each radial artery and exerting varying degrees of pressure.

Gentle pressure reveals the condition of the so-called Yang organs, otherwise known as the Fu's or active organs. By exerting heavier pressure down to the
"deep level" it is possible to determine the state of the Yin organs, otherwise known as the Tsang's or storage organs (11).

Each radial artery reflects the condition of specific organs. And as seen from the above reference, variations in pressure determine which organs "messages" are being interpreted. Three points are "read" by the index, middle, and third fingers. The following chart best illustrates this method of physical diagnosis and in addition relates to the "fire element" discussed earlier.

<table>
<thead>
<tr>
<th>Left Arteria Radialis</th>
<th>Slight Pressure Exertion</th>
<th>Strong Pressure Exertion</th>
</tr>
</thead>
<tbody>
<tr>
<td>With Pt. of Index Finger</td>
<td>Small Intestine</td>
<td>Heart</td>
</tr>
<tr>
<td>With Pt. of Middle Finger</td>
<td>Gall Bladder</td>
<td>Liver</td>
</tr>
<tr>
<td>With Pt. of Third Finger</td>
<td>Urinary Bladder</td>
<td>Kidneys</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Right Arteria Radialis</th>
<th>Slight Pressure Exertion</th>
<th>Strong Pressure Exertion</th>
</tr>
</thead>
<tbody>
<tr>
<td>With Pt. of Index Finger</td>
<td>Large Intestine</td>
<td>Lungs</td>
</tr>
<tr>
<td>With Pt. of Middle Finger</td>
<td>Stomach</td>
<td>Spleen</td>
</tr>
<tr>
<td>With Pt. of Third Finger</td>
<td>&quot;Triple Warmer&quot;</td>
<td>&quot;Controller of the Heart&quot;</td>
</tr>
</tbody>
</table>

C. The Acupuncture Needles and Technique of Application

Acupuncture needles originally consisted of stone, but were later made of copper or iron. Presently, gold, silver, and steel alloy needles are used for surgical instruments. Each needle consists of a holder and a stem. 3 Hao-chen needles of various lengths (and one with a triple edge) are used in conjunction with "skin needles." But, the "skin needle" is used almost exclusively in treating small children.

All needles are thoroughly disinfected before treatment (usually by boiling). The entire technique of application employs two basic steps, as is indicated below.

1. Determining the Points of Insertion and their Location on the Body

The system of measurement which applies to the entire body revolves around the "chinese inch"; which equals the length of the patient's cen-
tral phalanx on the middle finger. By using this "inch" the location and
distance between various acupuncture points can be determined.

In addition to locating the correct points, the physician must make
certain that the patient has adopted an appropriate posture. The patient
must prop his body firmly and remain perfectly still to prevent the needle
from missing the point, bending or even snapping off. The patient may
sit, or lie on his or her stomach, back or side. If sitting, the patient's
back must be supported.

2. Direction, Technique and Duration of Acupuncture

The needle can be inserted at three main angles. The more sensi-
tive points are stimulated at right angles to the skin surface since they
are located above thick layers of skin. The points on the chest are in-
serted at about 45 degree angles and those on the face at 12 to 15 degree
angles.

The normal depth of insertion ranges from 3 to 10 millimeters.
The actual mechanism of insertion varies with the type of needle. With
short needles, the skin near the point of insertion is pressed with the
doctor's thumb. The "guided insertion" method is utilized with long need-
les.

Using the thumb and index finger of his left hand, the
doctor presses down the skin in the vicinity of the
point of insertion in such a way that the point is lo-
cated between the top sections of each finger. The
needle is then guided down between the fingers. In
this way it is comparatively easy to insert long need-
les as well, since the doctor can support his right
hand, with which he holds the needle, on the back of
his left one. There is thus less danger of the needle
slipping or breaking. This technique is normally used
on the small of the back, in the vicinity of the hips,
and on the arms (12).

The needle can also be inserted into the small of the back if the doctor
places his left hand on the patient in a way that will place the selected
points of insertion between the index and middle fingers.

For the face and head, and wherever the musculature is relatively thin, the doctor pinches the skin between two of his fingers and presses the needle down into the raised fold of skin towards the point of insertion.

Acupuncture essentially produces no sensations of pain, except on the fingers. The only sensations which may be felt (and very rarely) are synesthetic (sour or bitter taste, numbness of limbs, feeling of warmth)

Insertion of the needle results in either weak or strong stimuli (depending, of course, on which is needed to bring about 'Tao'). A weak stimulus has a tonifying effect while a strong stimulus has a sedating one. The intensity of the stimuli is dependent upon the force with which the needle is inserted and not the direction in which it is rotated.

The techniques employed and points utilized are best described below.

1. Insertion of the needle into those points located symmetrically on each and common to both left and right halves of the body.
2. Insertion of the needle at points with a similar effect on both the upper and lower extremities.
3. Simultaneous stimulation of the front of the body and the back. In this connection mention should be made of a combination of superficial and deep acupuncture, whereby points on the front part of the body and on the back, for example, are punctured at the same time, but to varying depths.
4. Simultaneous "internal" and "external" treatment, that is, stimulation of a Yin point and a Yang point at the same time.
5. A combination of direct and indirect stimulation, that is, simultaneous stimulation of a point near the seat of a disease and one remote from it.
6. Simultaneous stimulation of points along the spinal column and on the extremities.
7. In the case of varying symptoms, simultaneous stimulation at various points.
8. "General Strengthening." This is based on simultaneous stimulation of the points treated for tonification purposes and those which "belong" to the
illness in question.

9. Treatment in accordance with the "corresponding and changing times." This implies a change in the choice of points of tonification or sedation during the period of treatment (14).

III. Discussion of Acupuncture Insertion Points and the Segmental Fields of Sensation
   A. The Dermatome Chart and its Derivation

   Each spinal nerve innervates a "segmental field" of the skin called a dermatome. As shown in figure 15, it would appear that there is a definite border between the adjacent dermatomes. However, some overlap does exist from segment to segment. Consequently, each segmental field receives innervation primarily but not entirely from the spinal nerve so indicated. Nevertheless, "either section of a nerve root or pressure upon it as by the herniation of the nucleus pulposus of an intervertebral disk produces sufficient alteration in the sensitivity of the primary area of skin supplied so that it can be mapped out (14)." And, when pain is referred it is in large part to a structure that developed from the same embryonic segment or dermatome as the structure in which the pain originates. This principle is called the dermatomal rule. For example, "the diaphragm migrates from the neck region during embryonic development to its adult location in the abdomen and takes its nerve supply, the phrenic nerve, with it. One third of the fibers in the phrenic nerve are afferent, and they enter the spinal cord at the level of the second to fourth cervical segments, the same location at which afferents from the tip of the shoulder enter (11)." In a similar way, the heart and arm have the same segmental origin, and the testicle has migrated with its nerve supply from the primitive urogenital ridge from which the kidney and water also developed.

But, as will be investigated later, the dermatome segment may very frequently be a "target area" for referred pain from an organ supplied by

*Fig. 15-Pg. XV
different spinal nerve segments; hence, the basis for the seemingly non-
usage of the dermatome chart in Chinese medicine.

B. Examination of the Acupuncture Points; Their Discovery and Quali-
ties of Local Tissue (Before and after Treatment)

Acupuncture points are strategic locations at certain points on
the surface of the body. Pain at the acupuncture point is, in essence, re
ferred pain from the part of the body which is in distress. And each
point is located on a specific meridian (Refer to sections II, III, and IV). The points were undoubtedly initially located by a trial and error method. Theories vary on the discovery; among them being observations of paralysis from arrow wounds (inflicted in ancient wars) at locations entirely diff
erent from the site (or point) of the puncture. Then, upon intentionally observing the effects of "needling" each effective point, the foundations were laid for meridians: the imaginary lines connecting acupuncture points which have similar effects.

It has been determined that there is a definite alteration in tis
sue at each acupuncture point:

The doctor looking for an acupuncture point will in the simplest of instances, discover a little nodule, like the fibrositic rheumatic nodules often present at the back of the neck, in the shoulders or in the lumbar ar

ea (a lesion). But, in many cases, instead of the nod
ule, the examining finger may find a strip of tense muscle within a group of muscles with, a particularly hard and indurated area. Sometimes, there is an area which is slightly swollen or discolored (12).

The pain or tenderness which is present at each point (upon the ap
plication of pressure) vanishes with the cure of the disease. This elim
ination of pain is independent of the type of cure administered; whether it be acupuncture, drugs, osteopathic manipulation or hypnosis. All that matters is that the pain is eliminated at the point itself. Consequently, there is a distinct relationship between disease and acupuncture points-
with the points serving a dual purpose; of diagnosis and treatment.


The spinal-gate theory is a feasible and logical approach in the ever-increasing exploration of the mechanisms of acupuncture. Although very little literature has been written about this theory, it unquestionably fills in a huge void in explaining a significant role of acupuncture.

The basic premise behind this theory is that nerve impulses to each particular spinal cord segment are blocked at the point of insertion of the acupuncture needle (at each particular point). As a result, target areas (which may be specific organs) are de-innervated. The effect is either polarization or alteration in function (of the target area or organ). This author's investigation has indicated the presence of two approaches to this theory. The first involves an over-production of all nerve impulses to the spinal cord. The thesis behind this version of the theory is that each acupuncture point encompasses a strategic intersection of all nerve fibers. As a result, the insertion of the acupuncture needle at the appropriate point causes an overproduction of all nerve impulses to the spinal segment(s) involved with a resultant blockage of all "messages." The second approach is more specific and implies that only the A-Beta fibers in the sensory nerves are over-stimulated at the acupuncture point (by the needle) and exert the effect of preventing pain from being transmitted to the spinal cord. This second approach has been presented by Melzack and Wall, as a result of extensive research. Its major premise is that over-stimulation of the A-Beta fibers (which are not pain-transmitting fibers) will prevent the transmission of pain.

The spinal-gate theory is discussed in greater detail in section VII, after necessary preliminary information is investigated.
D. The Relationship Between Dermatomes and Acupuncture Insertion Points

The dermatome chart, as stated earlier, is a dermal representation of spinal cord segments. And some of the acupuncture points, particularly those on the back having an effect on a specific organ, are in the appropriate dermatome. In addition, the majority of reflexes are segmental in nature and would therefore be closely related to a dermatome pattern of acupuncture points. These reflexes involve cutaneo-visceral, viscero-cutaneous and viscero-motor patterns.

Acupuncture is based on the fact that stimulating the skin has an effect on the internal organs and on other parts of the body; a relatively simple reflex whose therapeutic application is largely ignored in the West. For example, reflex responses of the gastric musculature and the pyloric sphincter in man have been described by Freude and Ruimann using a fluoroscope by means of warm, cold, chemical or mechanical stimulation of the skin of the epigastrum. They also produced hyperaemia of the ascending colon after it had been exposed at operation, by applying heat to the skin of the lower abdominal wall. In addition, nine patients with angina pectoris or acute myocardial infarction were investigated by (Dr. Janet) Travell and Rinzler. They found that if the trigger areas on the front of the chest were infiltrated with procaine or cooled with ethyl chloride, complete and prolonged relief of pain usually ensued (15).

Dr. Travell has been most associated with the introduction of cutaneo-visceral reflexes into the "mainstream" of western medical thought. But, the fact remains that the basic principles of osteopathic medicine (originating in the latter half of the 19th century by Dr. Andrew Taylor Still) are inherently intertwined with the cutaneo-visceral mechanisms. Osteopathic treatment utilizes these mechanisms in bringing relief to patients suffering from internal distress.

Viscero-cutaneous reflexes illustrate that a "two-way street" exists between the viscera and the skin. They are utilized in osteopathy as a means of diagnosis. Consequently, if a cutaneous area is sensitive it may
reflect a disorder of a particular internal organ. Sensitivity may present itself in a variety of ways such as pain, tenderness, hyperesthesia and hypoesthesia; and is labelled as "refined."

Each dermatome area (as has been discussed) represents the cutaneous innervation of a specific spinal segment. But, what also has to be considered is the effect of "adjustment" within each dermatome area on its corresponding spinal segment and target organ; as well as the effect of each organ on its referred dermatome areas.

Acupuncture, moxibustion and osteopathic treatment (either by manipulation or "soft tissue"-(massage)) all constitute forms of adjustment at a specific location within a dermatome segment. These methods of manipulation serve to intercept nerve impulses; both cutaneous-visceral and visceral-cutaneous. Internal discomfort is relieved and as a result so is discomfort at the external location. Viscero-motor and viscero-visceral reflexes follow patterns similar to that of viscero-cutaneous reflexes in that they occur within the same dermatome segment. For example:

Miller, Simpson and many others stimulated the viscera and obtained muscle contractions in the expected appropriate dermatomes (during human surgery). Distension of the stomach by air, traction on the stomach, mustard oil on the gastric mucosa, squeezing the small intestine, mechanical stimulation of the kidney or spleen all elicited the reflex, which could be abolished by dividing the appropriate dorsal root. The reflex from the stomach was stopped by dividing the splanchnic nerves, while stimulation of the central ends of the divided nerve restored it; similar results were obtained with the superior mesenteric nerves for the small intestine, the hypogastric nerve for the kidney, and the splenic nerve for the spleen (in animal experimentation).

But, the acupuncture point may or may not be located within the corresponding dermatome area of a specific spinal segment. All points on the back having an effect on a specific organ, are in the appropriate dermatomes. However, there are many reflexes that are intersegmental in na-
ture and will be presently discussed in conjunction with dermatome-acupuncture patterns.

Intersegmental patterns serve to explain how the distribution of acupuncture points is such that each organ corresponds to several dermatomes and each dermatome corresponds to several organs. The majority of acupuncture points on the abdomen, thorax and back are near the mid-ventral and mid-dorsal lines; and the meridians of the lung, pericardium and heart on the anterior surface of the arm approximately correspond to the appropriate dermatome. The meridians on the posterior surface of the arm, the large intestine, small intestine, and triple warmer, do not correspond to the appropriate dermatomes. Consequently, intersegmental pathways must exist to satisfy such relationships. The pathways involved appear to constitute viscero-motor, cutaneo-motor, viscero-visceral, visceral-cutaneo and cutaneo-visceral patterns. In order for such pathways to exist on an intersegmental basis (which encompasses such long channels), there would have to be a connecting "network" involved. The Autonomic Nervous System, via its tracts, satisfies virtually all of the requirements of this "network." As will be investigated later, it is in essence the "missing link" which allows for intersegmental "traffic," thereby explaining numerous discrepancies between dermatomes and acupuncture insertion points.

IV. Investigation of the Spinal Nerve Origins of Acupuncture Points and their Affected Organ(s) (Refer to Figs. 1-13)

Certain acupuncture points, especially those on the back, have an effect on a specific organ. Each involved organ, in turn, is innervated by a spinal nerve whose dermatome encompasses the location of its acupuncture point (Refer back to Fig. 15, pg. XV). However, there appears to be no definite pattern involved in the spinal nerve origins of acupuncture
points in each meridian. This fact is best illustrated by the re-examination of the main meridians and their sphere of influence; in conjunction with the sphere of influence of the spinal nerves associated (via the dermatome chart) with the acupuncture points on each meridian.

1. The lung meridian's pathway indicates that its acupuncture points travel a similar route as does the radial nerve. This would indicate that the spinal nerves of origin are C5, C6, C7, C8 and T1. (Henceforth C, T, L and S will represent cervical, thoracic, lumbar and sacral nerves). But by examining its sphere of influence (the lungs and the large intestine), it is observed that the appropriate spinal nerves for the target organs should be T1 through T5 for the lungs (via the thoracic sympathetic ganglia). In addition, the tenth cranial nerve (vagus) also innervates the lungs and the large intestine is innervated by the celiac plexus, which consists of branches from T1 to T12 and L1. See Fig. 1, pg. I

2. The heart meridian pathway indicates that its acupuncture points travel in a direction very similar to that of the ulnar nerve. The ulnar nerve consists of spinal nerve branches C8 and T1.

The sphere of influence includes the heart, small intestine, larynx and eyes. The extrinsic control of the heart is dependent on sympathetic and parasympathetic branches from the Autonomic Nervous System. The vagus (tenth cranial) nerve carries the parasympathetic innervation while the cervical sympathetic ganglia supply sympathetic innervation. The small intestine is innervated by branches from the celiac plexus, splanchnic nerves (T5-T12, L1) and a vagal branch. The larynx is innervated by laryngeal branches of the vagus nerve (parasympathetic) and the eye is innervated by the optic (second cranial) nerve. See Fig. 2, pg. II
3. The "controller of the heart" meridian runs a pathway very similar to that of the median nerve (which consists of spinal segments C6, C7, C8 and T1).

The sphere of influence includes the lungs, esophagus, stomach, small intestine, genitals and urinary bladder. The lungs are innervated by the anterior and posterior pulmonary plexuses (vagus nerve) and visceral rami from the upper 4 or 5 thoracic sympathetic ganglia. The esophagus receives its nerve supply from the esophageal branches and plexus (from vagus nerve) and all thoracic ganglia (including branches from the splanchnic nerves). —See Fig. 3, pg. III

4. The small intestine meridian follows a pathway in the arm similar to that of branches of the ulnar nerve (from spinal segments C8 and T1). In the face, its pathway approximates that of the facial and trigeminal nerves.

The sphere of influence encompasses the heart, stomach and the small intestine. The cardiac plexuses (vagal branches and upper 4 or 5 thoracic sympathetic ganglia) innervate the heart. And the thoracic splanchnic nerves (preganglionics), in conjunction with postganglionics from the celiac plexus, innervate the stomach. (Refer to heart meridian for small intestine innervation) —See Fig. 4, pg. IV

5. The "triple warmer" meridian follows a pathway in the arm that approximates both the median nerve and the ulnar nerve (Spinal segments C6, C7, C8 and T1).

It innervates the lungs, esophagus, stomach, small intestines, genitals and urinary bladder. (Refer to previous meridians for innervation)

6. The "large intestine meridian follows a pathway in the arm that approximates both the radial nerve and the median nerve (spinal segments C5, C6, C7, C8 and T1). In the face, it follows the pathway of the mandibular

* Refer to Fig. 5, Pg. V
** Refer to Fig. 6, Pg. VI
branch of the trigeminal nerve.

It innervates the teeth, gums, lungs and large intestine. (The lungs and large intestine innervations are discussed in previous meridians)

7. The spleen meridian follows a pathway in the leg which corresponds to branches from the lumbar plexus (L1-L4). Its pathway in the abdomen, chest and medial upper arm consists of all the thoracic segments (T1-T12).

The sphere of influence constitutes the stomach and the heart. (Refer to previous meridians for innervation)—See Fig. 7, pg. VII

8. The kidney meridian pathway encompasses spinal segments L1-L4 in the leg. In the abdomen and chest, all of the thoracic segments (T1-T12) are utilized.

This meridian innervates the kidney and the heart. The kidney is innervated by the aortic plexus (from lumbar splanchnics of L1 and L2). The kidney’s nerve supply comes from the celiac plexus (segments T5-T12 and L1). (The heart innervation is dissused with the small intestine meridian)—See Fig. 8, pg. VIII

9. The liver meridian follows a pathway in the leg which includes spinal segments L1-L4. In the thoracic region, spinal segments T5-T12 are part of the pathway.

The sphere of influence encompasses the stomach, liver, various locations on the face (including areas around the mouth, cheek and eye) and the scalp area along the sagittal suture. The innervation in the face appears to be from all three branches of the trigeminal (fifth cranial) nerve (maxillary, mandibular and ophthalmic) and that of the scalp to be the maxillary branch of the trigeminal nerve.—See Fig. 9, pg. IX

10. The bladder meridian pathway in the leg approximates pathways from S1-S2, T1-T12 and C2-C7; as well as those from the ophthalmic branch of
the trigeminal nerve (in the forehead and eye regions).

Immersed organs are the kidney and urinary bladder. (Refer to previous meridians for innervations) — See fig. 10, pg. X

11. The gall bladder meridian's pathway approximates branches from S1, L4-L5, T1-T2, and C2-C6; as well as those from the facial nerve.

Immersed organs are the gall bladder and liver (via the celiac plexus) — See fig 11, pg. XI

12. The stomach meridian follows a leg pathway similar to branches from L1-L5, T1-T2 and C1-C2; as well as those from the facial nerve.

The sphere of influence encompasses the stomach and small intestine. (Refer to previous meridians for innervations) — See fig. 12, pg. XII

The Jen-Mai* and Tu-Mai special meridians also merit investigation because of their significance. They follow a pathway inclusive of all thoracic and cervical segments. And the organs of innervation include the urinary bladder, small intestine, stomach, heart and lungs. Areas around the mouth and eye are also innervated; approximating ophthalmic and mandibular branches of the trigeminal nerve. (Innervations of the organs are previously discussed) (16).*

* Refer to fig. 13, Pg. XIII
V. The Autonomic Nervous System and its Relationship to Acupuncture Points and their Affected Organ(s)

A. Discussion of Autonomic Nerve Pathways via the Sympathetic and Parasympathetic Nervous Systems

The portion of the nervous system that controls the visceral functions of the body is the autonomic nervous system. Consequently, if acupuncture is to be effective, the mechanisms involved must be integrally related to those of the autonomic nervous system.

We know that the autonomic nervous system is activated mainly by centers located in the spinal cord, brain stem, and hypothalamus. And, it is also known that the thalamus acts in the manner of a "relay station" for "messages" coming to the brain from the spinal cord. The object of this research was to first find a relationship between acupuncture and the characteristics and functions of the autonomic nervous system, and then to incorporate autonomic nerve pathways (whenever and whenever possible) into the more complicated acupuncture pathways.

The autonomic impulses are transmitted to the body through two major subdivisions called the sympathetic and parasympathetic systems, the characteristics and functions of which will now be presented.

Figure 16 illustrates the general organization of the sympathetic nervous system, showing one of the two sympathetic chains on the side of the spinal column and nerves extending to the different internal organs. The sympathetic nerve fibers originate in the spinal cord between the segments T-1 and L-2. They begin in the sympathetic motor neurons of the intermediolateral horns of the spinal gray matter. No sympathetic nerve fibers originate in the neck segments of the cord or in the lumbar and sacral segments below L-2, but nerve fibers travel upward or downward from the sympathetic chains to supply the head and leg regions.

Each sympathetic pathway is composed of a preganglionic neuron and
a postganglionic neuron. It is known that the cell body of the pregangli-
onic neuron lies in the spinal cord, and its fiber passes through an anterior root of the cord into a spinal nerve and finally through the white ramus from the spinal nerve to the sympathetic chain. Here the fiber either synapses with postganglionic neurons in the sympathetic ganglia or often passes on through the chain into one of its radiating nerves to synapse with postganglionic neurons in one of the outlying sympathetic ganglia. The fiber of each postganglionic neuron then travels through an additional nerve to its destination in one of the organs.

Investigation of many of the fibers from the postganglionic neurons in the sympathetic chain has revealed that they pass back into the spinal nerves through gray rami at all levels of the cord. Type C fibers comprise these pathways. "They control the blood vessels, sweat glands, and pilo-
erec ter muscles of the hairs. Approximately 8 per cent of the fibers in the average skeletal nerve are sympathetic fibers, a fact that indicates their importance (17)." Some of the preganglionic neurons enter the spinal nerves directly from the spinal cord instead of first passing through the sympathetic chain. They then synapse with postganglionic neurons located in the spinal nerves themselves. Consequently, destruction of the sympathetic chain does not remove all sympathetic activity; however, it does remove at least 90 per cent of it.

The sympathetic pathways originating in the different segments of the spinal cord are not necessarily distributed to the same part of the body as the somatic nerve fibers from the same segments. Instead, "the sympathetic fibers from T-1 generally pass up the sympathetic chain into the head, from T-2 into the neck, T-3, T-4, T-5 and T-6 into the thorax, T-7, T-8, T-9, T-10 and T-11 into the abdomen, T-12, L-1 and L-2 into the
legs (18)." This distribution is approximate; there are areas that overlap to a significant degree. Variance is probably determined in part by the position in the embryo at which the organ originates. For example, the heart receives many sympathetic nerves from the neck portion of the sympathetic chain, because the heart originates in the neck of the embryo. In similar fashion, the abdominal organs receive their sympathetic innervation from the lower thoracic segments because the primitive gut originates in the lower thoracic area. Further investigation has determined that preganglionic sympathetic nerve fibers pass without synapsing all the way from the "intermediolateral horn cells of the spinal cord, through the sympathetic chains, through the splanchnic nerves, and finally into the adrenal medulla. There they end directly on special cells that secrete norepinephrine and epinephrine. These secretory cells are embryologically derived from nervous tissue and are analogous to postganglionic neurons; indeed, they even have rudimentary nerve fibers (18).

Figure 17 illustrates the general organization of the parasympathetic nervous system. It shows that parasympathetic fibers leave the central nervous system through several of the cranial nerves, the second and third sacral nerves from the spinal cord, and occasionally the first and fourth sacral nerves. The vast majority (at least 80 per cent) of all parasympathetic nerve fibers are transmitted in the vagus nerves, passing to the entire thoracic and abdominal regions of the body. But, the vagus nerve is not completely parasympathetic in function; it also carries some voluntary skeletal nerve fibers from the nucleus ambiguus to the laryngeal and pharyngeal muscles and some afferent nerve fibers from the pressoreceptors of the arteries and from stretch receptors of the lungs to the medulla. In spite of the additional functions of the 2 vagus nerves (one on each side of the
body), they are invariably considered the "backbone" of the parasympathetic nervous system. The vagus nerves supply parasympathetic nerves to the heart, the lungs, the esophagus, the stomach, and the small intestine, the proximal half of the colon, the liver, the gallbladder, the pancreas, and the upper portions of the ureters.

Parasympathetic fibers in the third nerve flow to the pupillary sphincters and ciliary muscles of the eye. Fibers from the seventh nerve pass to the lacrimal, nasal, and submaxillary glands, and fibers from the ninth nerve pass to the parotid gland. The sacral parasympathetic fibers congregate in the form of the two nervi erigentes, which leave the sacral plexus on each side of the cord and their peripheral fibers are distributed to the descending colon, rectum, bladder and lower portions of the ureters. This sacral group of parasympathetics also supplies fibers to the external genitalia to cause various sexual reactions.

The parasympathetic system, like the sympathetic, has both preganglionic and postganglionic neurons, but, in the vast majority of cases, the preganglionic fibers pass uninterrupted to the organ that is to be "excited" by parasympathetic impulses. In the wall of the organ are located the peripheral ganglia of the parasympathetic system.

The preganglionic fibers synapse with the peripheral ganglia, and then short postganglionic fibers, 1 millimeter to several centimeters in length, leave the ganglia to spread in the substance of the organ. This location of the peripheral parasympathetic ganglia in the visceral organ itself is quite different from the arrangement of the sympathetic ganglia, for the cell bodies of the sympathetic postganglionic neurons are always located in the ganglia of the sympathetic chain or in various other discrete ganglia in the abdomen or thorax rather than in the excited organ itself (19).

It should be noted that surgery of some autonomic pathways has come into prominence within the last 20 years to alleviate certain disorders.
Treatment of hypertension by removal of the thoracolumbar outflow which supplies the vasoconstrictor fibers to the blood vessels of the splanchnic area and kidneys as well as the innervation of the adrenal medulla has been successful in certain cases. Section of the vagus nerves supplying the areas of stomach and duodenum subject to ulcers has at times afforded relief (19).

In addition, other methods of autonomic "manipulation" have been utilized. For example, injections designed to block the thoracolumbar ganglia supplying an area in which thrombophlebitis exists have often shown immediate as well as continued improvement.

One final area of interest that will be mentioned concerns the control of autonomic outflow by suprasegmental central mechanisms. Lesions of the spinal cord best exemplify this control. Such a lesion now follows:

When the urinary bladder is distended in the patient with cervical cord damage, responses of visceral character occur, as sweating, flushing, pilomotor responses, and marked rise of blood pressure; and the changes are much greater than would occur in a normal individual, who retains the connections with higher levels necessary for inhibitory and excitatory control of visceral neurons at spinal level (19).

B. Comparison Between Acupuncture and Autonomic Pathways within the Spinal Cord

The examination of the comparisons involved between acupuncture and autonomic pathways will follow an investigation of each meridian individually; to be consistent with previous research in this paper.

1. The lung meridian's pathway is comprised of spinal nerves of origin C5, C6, C7, C8 and T1 (as previously determined). Also, as previously attained, its sphere of influence (the lungs and large intestine) is innervated by spinal nerves T1 through T12 and L1.

Examination of the nerves of origin as well as the organs involved (lungs and large intestine) suggests involvement of the sympathetic pathways. It must be noted that cervical spinal nerves are not involved in
the autonomic nervous system and consequently must be disregarded in this
discussion of the lung meridian's (and all ensuing meridians) pathways.
A possible linking of the cervical segments will be reserved, however, for
section VIIIB of this paper when all facts will be accumulated, analyzed
and reduced to formulate the most logical hypothesis possible on the auton-
omic involvement (as well as all other conceivable involvement) in acupunc-
ture. Sympathetic involvement is apparent if there is either thoracic or
lumbar involvement; and this is indeed the case for the lung meridian.

By directing attention to possible parasympathetic involvement, it
is immediately observed that there is no sacral involvement in the lung mer-
idian but there is cranial innervation via the vagus nerve. Hence, para-
sympathetic implication is very much evident. The vagus nerve innervates
both the lungs and the proximal portion of the large intestine. Refering
to Fig. 1 (pg. 1), it can be further observed that the share of influence
"imaginary line" follows a track running along the spinal cord itself; but
does not go as superior as the cranial region.

The relationship between the lung meridian and the autonomic nervous
system is consequently very definite once we trace the the spinal segment
origins of the actual pathway. However, the pathway itself is reflective
of only the sympathetic division while the innervated organs implicate the
parasympathetic division as well.

2. The heart meridian's pathway is reflective of spinal nerves C8 and T1
and it's "imaginary line" is also following the "phantom" of the spinal
cord. However, there is a distinct diversion from this pathway in the
regions of the heart, small intestine, larynx and eyes.

Once again the pathway itself is reflective of the sympathetic nerv-
ous system since the first thoracic segment innervates this meridian. But,
examination of the sphere of influence, while more than substantiating the sympathetic involvement (via the celiac plexus and splanchnic nerves) also introduces parasympathetic involvement by means of the vagus nerve. The vagus nerve innervates the small intestine and the larynx. Parasympathetic involvement is also incorporated through the oculomotor cranial nerve. There is no cervical sympathetic origin as previously pointed out; but the two sympathetic chains travel the entire length of the spinal cord into the cervical region of the body. The chain in the cervical region "supplies" the cervical segments with sympathetic innervation from the thoracolumbar segments; which is the case with the heart meridian.

Consequently, as with the lung meridian, the pathway is reflective of the sympathetic nervous system alone; while the sphere of influence implicates both divisions of the autonomic nervous system. (See Fig. 2, pg. III)

3. The "controller of the heart" meridian has a pathway (C6, C7, C8 and T1) which can be referred to the sympathetic division. The innervated organs (lungs, esophagus, stomach, small intestine, genitals and urinary bladder) receive their nerve supply from thoracic ganglia and vagus nerve branches; implying involvement with the sympathetic and parasympathetic divisions. (Refer to Fig. 3, pg. III)

4. The small intestine meridian has a pathway (C8 and T1) which can also be referred to the sympathetic division. The innervated organs (heart, stomach and small intestine) receive their nerve supply from thoracic ganglia, thoracic splanchnic nerves, the celiac plexus and vagal branches; indicating involvement with both autonomic divisions. (Refer to Fig. 4, pg. IV)

5. The "triple warmer" meridian follows a pathway (C6, C7, C8 and T1) which corresponds to the sympathetic division. The organs of innervation (lungs, esophagus, stomach, small intestine, genitals and urinary bladder)
are supplied by thoracic sympathetic ganglia, the celiac plexus, splanchnic nerves and branches from the vagus nerve. Hence, once again, the innervation corresponds to both the sympathetic and parasympathetic branches. (Refer to Fig. 5, pg. V)

6. The large intestine meridian's pathway (C5, C6, C7, C8 and T1) is reflective of the sympathetic division. The areas of innervation are supplied by the mandibular branch of the trigeminal nerve, thoracic ganglia and the vagus nerve; hence both divisions of the autonomic nervous system. (Refer to Fig. 6, pg. VI)

7. The spleen meridian's pathway (T1-T12, L1-L4) is solely referred to the sympathetic branch of the autonomic nervous system. The innervated organs (stomach and heart) are supplied by thoracic ganglia and vagal branches; indicating total autonomic involvement. (Refer to Fig. 7, pg. VII)

8. The pathway of the kidney meridian encompasses only sympathetic branches (T1-T12, L1-L4) of the autonomic nervous system. Lumbar splanchnics and the celiac plexus are the sympathetics involved with the innervated organs. The vagus nerve and its branches are the involved parasympathetics. (Refer to Fig. 8, pg. VIII)

9. The liver meridian's pathway is also reflective of only sympathetic involvement (T5-T12, L1-L4). But, its sphere of influence (in the face, stomach and liver) indicates involvement of various thoracic segments as well as that of the trigeminal (fifth cranial) nerve; indicating both sympathetic and parasympathetic utilization. (Refer to Fig. 9, pg. IX)

10. The bladder meridian has a pathway (C2-C7, T1-T12, S1-S2) which is reflective of both sympathetic and parasympathetic (since there is sacral nerve supply) involvement. It should be noted that this meridian is the first in this investigation to have its pathway represented by both branch-
es of the autonomic nervous system. In addition it's the first meridian to encompass all divisions of the spinal cord. Examination of the organs of innervation (the kidneys and urinary bladder) indicates a nerve supply from lumbar splanchnics, the hypogastric plexus and the nervi erigentes; showing a sharing, once again, of involvement from both branches of the autonomic nervous system. (Refer to Fig. 10, pg. X)

11. The gall bladder meridian's pathway is the only other meridian (besides the bladder's) which includes all spinal cord divisions. Hence, both autonomic divisions are represented in its pathway. The sphere of influence (gall bladder and liver) shows involvement from both the sympathetic (via the celiac plexus) and parasympathetic (via branches from the vagus nerve) divisions. (Refer to Fig. 11, pg. XI)

12. The stomach meridian also shows total autonomic involvement in its pathway. But, unlike the bladder and gall bladder meridians, there is no representation from the sacral segments; parasympathetic involvement is a result of facial nerve incorporation. The innervated areas and organs (stomach, small intestine and supraorbital region) are reflective of both the sympathetic (via the celiac ganglion) and parasympathetic (via the vagus nerve and branches from the ophthalmic branch of the trigeminal nerve. (Refer to Fig. 12, pg. XII)

In analyzing the above autonomic involvement in acupuncture, this author has concluded that there is sympathetic involvement in all of the acupuncture pathways; but parasympathetic involvement is limited to the bladder, gall bladder and stomach meridians. Furthermore, there is both sympathetic and parasympathetic incorporation in the spheres of influence for all twelve main meridians.

Much of the present research done on acupuncture is concerned with
its physiological basis either at the acupuncture point or en route to the spinal cord or brain, and primarily in relation to anesthesia. However, Dr. Hamilton S. Davis of the University of California Medical School has concerned himself with mechanisms within the central nervous system, itself. The dorsal column of the spinal cord is a strategic focus of his investigation:

This study seeks to answer the question: what are the effects of peripheral mechanical needling (acupuncture) and electrical stimulation (simulated acupuncture) on both spontaneous and evoked nervous activity in the spinal dorsal horn, spinal dorsal column, midbrain reticular formation, specific and non-specific thalamic nuclei and the cerebral cortex? The model proposed for this study is the alert, muscle-relaxed cat, previously prepared by chronic implantation of suitable electrodes in the brain and a plugged window in the lumbar spine through which recordings can be made from the spinal cord (20).

The dorsal column and horn receive sensory input from the dermatomes. Consequently, the movement of this sensory input would have to travel along the dorsal portion of the spinal cord in order to reach another location on the cord. Even though the experimentation involved utilized a cat, it can be strongly assumed that the basic principles apply to the human nervous system as well (due to the similarities involved). The procedure of the experimentation involved the implantation of intracranial electrodes for the purposes of both recording and stimulation. They were placed stereotaxically into midbrain reticular formation, specific thalamic nuclei (VPL or VPM) and non-specific thalamic nuclei, e.g., centrum medianum, as well as overlying cerebral cortex. (Refer to sections VIA and B for further involvement of the thalamus.) Simultaneously, a lumbar laminectomy was performed with the subsequent placement of electrodes in the spinal dorsal horns and columns for the detection of extracellular
single unit neuronal activity (also stereotaxically). Bipolar stimulating needles were inserted into the skin of both paws (since certain locations on the paws simulated human acupuncture points). The stimulation of the needles at these points resulted in electrode detection of remarkable similarity at both the lumbar and cranial levels. It is apparent that the spinal cord served as a "highway" to allow the very same subconscious message which reached a specific spinal segment (as it does in the human dermatome chart) to, in turn, reach the midbrain reticular formation, thalamic nuclei and cerebral cortex. (Refer, once again to sections VII and B for further involvement of the thalamus; as well as its co-involvement with the reticular formation.)

In analyzing the "highway" referred to above, an analysis of the known longitudinal organization of the central nervous system is forthcoming. It is represented by shorter or longer intersegmental connections which link neural segments of different levels, and by suprasegmental connections from the colliculi, the cerebellum and forebrain which integrate the activity of neural segments in the performance of complex tasks.

Segmental motor neurons of the somatic division of the central nervous system arise from the ventral horn of the spinal cord and from the nuclei in the hind- and the midbrain; they emerge in successive order from the spinal cord and brainstem as ventral spinal roots and motor cranial nerves, which eventually innervate the segmental effector organs, i.e., the striated muscle. In addition, the afferent components of somatic neural segment are represented by the cells of the dorsal spinal root ganglia and by the cells of the sensory ganglia of the lower cranial nerves as far rostral as the trigeminal. The peripheral axons of these segmentally arranged sensory cells innervate the receptor end-organs of fairly well delineated areas of
the skin and of deeper structures, such as muscles, joints and tendons. Both efferent and afferent components of specific neural segments are connected by intervening neurons, i.e., the intrasegmental or intermucnial neurons which form the foundation of spinal reflex arcs.

Theoretically, efferent autonomic body segments are represented by the smooth muscle, glands and heart, and the afferent component of these segments by the receptor end-organs in viscera and blood vessels. The "neural segment" approach to the autonomic nervous system encompasses both efferent and afferent pathways and can best serve as a strategic model to correlate the physiological basis of acupuncture.

If a definition of an autonomic neural segment might comprise all peripheral neurons that innervate a specific body segment, it is logical to designate the post-ganglionic fibers as the constituents of these neural segments. Not only are post-ganglionic fibers immediately concerned with the innervation of autonomic effector organs, but they can also be correlated more readily with somatic neural segments, especially those that emerge from the spinal cord.

When adopting this definition, it follows that motor autonomic neural segments are placed outside the cerebrospinal axis, and are formed by the cell bodies of post-ganglionic parasympathetic and sympathetic neurons which comprise in part distinct ganglionic masses for the supply of smooth muscle and glands near the body surface and in part diffusely arranged cell groups designated for the innervation of the viscera of the thorax, abdomen and pelvis.

Thus, cranial parasympathetic segments are represented by the ciliary, sphenopalatine, otic and submaxillary ganglia. Sympathetic segments to the head and to the skin and muscles of the trunk and extremities are represented by the paravertebral ganglia and gray rami communicantes of the sympathetic trunk. Motor sympathetic segments to individual viscera and their blood vessels are more difficult to recognize, as they are widely scattered along the course of the splanchnic nerves, in prevertebral ganglia and in their peripheral extensions. Sacral parasympathetic segments are even more widely spread; they are represented by the diffusely arranged cell groups in the pelvic plexus and also are placed near or even within the organs of supply.

Afferent neural segments from viscera and blood vessels, similar to their somatic counterpart and situ-
ated outside the central nervous system, are comprised by the sensory ganglia of spinal and lower cranial nerves (21).

In line with the "neural segment" approach, it follows that the preganglionic sympathetic and sacral parasympathetic components are also representative of specific spinal segments. In fact, these components have been considered "connector cells" by leading investigators of the autonomic nervous system, including one of the earliest, W.H. Gaskell. In order to fully understand the exact involvement of the spinal cord (and ultimately the segment extensions involved), an analysis of the research of these leading investigators will now follow.

It has often been stated in textbooks that the source of the spinal preganglionic autonomic outflow is provided by the cells of the intermediolateral horn of the spinal cord. The sum of these cells, which are present in the first thoracic down to the second or third lumbar segment, is variously referred to as either the "superior nucleus intermediolateralis, lateral splanchnic motor cell column, superior lateral sympathetic nucleus or thoracolumbar cell group (21)." The inferior intermediolateral nucleus in the second, third and fourth sacral spinal segments is believed to constitute the origin of parasympathetic preganglionic fibers of the pelvic organs.

According to Grove (1926), the superior intermediolateral nucleus begins at the eighth cervical segment; it has one enlargement between the third and the fifth thoracic segments and another between the eleventh and the first lumbar segments; terminating at the second or third lumbar segments. Both Massazzaar (1922, 1924) and Bok (1928) came to different conclusions when they stated that the intermediolateral cell column simply grew smaller at the second lumbar segment and increased again between the fourth and fifth lumbar segments, while it continued as reticular cell
groups with the inferior intermediolateral nucleus in the mid-sacral region.

The inferior intermedio-lateral nucleus extends from the second to the fourth sacral spinal segments, and is similar histologically to its counterpart in the thoraco-lumbar region (Greving, 1928). The details of the distribution of autonomic nuclei and their relationships to other cell groups indicates that it is their presence alone which accounts for the varied effects of both the sympathetic and parasympathetic nervous systems. Proof of this fact was shown experimentally by several investigators (particularly Biedl (1895) and Hoeben (1896). They showed that the lateral horn cells exhibited pathological changes upon either degeneration or a disease process of the autonomic nervous system.

Fine myelinated fibers, which are the trademark of autonomic function, are not limited to the thoracolumbar and midsacral ventral spinal roots:

The late Harvey Cushing suggested a sympathetic outflow in the hypoglossal nerve, and Gaskell mentioned the presence of fine myelinated fibers in the spinal accessory nerve which were regarded by Mitchell (1953) as being of visceral function. Furthermore, a moderate number of fine medullated fibers in the roots of all cervical and lower lumbar spinal nerves was recorded by Schwalbe (1882), Siemerling (1887), Langley (1922), Greving (1928), Swensson (1936), Sheehan (1941) and Mitchell (1953). The problem of the limits of the spinal autonomic outflow is made even more complicated by a possible efferent autonomic component in the dorsal spinal roots. This matter has been a subject of discussion since Stricker (1876) (who first investigated the subject). The evidence suggests that a variable dorsal autonomic outflow exists not only in lower chordates (Pick, 1957), but also in higher mammals and in man (Sheehan, 1935; Mitchell, 1953) (21).

Furthermore, there is some evidence which suggests the existence of additional nuclei in the spinal cord that may give rise to autonomic fibers. For example, Bok (1922) and Poljak (1924) found an intermediodorsal nucleus along the entire length of the spinal cord, which is located latero-
dorsal to the central canal and can be divided into a paracentral and a postero-central group. Some of these intermediomedial cells were interpreted as intercalated neurons which connect afferent as well as intersegmental and suprasegmental efferent fibers with the cells of the intermediolateral column; others give rise to nerve fibers which uninterruptedly emerge with the ventral spinal roots, forming part of the automatic outflow.

There exists in the spinal cord a conspicuous cell group along the medial limit of the anterior horn, which begins abruptly at the 3rd lumbar segment, reaches its widest diameter at the 5th lumbar, and extends to the 2nd coccygeal level. This nucleus, discovered by Jacobsen, was subsequently named nucleus medialis myelotius and supposedly gives rise to parasympathetic fibers. Finally, there are small, chromatophore cells scattered through the intermediate part of the spinal cord and forming the cellulae disseminatae intermediæ, which in part may represent intrasegmental autonomic neurons or perhaps participate in the preganglionic outflow (22).

Ascending and descending autonomic pathways (or "highways") undoubtedly exist, resulting in the great variance present in fiber tracts. However, the exact location of these tracts has never been irrevocably proven.

The following analysis is the most logical offered at present:

The nucleus reticularis and the nucleus proprius of the posterior horn issue an arcuate bundle of nerve fibers, i.e. the Bogenfasern of Hiss, which passes through the pars intermedia of the gray substance and the deepest layer of the anterior horn, crosses in the anterior white commissure to the opposite side, and terminates with ascending and descending collaterals in the anterolateral tracts. Collaterals of this fiber tract, representing autonomic intrasegmental fibers, terminate at the cells of the intermediomedial nucleus. Some neurons of this latter nucleus emerge uninterruptedly as part of the preganglionic outflow into the spinal roots; another bundle of the intermediomedial nucleus forms the mediolateral tract, which in part ends as a second set of intrasegmental fibers at the lateral horn cells of the same segment. The remaining component of the mediolateral tract serving intersegmental connections passes through the lateral horn into the deepest layers of the spinal tract as the mediolongitudinal bundle, which connects by means of ascending and descending collaterals the lateral horn cells of the higher and lower segments.
Acupuncture pathways require involvement of the total autonomic nervous system; consequently, suprasegmental connections must be incorporated. The existence of such suprasegmental connections has been substantiated by experimental evidence obtained from laboratory mammals as well as clinical observations made on patients who had suffered spinal cord injuries. Accuracy as to the exact anatomical distribution of these connections has yet to be accomplished. However, some research has been done.

Descending suprasegmental pathways travel mostly in the anterolateral fasciculi of the spinal cord, as described by Greving. In cats in which the spinal cord had been transected in the cervical region, a profuse sympathetic discharge such as erection of hair over the entire trunk, vasoconstriction in both kidneys, sweating of all 4 footpads, and pupillary dilatation could be produced after stimulation of the lateral fasciculi of the lower cut surface of the spinal cord. Such a widespread autonomic response did not ensue, however, after the stimulation of any other area of the spinal cord. The contraction of the urinary bladder seems to be under the control of suprasegmental pathways which travel in the posterior parts of the lateral tract.

Ascending fiber tracts which convey visceral impulses from the spinal cord to the brain take presumably a course similar to somatic sensory pathways (17).

From the preceding analysis of autonomic pathways, it becomes apparent that a neurological and anatomical mechanism could exist to elicit the enormously varied results of acupuncture. The University of Southern California Acupuncture Study Group has attempted to develop a single hypothesis to explain the manifold phenomena of acupuncture, with the net result being complete involvement with the autonomic nervous system. The crux of the Study Group's very recently (June 1974) developed theory (since it is based upon known fact) involves cutaneousvisceral and viscerocutaneous reflexes, which were previously investigated in the "Relationship Between Dermatomes and Acupuncture Insertion Points" (Sec. IIID).

An interesting aspect of the above theory is that it contains little
that is basically new. For example, it is anatomically known that the entire nervous system is derived from the surface layer of the embryo, the ectoderm. Consequently, the obvious fact is that nerve tissue is from the same origin, regardless of present location. However, critical investigation into cutaneovisceral and viscerocutaneous reflexes (which would serve to link nerve tissue and tract involvement) has been frequently disregarded. This is probably due to the fact there has previously been little comprehensive documentation of these reflexes and no well-proven neurophysiologic mechanism that offered a ready explanation.

Such a mechanism has now been provided through the recent use of computers and other sophisticated technology (specifically by the University of Southern California Acupuncture Study Group) to elucidate the surprising specificity and complexity of somatosympathetic reflexes. The recent resulting documentation is entirely conclusive:

Stimulation of somatic afferents in cutaneous and muscle nerves produces a direct and immediate effect on pre-ganglionic and postganglionic sympathetic nerve activity. In other words, stimulation of fibers from the peripheral division of the central nervous system with tiny metal wires (electrodes in this case, not needles) causes remote but specific and immediate responses in the thoracolumbar division of the autonomic nervous system, adding laboratory evidence to the increasing clinical impression that the central nervous system and the autonomic nervous system are highly integrated, perhaps to the point of even being ultimately inseparable (23).

The reflexes discussed above provide a plausible explanation for many of the motor effects and therapeutic results of acupuncture, but offer no clue to explain acupuncture's surprising effects on pain. In fact, after several decades of medical education that have propounded the concept that the autonomic nervous system is purely motor, it would seem illogical to postulate that an autonomic mechanism of acupuncture may have sensory effects and the ability to influence pain. As previously investigated, a
separate pain-control theory has been implicated, based on a proposed gating mechanism in the central nervous system. Although the "spinal-gate theory" explains the analgesic effects of acupuncture, there is no incorporation with the autonomic nervous system; as well as no explanation of the motor effects and therapeutic action of acupuncture.

The University of Southern California Acupuncture Study Group points out that autonomic function is, indeed, involved in the generation and perception of pain in the human body:

Patients with familial dysautonomia (Riley-Day syndrome) have almost no pain perception; patients with many types of sympathetic dystrophy and causalgia gain relief from their severe pain only after sympathectomy; conversely, patients who have had sympathectomy for circulatory problems may develop postoperatively a very painful and hypersensitive limb distal to surgery. Such phenomena seem almost paradoxical unless one remembers the embryo and recalls that autonomic and sensory ganglia develop from a common origin in the neural crest, a bond that may have been reaffirmed in the laboratory when it was shown that the highly specific nerve growth factor, which stimulates growth of postganglionic sympathetic fibers, stimulates dorsal ganglion sensory fibers as well (23).

Recent further autonomic involvement has been reported from the People's Republic of China:

Varied reports from China indicate significant involvement of the autonomic nervous system in the sensory phenomena noted with acupuncture: paraplegic patients with sweating and other autonomic functions intact are able to feel "Teh Chi" (sensation) when acupuncture points are stimulated in the involved limbs, while those paraplegics who have lost autonomic nervous system function as well as central nervous system function perceive no sensation; animal studies indicate that the ability to produce acupuncture analgesia in the nasal area of the rabbit is lost if the sympathetic chains are surgically interrupted. By invoking poetic as well as scientific license, it is fascinating to postulate that the key to the gate theory may be found hanging on the sympathetic chain (23).

Thus, autonomic involvement in acupuncture is quite apparent and
the central nervous system-autonomic nervous system "axis" actually becomes more comprehensible when viewed as a highly integrated and unified system that is involved directly or indirectly in the dysfunction and pathology of other body systems. In addition, the pathways which exist within the spinal cord itself are extremely complicated and allow for the vast distribution of preganglionic spinal autonomic outflow and its intrasegmental connections so essential in allowing the "channels" of acupuncture to work. The purpose in the preceding investigation was to acquaint the reader with the known specific structures present which allow for central autonomic connections; as well as the possible structures involved. The fact that visceral and somatic afferent fibers as well as suprasegmental axons from the brain send impulses to the nucleus proprius and reticularis of the posterior horn indicates a definite connection between sensory and motor fibers and the autonomic nervous system (as well as acupuncture pathways). And the arcuate fibers (Bogenfasern of His) which carry messages from the above nuclei may very conceivably serve as a "filter" to either allow or disallow acupuncture "messages" through. And, even if messages pass through (via collaterals and intrasegmental connections to the intermediomedial nucleus), they may conceivably be terminated upon reaching the intermediomedial nucleus. But, they may pass into the ventral spinal root of the involved spinal segment or pass into the middle of the lateral fascicle of the spinal cord, whereupon they split into ascending and descending collaterals (representing the mediolongitudinal bundle). The strategic importance of the mediolongitudinal bundle involves its intrasegmental connections which provide the link between autonomic fibers in higher and lower levels of the spinal cord. The link is essential for autonomic pathways to occur and serves to explain the seemingly illogical
cause and effect relationship between any given acupuncture point and its "target area."

In the preceding discussion of autonomic nerve pathways via the sympathetic and parasympathetic nervous systems, it was determined that sympathetic involvement exists in all acupuncture pathways; but parasympathetic involvement is limited only to the bladder, the gall bladder and stomach meridians. This is coupled with the fact that there is both sympathetic and parasympathetic incorporation in the spheres of influence for all twelve meridians. The total involvement of the sympathetic nervous system in all acupuncture pathways appears quite logical when considering the intersegmental relationships (always incorporating thoracic and/or lumbar segments) involved. The fact that the sphere of influence of all the meridians involves the entire autonomic nervous system also relates to intersegmental pathways; but at all spinal cord levels, and with cranial involvement.

Since the spinal cord pathway for the sphere of influence of all meridians involves the entire length of the cord, an analysis of the nerve structures and pathways of probable utilization will be discussed. Any given acupuncture point may be located in any given dermatome with the dorsal column and horn of the spinal cord receiving sensory input from that dermatome. As previously discussed, Dr. Hamilton Davis concerned himself primarily with the dorsal column of the spinal cord in his investigation into mechanisms within the central nervous system. It was determined that a "highway" was present between any given spinal segment and either another spinal segment, the midbrain reticular formation, thalamic nuclei, the colliculi, the cerebellum, the forebrain and the cerebral cortex. Since internuncial neurons are involved only with the same neural segments
that they are located in, they could not be incorporated into such a theoretical "highway." The motor autonomic neural segments serve as the recipient of messages sent along the "highway system." Where each individual message is to be released is determined in advance by the acupuncture point involved (and consequently by the dermatome in which the point is located). Two possible theories as to the neural mechanism were investigated previously by the author, but primarily in reference to the blocking of pain. Since the first theory incorporates the premise that each acupuncture point is located at a strategic intersection of all types of nerve fibers, it is hypothesized that an overstimulation of all nerve impulses from that point results. If this is indeed the case, then a resultant blockage of messages is entirely plausible. And if "normal nerve messages" are blocked, it is within the realm of reality that a different type of message may be substituted. Since the second theory (or approach to the theory) specifically involves the A-delta fibers and their over-stimulation, it is also theoretically possible that a message involving inhibition of pain may also accompany one of a "different type." It is this "different message" which may very well determine which spinal cord segment will be involved and consequently which motor autonomic neural segments will be the message recipient after initially reaching either the cranial parasympathetic ganglia, sympathetic ganglia or sacral parasympathetic segments (represented either by the pelvic plexus cell groups or cell groups near or even within the organs of supply.

The "different message" discussed above may be transported along any of a variety of pathways discussed by the author in the analysis of possible structures involved in intersegmental connections. Involvement initiating from the dorsal horn of the spinal cord (as interpreted from
various initially unrelated study) does not reflect a total mechanism of involvement; but is rather the final recipient in the spinal cord of a "pre-ordained" route in the hypothetical highway previously discussed. As investigated, the intermediomedial nucleus runs along the entire length of the spinal cord and is located laterodorsal to the central canal. It also consists of a paracentral and a posterocentral group. Further analysis of the interpretation of the intermediomedial cells as intercalated neurons which connect afferent as well as intersegmental and suprasegmental efferent fibers which, in turn, connect afferent as well as intersegmental and suprasegmental efferent fibers with the cells of the intermediolateral column deserves consideration as an interim route in the hypothetical route within the spinal cord. The very fact that the intermediomedial nucleus contributes to the intermediolateral nucleus rather than the converse is significant since the former nucleus runs the entire length of the spinal cord.

Although the dorsal or posterior horn of the spinal cord apparently serves as the recipient of "trans-spinal" messages, it is the nucleus proprius as well as the nucleus reticularis which issues forth the arcuate fibers, which were previously discussed as being very strategic in the transference of intersegmental messages. But, both nuclei are located within the dorsal horn itself, confirming the author’s hypothesis of dorsal horn involvement as being a means to the end, but not an end in itself. In addition, its involvement at supraspinal levels is entirely possible in the form of an intermediary mechanism.

Investigation of supraspinal involvement in both the autonomic nervous system and acupuncture pathways is essential to determine the interrelationships involved at that level as well as the mechanisms involved and
structures utilized. And the autonomic control of functions essential for maintaining life in higher vertebrates and in man is placed in a small area of the hindbrain or rhombencephalon. It contains the cell stations of the principal cranial parasympathetic fibers to the cardiovascular system, the lungs, bronchi and the intestine, including their accessory glands. The central processes of afferent neural segments which are placed in the sensory ganglia of certain cranial nerves carry impulses from viscera, blood vessels, special sense organs and pain-receptors also into the rhombencephalon and terminate at suprasegmental nuclei of the hindbrain. Intrasegmental neurons arise from there and "convey these messages to efferent autonomic nerve fibers, thus forming the anatomical foundation of important reflexes (21)." In addition, there exist many aggregates of cells in the reticular substance of the hindbrain which serve to integrate specific autonomic functions such as vasomotion, respiration, vomiting and certain metabolic processes. All rhombencephalic areas concerned with autonomic functions are connected with one another by "interssegmental neurons, as well as with autonomic nerve centers in the diencephalon and forebrain, by suprasegmental pathways which travel in the reticular substance." "Rhombencephalic autonomic neurons also connect with autonomic neurons in the spinal cord through anatomically still ill-defined pathways incorporating the mediolongitudinal bundle (21)."

The most significant cranial nerve in both the autonomic nervous system (parasympathetic division) and autonomic pathways is the vagus. This fact has already been revealed by the author's investigation. The origin of the nerve consists of two vagal nuclei: the dorsal vagal nucleus and the ventral vagal nucleus. The dorsal vagal nucleus issues visceral fibers, and the ventral vagal nucleus (nucleus ambiguous) issues motor fib-
ers to striated muscle. The central connections are very complex, reflecting the enormous importance and involvement of this nerve:

The somatic efferent fibers to the striped muscles arise in the nucleus ambiguous; the visceral efferent fibers from the dorsal motor nucleus; taste fibers relay in the nucleus of the solitary tract; visceral afferent fibers may also pass to this nucleus or to the dorsal sensory nucleus; somatic afferent fibers (e.g., from the concha) connect centrally with the spinal tract and nucleus of the trigeminal nerve (21).

It is most interesting to note that of the three cranial nerves which are involved in the "sphere of influence" of acupuncture pathways, there is a direct relationship between two of them: the vagus and trigeminal nerve. The fact that the connection originates from the vagus nerve is significant since the vagus is by far the most highly involved of the three nerves. The trigeminal nerve involvement may also receive input from the mediolongitudinal bundle; and the same applies to the vagus and optic nerves (24).

In summing the comparison between acupuncture and autonomic pathways, it appears that there is legitimate reason to believe that acupuncture utilizes many of the significant "transmitter-type" structures within the spinal cord which are essential for the very effectiveness of the autonomic nervous system. The involvement of these structures allows for movement of "messages" throughout the entire spinal cord; as well as integration with cranial nerves (of those the vagus, trigeminal and optic nerves are incorporated into the sphere of influence of acupuncture pathways).
VI. The Thalamus and its Possible Involvement in Acupuncture

A. Function of the Thalamus in Pathways from Above or Below the Spinal Cord

In order to fully understand the function of the thalamus in pathways from either above or below the spinal cord, it is essential to understand both the important anatomical structures within the thalamus as well
as their connections. The thalamus consists of two halves which lie on either side of the third ventricle and are bounded laterally by the internal capsules. Each half is divided by the internal medullary lamina (which splits anteriorly) into medial, ventrolateral and anterior nuclei. The geniculate bodies and pulvinar are part of the ventrolateral nucleus. The medial and anterior nuclei are phylogenetically old and constitute the paleothalamus; the large ventrolateral nucleus which has evolved in relation to the neocortex and reaches its greatest development in the anthropoid apes and man constitutes the neothalamus.

The main nucleus of the ventrolateral complex is the ventral nucleus. Its anterior portion (anteroventral nucleus) receives projections from the basal ganglia. The lateroventral nucleus receives the dentatorubrocerebellar tract and is reciprocally connected to areas 4 and 6 of the frontal lobe. The posteroverentral nucleus is divided into a medial portion, which receives the sensory fibers from the face and head, and a lateral portion, which receives the sensory fibers from the rest of the body, the leg being represented most laterally, the arm intermediately between head and leg. From this nucleus there is a point-to-point projection via the thalamic radiations to the postcentral and precentral gyri. The lateral geniculate body is a relay station for the visual fibers and projects via the optic radiation to the calcarine cortex. The medial geniculate body receives auditory fibers (chiefly from the opposite ear) via the lateral lemniscus and projects by way of the auditory radiation to the auditory cortex of the temporal lobe.

Other relay nuclei are:

a) the anterior nucleus, which receives the mammillothalamic tract of Vicq d'Azry from the mammillary bodies and in turn projects to the cingulate gyrus (this is part of a circuit thought to be involved in emotional...
processes: hippocampus-fornix-mammillary body-mammillo-thalamic tract-anterior thalamic nucleus-cingulate gyrus-cingulum-hippocampus); (b) the dorsomedial nucleus (in the medial nuclear mass), which receives fibers from the hypothalamus and projects to the prefrontal cortex (the latter fibers are severed in the operation of prefrontal lobotomy); and (c) the pulvinar, which projects to the parietotemporo-occipital junctional areas. Other nuclei project to the posterior parietal lobe (25).

In addition, various midline thalamic nuclei belong to the thalamic reticular system. They project indirectly to wide areas of cortex through multisynaptic relays and constitute the diffuse or nonspecific thalamocortical projection nuclei, as opposed to specific thalamocortical projection nuclei, whose projection systems are organized on a topographical basis.

It is interesting to note that the thalamus is a primitive organ which is essential in lower animals as well as man; since acupuncture charts do exist for certain animals. This fact will be discussed in more detail, later in this paper. And, the prime functions of the thalamus are just as strategic in any of the involved species:

The thalamus is the chief sensory organ in lower animals. With ascent of the phylogenetic scale, there has been progressive encephalization of sensory function; but the thalamus probably continues in man to mediate the more primitive forms of sensation: pain, the extremes of heat and cold, and the cruder aspects of touch. There are reciprocal connections between the thalamus and cortex, and the corticothalamic projections are probably no less important than the thalamocortical; so it is perhaps best to regard the thalamus and cortex as a sensory unity. It may be that the affective aspects of sensation are mediated via circuits connecting the thalamus with the hypothalamus and with the frontal and temporal lobes. The thalamus is also involved in cerebellar and basal ganglia circuits (25).

However, the circuits themselves are dependent upon the type of pathways involved in reaching the thalamus. And, research has proven that all sensory information from the somatic segments of the body enters the spinal cord through the posterior roots.
After the sensory information reaches the posterior roots of the spinal cord, the fibers separate into medial and lateral divisions. The medial fibers immediately enter the dorsal columns of the cord and ascend to the brain, while the lateral fibers travel upward for one to six segments and downward for one to two segments, and then synapse with dorsal horn cells that give rise to the ventral and lateral spinothalamic tracts. These tracts ascend to the brain in the anterior and lateral columns of the spinal cord. This separation of the fibers at the dorsal roots represents a separation of the pathways for transmission of sensory impulses: the dorsal column pathway gives rise to the dorsal column system, while the spinothalamic tracts give rise to the spinothalamic system.

The dorsal column system is composed of large, heavily myelinated nerve fibers and transmits signals to the brain at velocities of 35 to 100 meters per second. Also, there is a high degree of spatial orientation of the nerve fibers with respect to their origin on the surface of the body. On the other hand, the spinothalamic system is composed mainly of small fibers, some of which are not myelinated at all or are poorly myelinated and transmit impulses with low velocities. These fibers are spatially oriented but only poorly so (26).

These differences in the two systems immediately characterize the types of sensory information that are transmitted by the two pathways. First, sensory information which must be transmitted rapidly is transmitted in the dorsal column system, while that which does not need to be transmitted rapidly is transmitted mainly in the spinothalamic system. Second, those sensations that detect fine gradations of intensity are transmitted in the dorsal column system, while those that lack the fine gradations are transmitted in the spinothalamic system. And, third, sensations that are
discretely localized to exact points in the body are transmitted in the dorsal column system, while those transmitted in the spinothalamic system can be localized much less exactly (27).

In the dorsal column system (See Figs. 18 and 19*), the nerve fibers entering the dorsal columns pass all the way up these columns to the medulla, where they synapse in the cuneate and gracile nuclei. From here, second order neurons pass upward to the thalamus. The fibers decussate entirely to the opposite side in the medulla, and form bilateral pathways called the medial lemnisci. Each medial lemniscus terminates in the ventrobasal complex of nuclei located posteriorly in the thalamus. In its pathway through the hindbrain, the medial lemniscus is joined by additional fibers from the main sensory nucleus of the trigeminal nerve; these fibers subserve the same sensory functions for the head that the dorsal column fibers subservice for the body.

From the ventrobasal complex, third order neurons project, as shown in Fig. 19, mainly to the postcentral gyrus of the cerebral cortex. But, in addition these neurons also project to closely associated regions of the cortex behind, in front of, and lateral to the postcentral gyrus.

Collateral fibers deviate from the dorsal column system to several distinct areas; the thalamus being the one of interest in this investigation. The collaterals involved project to additional nuclei in the thalamus besides those of the ventrobasal complex. These collateral fibers subservice the functions of:

(a) localized segmental reflexes in the cord, (b) cerebellar reflexes that help to coordinate motor movements in the body, and (c) tegmental and thalamic responses that are probably at least partially responsible for the conscious perception of sensations (25).

All the way from the origin of the dorsal columns to the cerebral...
cortex, a distinct spatial orientation of the fibers from individual parts of the body is maintained. The fibers from the lower parts of the body lie toward the center of the dorsal columns, while those that enter the dorsal columns at progressively higher and higher levels form successive layers to the lateral sides of the dorsal columns.

In the thalamus, the distinct spatial orientation is still maintained, with the tail end of the body represented by the most lateral portions of the ventrobasal complex and the head and face represented in the medial component of the complex. However, because of the crossing of the medial lemniscs in the medulla, the left side of the body is represented in the right side of the thalamus and the right side of the body is represented in the left side. In a similar manner the fibers passing to the cerebral cortex also are accurately spatially oriented so that a single part of the cortex receives signals from a discrete area of the body.

Each time a point in the periphery is stimulated, a signal ordinarily is transmitted all the way to the somesthetic cortex. And, if this peripheral stimulus increases or decreases in intensity, the intensity of the signal at the cerebral cortex appropriately increases or decreases in intensity. In addition, when a discrete area of the body is stimulated, the signal from this area is transmitted to a discrete area of the cerebral cortex. Thus, the dorsal column pathway is adequately organized for transmission of accurate information from the periphery to the sensorium. Furthermore, the responsiveness of this system can be altered only moderately by stimuli from other areas of the nervous system. Hence, alteration (as in acupuncture) would have to occur within the pathway, itself. An investigation into the basic organization of the neuronal circuit of the dorsal column system would, therefore, serve as a basis in analyzing possible means
of alteration.

The steps involved in the transmission of a pinpoint stimulus signal to the cortex are illustrated in Figure 20, showing that at each synaptic stage a moderate degree of divergence occurs. However, the upper part of the figure shows that a single receptor stimulus on the skin does not cause all the cortical neurons with which that receptor connects to discharge at the same rate. Instead, the cortical neurons that discharge to the greatest extent are those in a central part of the cortical "field" for each respective receptor. Thus, referring to Figure 20 once again, a weak stimulus causes only a few of the central neurons to fire. A moderate stimulus causes still more neurons to fire, but those in the center still discharge at a considerably more rapid rate than those farther away from the center. Finally, a strong stimulus causes widespread discharge in the cortex, but again rapid discharge of the central neurons in comparison with the peripheral neurons. The thalamus apparently serves as a "filter-mechanism" which allows for both the amount of intensity registered as well as its areas of discharge in the cortex.

As was pointed out earlier, the spinothalamic system transmits sensations that do not require rapid transmission nor highly discrete localization in the body. These include pain, heat, cold, crude touch, crude pressure, and sexual sensations.

Figure 21 illustrates the spinothalamic pathway. On entering the cord through the posterior roots, the pain and temperature fibers travel upward in the tract of Lissauer for one to three segments and then terminate on second order neurons in the gray matter of the dorsal horns. The fibers from these then form the lateral spinothalamic tract that passes all the way to the thalamus. Almost all the fibers cross through the anterior
commissure of the cord gray matter immediately after their origin and pass to the opposite lateral column of the spinal cord.

The fibers subserving the senses of touch and pressure first enter the dorsal columns, then travel upward as much as six segments or downward as much as two segments before ending on second order neurons located in the dorsal horns. Fibers from these cross through the anterior commissure to the opposite anterior column and form the ventral spinothalamic tract that also passes all the way to the thalamus.

Both the ventral and lateral spinothalamic tracts terminate in the posterior portion of the thalamus in close association with the dorsal column pathway. In fact, some of the fibers pass directly to the ventrobasal complex, the major terminus of the dorsal column pathway, but many of the fibers also end in an area of the posterior nuclei of the thalamus that lies between the ventrobasal complex and the medial geniculate body. In their passage through the brain stem these tracts are joined by the bulbothalamic tract, which arises in the spinal nucleus of the fifth nerve and transmits sensations from the head comparable to those transmitted from the body by the spinothalamic tracts.

Both the dorsal column pathways and the spinothalamic pathway terminate in the cerebrum in somatic sensory areas I and II.

Third order neurons project from the thalamus to both somatic sensory areas of the cortex. Though a few of these project from the ventrobasal complex of the thalamus to somatic sensory area I along with the fibers of the dorsal column pathway, most of them probably project from the posterior nuclei of the thalamus to somatic sensory area II. ...Sensory area I is principally concerned with sensations transmitted in the dorsal column system while somatic sensory area II is principally concerned with impulses transmitted in the spinothalamic system (25).

Figure 22* illustrates the two somesthetic cortical areas.
Somatic sensory area I lies in the postcentral gyrus of the human cerebral cortex. A distinct spatial orientation exists in this area for reception of nerve signals from the different areas of the body. Figure 23 illustrates a cross-section through the brain at the level of the postcentral gyrus, showing the representations of the different parts of the body in separate parts of somatic sensory area I. It must be noted, however, that each side of the cortex receives sensory information almost exclusively from the opposite side of the body except for a small amount of sensory information almost exclusively from the opposite side of the face. Decussation of fibers (crossing over) which occurs in all spinal sensory tracts is the factor which brings this about.

Some areas of the body are represented by large areas in the somatic cortex—the lips by far the greatest area of all, followed by the face and thumb—while the entire trunk and lower part of the body are represented by relatively small areas. The sizes of these areas are directly proportional to the number of specialized nerve endings (mainly Meissner's corpuscles) in each respective peripheral area of the body. For example, a great number of specialized nerve endings are found in the lip and thumb, while only a few are present in the skin of the trunk.

B. The "Second Gate Theory"—Blockage of Pathways in the Thalamus

Dr.'s Calvin H. Chen and Pang L. Man have proposed that there may be a second gate in the thalamus that closes to prevent pain sensations from reaching the cerebral cortex from below or above the level of the spinal cord. It is their belief that the thalamus is essential in acupuncture pathways since certain thalamic nuclei serve as relay stations on pathways to the cerebral cortex. As previously discussed, the nuclei which serve in a relay capacity are the ventral, (lateroventral, posteroverentral, anter-
oventral) nuclei, the medial and lateral geniculate bodies (part of the ventrolateral nuclear complex), the pulvinar (also part of the ventrolateral nuclear complex), the anterior and the dorsomedial nucleus. Chen and Man, for the most part, dismiss the "spinal-gate theory" as not being specific enough in explaining how pain sensations are either significantly reduced or totally obliterated with acupuncture. Their investigations have shown that "thalamic cell units" exist in the relay nuclei. These unit cells fire when impulses from the spinothalamic tracts, dorsal column system and other "thalamic tracts" reach the thalamus. If the thalamic-firing units do not "fire", then the transmission of the "mechanoreceptive somatic sensations" could not take place. Their report is based upon microelectrode studies in 13 patients. 10 of these patients had Parkinsonism, 2 had dystonia, 1 had tremor secondary to multiple sclerosis and 1 had resting tremors of obscure etiology. The sensations which were recorded almost precisely paralleled the types of sensations which are transmitted by the dorsal column system and the spinothalamic system. Localized touch sensations, vibratory sensations, kinesthetic sensations, muscle sensations, and fine pressure sensations were recorded with a microelectrode in direct contact with a specific thalamic "relay" nucleus. The same microelectrode also elicited different sensations when in contact with different thalamic nuclei or different locations on the same thalamic nuclei. These sensations included pain, heat and cold, crude touch, crude pressure and tickling. All research was carried on at the Northville State Hospital in Michigan during surgery and with the complete prior approval of the patients.

Both Dr. Chen and Dr. Man are continuing their studies in hopes of finding additional evidence as to the existence of thalamic-firing units.
which in actuality constitute a "second gate." Their present conclusions are best summarized by the following:

It appears quite logical to assume that thalamic cell units must exist. If inhibition of these units is to occur, appropriate and relative inhibition of the affected sensation would similarly occur. It also should follow that variations in the intensity of the sensations received at the thalamic nuclei in question may similarly occur. Both the complete inhibition and a fluctuation in intensity may be achieved by acupuncture, and the specificity of the acupuncture point in question would be paralleled by an equal specificity of the thalamic nucleus involved and its thalamic cell unit. 

As to an explanation of the segmental reflexes, the thalamus is a recipient of collaterals from the spinal tracts and they would coordinate any degree of inhibition. 

Treatment of auditory difficulty also refers back to the thalamus (medial geniculate). Eye pathology may very well be alleviated by acupuncture pathways as well.

The enormity of the collateral fibers and connections (thalamic) with the cerebellum, basal ganglia and hypothalamus must inevitably contribute to the complexity of the pathways involved. Their involvement is most probable.

Further investigation will center on the ventrobasal complex of nuclei (in the thalamus). Since their response is reflective of the head (from the main sensory nucleus of the trigeminal nerve), it is a natural continuum (28).

Unfortunately, the latest investigations by Chen and Man have yet to be reported. This author is of the opinion that they will fall in line with the previous investigations. But, conjecture about the ventrobasal complex as well as the strategically important collateral connections will have to suffice for the present. As previously stated the fibers from the main sensory nucleus of the trigeminal nerve subserve the same sensory functions for the head that the dorsal column fibers subserve for the body. This fact undoubtedly must have presented itself to Chen and Man when they alluded to that nucleus as a "natural continuum." The collateral involvement is an immeasurably important link since inter-segmental reflexes are an integral part of acupuncture pathways. Since spatial orientation is
maintained in the thalamus from the dorsal column system, it would be reflective of "the area" of the involvement; not the acupuncture point which, in turn, has a direct influence on that area.

In the final analysis of the "second gate theory", it is now clear that the "filter mechanism" role (which was discussed in reference to figure 20) of the thalamus is dependent upon which thalamic nuclei are involved and which units are utilized the most. And acupuncture would serve primarily to reduce the "strong stimulus"; hence inhibiting the involved thalamic cell units. In addition, the collateral fibers which deviate from the dorsal column system to subserve the function of segmental reflexes in the cord, would also relate back to the spinothalamic tracts since they all enter the dorsal root and spinal ganglion, as well as contribute fibers to the ventrobasal complex. The head is supplied with fibers from the main sensory and spinal nucleus of the fifth cranial nerve; which serves to complete the body innervation for the senses discussed. Hence, there is a system present in the thalamus which allows for the transmission of a pinpoint stimulus signal to the cortex. And, whenever this pinpoint stimulus is substituted with an acupuncture needle (assuming that the stimulus is at an acupuncture point), then the stimulus itself is referred back to the "target area" of the acupuncture point and is altered in quality and intensity.

VII. The "Total Mechanism" Theory

This paper has thus far analyzed possible mechanisms of acupuncture that have previously been investigated; and indeed are still under investigation. It has also concerned itself with the author's contributory theories. All of the material that has been presented poses valid arguments. Therefore, an integrative investigation would appear to be a log-
ical way to focus in on a cumulative or "total mechanism" theory. It is, in fact, the opinion of the author that all of the mechanisms investigated contribute significant input into a total theory.

The spinal-gate theory was discussed in section IIIC in a superficial manner since an adequate knowledge of its resultant implementation requires the additional subsequent material investigated. It was stated that essentially two theories exist (concerning the blocking of pain in the spinal cord) which are both dependent upon nerve endings at the acupuncture point itself. Most of the initial research which comprise the resulting theories was carried on by Dr. Ronald Melzack (professor of psychology at McGill University and Dr. Patrick Wall (professor of biology at the Massachusetts Institute of Technology). Their theories were essentially comprised from the previously known specificity and pattern theories; with additions and deletions made whenever they felt the need.

The specificity theory presents the concept of a fixed, direct-line nervous system: since the

(Specificity theory) proposes that a mosaic of specific pain receptors in the body tissue projects to a pain center in the brain. It maintains that free nerve endings are pain receptors and generate pain impulses that are carried by A-delta and C fibers in the "infinite" peripheral nerves and by the lateral spinothalamic tract in the spinal cord to a pain center in the thalamus. Despite its apparent simplicity, the theory contains an implicit statement of physiological specialization and an implicit psychological assumption. Consider the proposition that the skin contains "pain receptors," To say that a receptor responds only to intense, noxious stimulation of the skin is a physiological statement of fact; it says that the receptor is specialized to respond to a particular kind of a stimulus. To call a receptor a "pain receptor," however, is a psychological assumption; it implies a direct connection from the receptor to a brain center where pain is felt, so that stimulation of the receptor must always elicit pain and only the sensation of pain. This distinction between psychological assumption also applies to peripheral fibers and central projection systems (29).
This analysis of the specificity theory by Melzack and Wall disputes the assumption of a direct-line, fixed communication system from the skin to the brain. In refuting such a concept, Melzack and Wall have analyzed various clinical syndromes; which, in turn, have a direct impact on the author's "total mechanism" theory.

Melzack and Wall have analyzed the pathological pain states of causalgia (a severe burning pain that may result from a partial lesion of a peripheral nerve), phantom limb pain (which may occur after amputation of a limb), and peripheral neuralgias (which may occur after peripheral nerve infections or degenerative diseases) to refute the specificity theory.

1) Surgical lesions of the peripheral and central nervous system have been singularly unsuccessful in abolishing these pains permanently, although the lesions have been made at almost every level. Even after such operations, pain can often still be elicited by stimulation below the level of section and may be more severe than before the operation.

2) Gentle touch, vibration, and other nonnoxious stimuli can trigger excruciating pain, and sometimes pain occurs spontaneously for long periods without any apparent stimulus. The fact that the thresholds to these stimuli are raised rather than lowered in causalgia and the neuralgias together with the fact that referred pain can often be triggered by mild stimulation of normal skin, makes it unlikely that the pains can be explained by postulating pathologically hypersensitive "pain receptors."

3) The pains and new "trigger zones" may spread unpredictably to unrelated parts of the body where no pathology exists.

4) Pain from hyperalgesic skin areas often occurs after long delays, and continues long after removal of the stimulus. Gentle rubbing, repeated pin pricks, or the application of a warm test tube may produce sudden, severe pain after delays as long as 35 seconds. Such delays cannot be attributed simply to conduction in slowly conducting fibers; rather, they imply a remarkable temporal and spatial summation of inputs in the production of these pain states (29).

In analyzing the physiological evidence present in the specificity theory, Melzack and Wall acknowledge that there is convincing physiological
evidence that specialization exists within the somesthetic system, but be-
lieve that there is none to show that stimulation of one type of receptor,
fiber or spinal pathway elicits sensations only in a single psychological
modality. They refer to investigations in search for peripheral fibers
that respond exclusively to high-intensity stimulation. For example, Hult
and McIntyre found only 7 out of 421 myelinated A fibers, and Maruhashi
found 13 out of several hundred. In addition, Douglas and Ritchie failed
to find any high-threshold C fibers, while Iggo found a few. Consequently,
Melzack and Wall concluded that a small number of specialized fibers may
exist that respond only to intense stimulation; but it is more than likely
that they represent the extreme of a continuous distribution of receptor-
fiber thresholds rather than the special category of pain.

In disputing the specificity theory even further, Melzack and Wall
cite evidence that central nervous system pathways have specialized func-
tions that play a role in pain mechanisms. Most significant is the fact
that surgical lesions of the lateral spinothalamic tract or thalamus may
abolish pain of pathological origin; but they also reduce the total number
of responding neurons. This serves to change the temporal and spatial re-
lationships among all ascending systems; affecting the descending feedback
that controls transmission from peripheral fibers to dorsal horn cells.
In addition, it was pointed out that the nature of the specializations of
central cells remains elusive despite the large number of single-cell stud-
ies. For example, cells in the dorsal horns and the trigeminal nucleus re-
spond to a wide range of stimuli and respond to each with a characteristic
firing pattern.

The pattern theory is in actuality comprised of theories which devel-
oped in opposition to the specificity theory. The hallmark of the result-
ant theory is the recognition of the concept of patterning of the input.
The pattern theory of Weddell and Sinclair is based on the earlier sugges-
tion, by Rafe, that all cutaneous qualities are produced by spatiotemporal
patterns of nerve impulses rather than by separate modality-specific trans-
mision routes. The theory proposes that all fiber endings (with the ex-
ception of those that innervate hair cells) are alike, so that the pattern
for pain is produced by intense stimulation of nonspecific receptors. How-
ever, Melzack and Wall cite physiological evidence which has revealed a
high degree of receptor-fiber specialization. They believe that it is more
reasonable to assume that the specialized physiological properties of each
receptor-fiber unit—such as response ranges, adaptation rates and thresholds
to different stimulus intensities—play an important role in determining
the characteristics of the temporal patterns that are generated when a
stimulus is applied to the skin.

Other pattern theories have been proposed which stress central sum-
mation mechanisms rather than excessive peripheral stimulation. Livingston
first suggested that specific neural mechanisms account for the remarkable
summation phenomena in clinical pain syndromes. He proposed that intense,
pathological stimulation of the body sets up reverberating circuits in
spinal internuncial pools or "evoke spinal cord activities such as those
reflected by the dorsal root reflex, that can then be triggered by normally
non-noxious inputs and generate abnormal volleys that are interpreted cen-
trally as pain (30)." Similar conceptual mechanisms were proposed by Hebb
and Gerard, who suggested that hypersynchronized firing in central cells
provides the signal for pain.

In relation to the theories of central summation, there is a theory
which states that a specialized input-controlling system normally prevents
summation from occurring and that destruction of this system leads to pathological pain states. Basically, this theory proposes the "existence of a rapidly conducting fiber system which inhibits synaptic transmission in a more slowly conducting system that carries the signal for pain. These two systems (are identified) as the epicritic and protopathic, fast and slow, phylogenetically new and old, and myelinated and unmyelinated fibers (31)." Under pathological conditions, the slow system establishes dominance over the fast; and the result is protopathic sensation, slow pain, diffuse burning pain or hyperalgesia.

Although Melzack and Wall acknowledge that the concepts of central summation and input control have shown "remarkable power" in their ability to explain many of the clinical phenomena of pain, they believe that a satisfactory general theory of pain is lacking. It has also been indicated that these mechanisms have not received any substantial experimental verification. Consequently, unsatisfied with their interpretations of both the pattern and specificity theories, Melzack and Wall have adopted their own explanation for the physiological "control" of pain. They have utilized recent physiological evidence on spinal mechanisms, together with the evidence demonstrating central control over afferent input, to provide the basis for a new theory of pain mechanisms (the gate control theory of pain) that is consistent with the concepts of physiological specializations as well as with those of central summation and input control.

In introducing their gate control theory of pain, Melzack and Wall refer to the origin of surface nerve impulses (the skin) and follow the ensuing transmission; developing theoretical concepts along the way:

Stimulation of the skin evokes nerve impulses that are transmitted to three spinal cord systems: the cells of the substantia gelatinosa in the dorsal horn, the dorso-
al-column fibers that project toward the brain, and the first central transmission (T) cells in the dorsal horn, we propose that (1) the substantia gelatinosa functions as a gate control system that modulates the afferent patterns before they influence the T cells; (2) the afferent patterns in the dorsal column system act, in part at least, as a central control trigger which activates selective brain processes that influence the modulating properties of the gate control system; and (3) the T cells activate neural mechanisms which comprise the action system responsible for response and perception. One theory proposes that pain phenomena are determined by interactions among these three systems (29).

The substantia gelatinosa consists of small, densely packed cells that form a functional unit extending the length of the spinal cord. The cells connect with one another by short fibers and by the longer fibers of Lissauer's tract, but do not project outside the substantia gelatinosa. Experimentation by Wall suggests that the substantia gelatinosa acts as a gate control system that modulates the synaptic transmission of nerve impulses from peripheral fibers to central cells. Since it is continuous with the nucleus of the spinal tract of the trigeminal nerve, this author believes that the "gate" is continuous in similar fashion.

Figure 24 shows the factors involved in the transmission of impulses from peripheral nerve to T cells in the cord. Melzack and Wall performed studies which have shown that "volleys" of nerve impulses in large fibers are extremely effective initially in activating the T cells; but their later effect is reduced by a negative feedback mechanism. In contrast, "volleys" in small fibers activate a positive feedback mechanism (mediated by cells of the substantia gelatinosa) which exaggerates the effect of arriving impulses. It was also determined (by Wall) that activity in these cells modulates the membrane potential of the afferent fiber terminals and thereby determines excitatory effects of arriving impulses. And it was Wall's conclusion that although there is only evidence for presynaptic

*Fig. 24-Pg. XXIV
control, there may also be undetected postsynaptic control mechanisms that contribute to the observed input-output functions.

Melzack and Wall further proposed that three features of the afferent input are significant for pain:

1) the ongoing activity which precedes the stimulus,
2) the stimulus-evoked activity, and 3) the relative balance of activity in large versus small fibers (29).

The spinal cord is continually bombarded by incoming nerve impulses even in the absence of obvious stimulation. This ongoing activity is carried predominantly by small myelinated and unmyelinated fibers, which tend to be tonically active and to adapt slowly, and it holds the gate in a relatively open position. When a stimulus is applied to the skin, it produces an increase in the number of active receptor-fiber units as information about the stimulus is transmitted toward the brain. Since many of the larger fibers are inactive in the absence of stimulus change, they believe that stimulation will produce a disproportionate relative increase in large-fiber over small-fiber activity. Thus,

if a gentle pressure stimulus is applied suddenly to the skin, the afferent volley contains large-fiber impulses which not only fire the T cells, but also partially close the presynaptic gate, thereby shortening the barrage generated by the T cells... If the stimulus intensity is increased, more receptor-fiber units are recruited and the firing frequency of active units is increased. The resultant positive and negative effects of the large-fiber and small-fiber inputs tend to counteract each other, and therefore the output of the T cells rises slowly. If stimulation is prolonged, the large fibers begin to adapt, producing a relative increase in small-fiber activity. As a result, the gate is opened further, and the output of the T cells rises more steeply. If the large-fiber steady background activity is artificially raised at this time by vibration or scratching (a maneuver that overcomes the tendency of the large fibers to adapt), the output of the cells decreases. (Thus), the effects of the stimulus-evoked barrage are determined by the total number of active fibers and the frequencies of nerve impulses that they
transmit, and the balance of activity in large and small fibers... (in addition) pain results after prolonged monitoring of the afferent input by central cells... we suggest, then, that there is temporal and spatial summation or integration of the arriving barrage by the T cells. (29).

Kuyper, Fleming and Sarinholt have firmly established that stimulation of the brain activates descending efferent fibers which can influence afferent conduction at the earliest synaptic levels of the somesthetic system. As a result, Melzack and Wall have proposed that a mechanism exists in the nervous system (which they call the "central control trigger") that activates the particular, selective brain processes that exert control over the sensory input (Refer, once again, to Fig. 24). They further state that there are two systems (or tracts) that could fulfill such a function: the dorsal column and lateral spinothalamic systems. In addition, it is hypothesized that the triggering of the action system by the T cells marks the beginning of the sequence of activities that occur when the body sustains damage. As a result, the final conclusion derived by Melzack and Wall is that the presence or absence of pain is determined by the balance between the sensory and the central inputs to the gate control system.

The dorsal column system (discussed in detail in section VIA) has been the subject of continued investigation as to its potential importance in analgesia:

Long-term stimulation of the dorsal columns has been proposed recently as a potential method for relief of pain. Acute electrophysiologic and chronic behavioral studies in animals suggested the possibility of this method. Further experimental studies confirmed its potential safety and have thus led to application in patients (30).

In analyzing the above practicality of the Dorsal Column System, Shealy, Mortimer and Reswick point out their interpretations of the lacking of peripheral nerve stimulation:
Since submission of the original paper on experimental observations, Wall and Sweeny have reported that peripheral nerve stimulation can produce specific focal analgesia and anesthesia. We have confirmed their results in 10 cases in which peripheral nerve stimulation was used. Frequencies of 20 to 100 cps, currents of 0.5 to 1 mA., and pulse widths of 0.5 msec. have resulted uniformly in analgesia of the nerve’s peripheral area of innervation. With stimulation of the peroneal nerve, however, no decrease in sensation could be elicited in the lateral part of the foot. This emphasizes the impracticality of peripheral nerve stimulation for relief of diffuse pain (31).

Shealy, Taslitz, Mortimer and Becker point out that since most intractable pain arises from diffusely involved structures, the logical approach is to concentrate on stimulation of the dorsal columns, where large fibers are compactly arranged, or on the spinothalamic tracts (lateral and ventral) where small fibers predominate. Their experimentation involved the inhibition of FSAD (prolonged small fiber afterdischarge), which they have determined is uniquely related to pain. The motivation for such experimentation was derived from work done by Melzack and Wall which showed that activation of the largest "surface" sensory fibers, the A-beta group, inhibits spinal input through the smaller pain fibers capable of evoking pain. Shealy and associates consequently concluded that stimulation of the dorsal columns of the spinal cord (which have almost pure beta input) might give significant relief of pain. Such stimulation would have the effect of totally "neutralizing" the small peripheral nerve fibers (A-delta, A-gamma and C) which are located within the spinothalamic tracts.

However, it should be noted that although the A-beta would be the only fibers stimulated in blocking out the effects of the small pain fibers, their function (touch and kinesthesia) would not be "perceived" at a greater level of intensity (32).

Although the various theories and experimentations that this author
has investigated relate to possible mechanisms that would function in relation to certain aspects of acupuncture, the author's "total mechanism" theory seeks to explain the entire "route" involved from the insertion of the acupuncture needle at any "recognized" point to its effect on a specific target area. The analgesic process of acupuncture is unquestionably initiated at the acupuncture point itself. Physiological effects of acupuncture (other than reduction or elimination of pain) are dependent upon the alteration of nerve impulses at the acupuncture point, too; however, alterations in the target areas or organs (other than analgesia) are undoubtedly "programed" via the autonomic nervous system.

From this author's analysis, the most logical initial formulation of the entire acupuncture pathway does result from a "neutralization" of the small peripheral fibers. Consequently, the pathway that reaches the spinal cord would follow either the "gate Control System" as described by Melzack and Wall; or a system of close similarity. Involvement of both the substantia gelatinosa and the "central control trigger" also appear to be both logical and applicable. It was, in fact, stated in section VII (pg. 51) that "visceral and somatic afferent fibers as well as suprasegmental axons from the brain send impulses to the nucleus proprius and reticularis of the posterior horn." In conjunction with that fact, autonomic connections were investigated; as well as the role of the arcuate fibers which probably serve as a "filter"; to either let messages pass through or not. Consequently, it was concluded that a "highway" exists within the spinal cord with a "pre-ordained" route functioning in facilitation with the autonomic nervous system; the intermediomedial nucleus serving as the most significant "channel." Involvement of the vagus and trigeminal nerves (as well as the mediolongitudinal bundle) were also considered essential
for the modification and "programing" of the pathway throughout the entire spinal cord; as well as integration with cranial nerves.

The "total mechanism" theory is also dependent on the "second gate" in the thalamus as presented by Mrs. Chen and Man. It is this author's contention that the "second gate" serves as a "refinement" vehicle. In other words, after the pathway "travels" along the "trans-spinal highway" for localization at a particular spinal segment (or cranial nerve), its final route to the brain itself is intercepted to allow for a specificity of function; i.e. a maintenance of pain inhibition, alteration of auditory nerve supply, alteration of joint nerve supply.

Consequently, the "total mechanism" theory is related to all of this author's previous investigations: from the acupuncture point itself (located within a particular spinal-segment related dermatome) to the ultimately perceived effect on the target area. And in all acupuncture pathways, the relationship between the central and autonomic nervous systems is almost "inseparable" (as the Southern California Acupuncture Study group has termed it).
VII. Explorations of the Practical Applications of Acupuncture
A. Accounts of Witnesses to Acupuncture (including Practitioners)

Although acupuncture is indeed an ancient Chinese art of medicine, both public and professional interest in its possible application to contemporary "western" medicine has received prominence in only the last few years; with perhaps the most significant "publicity" being derived from President Nixon's trip to China. However, interest in its practical application started to grow in significance at the very onset of this decade.

The fact remains that although acupuncture originated in ancient China, it has been under the leadership of Mao Tse-Tung, that China has utilized acupuncture as a practical form of medicine. The lack of "tradi-
tional medicine" in China fostered the development of acupuncture as a necessity.

The use of acupuncture as a general anesthetic, interestingly enough, is a relatively recent innovation, even in China. Certain points, such as 隔 to 隔 in the fleshy area between the thumb and forefinger, had long been used to treat toothaches, headaches, abdominal cramps and sore throats. Then, in the late 1950s, Chinese doctors reasoned that needling the same points might also prevent pain during surgery and began using acupuncture for tooth extractions and tonsillectomies. With experience, the acupuncturists gained enough confidence to use their needles in major operations (33).

Although a vast number of "witnesses" to acupuncture have been lay people, physicians' accounts invariably receive greater credibility. One of the most noted involved an observation of the removal of the lobe of one lung from a patient with tuberculosis at the Peking Medical College, which was observed by Dr. Sam Rosen (noted New York ear surgeon) and associates:

The acupuncturist carefully swabbed the patient's left forearm with alcohol (for antiseptic purposes) and then inserted a single needle midway between the wrist and elbow and began to move it up and down and to and fro between her fingers. After about twenty minutes, the patient said he felt the typical sensation of heaviness and numbness in the areas around the needles and the acupuncturist signaled the surgeon to go ahead... While Rosen and his colleagues looked on incredulously, the surgeon swiftly made a 1/4-inch incision running from the spine across the left side of the chest to the patient's breastbone. Then, with a scissors-like instrument, he cut away two ribs and inserted a chest retractor to spread open the rib cage and expose the lung. The patient, who happened to be a Western-style chest surgeon himself, kept up a steady stream of banter with his doctor. And at one point, the operation was interrupted so that he could eat some fruit. Throughout the two-hour procedure, the acupuncturist steadily manipulated the needle in the patient's arm. The patient, Rosen recalls, 'didn't jerk, move or sweat. He did nothing to indicate pain or discomfort (33).'

The maintainment of acupuncture is either by a twirling motion of
the needle or by electrical stimulation. Electrical stimulation originated in China in recent years and has grown in significance in western medicine, as well. The following observation by Mr. Walter Thach (President Nixon’s personal physician) and subsequent conversation with Mr. Wu (Chinese acupuncturist) illustrate the effectiveness and practicality of electrical stimulation:

The aging patient did not show the slightest grimace at the prick of either needle. It was as if he did not feel anything at all, or if he did, the puncture was less annoying than a mosquito bite. The acupuncturist then attached electrodes to both needles. They led to what I believe was a nine-volt battery capable of generating a pulsing current of 60 to 120 surges per minute... 'I had heard that the manual twirling of the needles throughout the operation was standard practice,' I said. 'Have these electrodes completely replaced it?' 'Some hospitals still do it by hand,' Mr. Wu replied. 'But you can see that there would be too many hands in the way if we twirled the needles all the time. There is a cable system that spins them mechanically. But here, a woman doctor suggested that we try electric current, and we did. We think it is superior (34).

Perhaps, the most noted non-physician’s experience with acupuncture was that of James Reston, (New York Times columnist); who had an emergency appendectomy performed in China under acupuncture anesthesia. Credence in a "new" medical anesthesia and treatment certainly could not have been more effectively presented to the "West." Another noted experience (in the amount of ultimate news coverage it received) was that of U.S. scientists Arthur Calston (of Yale) and Ethan Signer (of M.I.T.); who witnessed the removal of an ovarian cyst in Peking:

The patient, a woman of middle years, remained fully conscious throughout the operation. Anesthesia was achieved through the use of acupuncture, in this case a number of brass-handled metal needles inserted at her wrists. As the surgeons probed and cut, she showed no sign whatever of distress. When the baseball-sized cyst was finally removed, she asked to see it. The cyst was placed on a tray, and the patient examined it with
some interest (while the operation was still under way). An equally noted demonstration in Wanan, China (for visiting Canadian diplomats) was even more dramatic:

The (female) patient was on the table for open-heart surgery. ...The anesthetic was limited to acupuncture and the needles (were) inserted at a number of points in the patient's wrists and forearms. She lay fully conscious and completely composed as the surgeon's knife slashed into her chest cavity and the necessary rib bones were sawed through. At one point, a surgeon actually removed her heart and held it in his hand. The lady never batted an eyelid. Instead, as the operation progressed, she requested and was given some orange juice. She drank it with gusto, and later, her chest sewn up, was wheeled off smiling to her ward (35).

An enormous number of first-hand observers and patients have witnessed and experienced acupuncture (respectively) since the above accounts were noted. And, needless to say, the growth of acupuncture has almost entirely been dependent upon the accounts of these witnesses—both professional and lay.

B. Case Histories Explored

The credibility of any given science is in large part dependent upon proven evidence of its effectiveness. Acupuncture has unquestionably "met the test" in establishing its own credibility. A vast number of case histories substantiate the utilization of acupuncture in anesthesia, as well as in other "roles." The following ones have been reported to either the American Journal of Chinese Medicine or the National Institute of Health's Acupuncture Research Conference (held between February 28 and March 1, 1973):

1. Preliminary Findings with Acupuncture Treatment of Pain
   K.J. Seebe, T.W. Anderson, and L.M. Perkins

   ...Eighteen male veterans suffering from different types of chronic pain were treated (with) acupuncture. ...Approximately 60 percent of our patients experienced at least 50 percent relief of their pain (36).
2. **Therapeutic Effects of Acupuncture on Cases of Chronic Pain**
   James A. P. Chen

   This report deals with our preliminary results obtained with modernized Chinese acupuncture techniques during the last six months in small series of selected cases of chronic pain which responded poorly to conventional drug therapy and physiotherapy. The patients were selected from those with chronic pain due to migraine headaches, cervical syndrome, osteoarthritis of the knee and peptic ulcer. The overall results, based on pain relief indicate that acupuncture is effective in at least 70% of the cases in this study (37).

3. **The Effects of Acupuncture in Rheumatoid Arthritis**
   Ephraim P. Engelman

   Of seven patients whose trial with acupuncture is complete, one "felt better" during one five-week period of acupuncture while four noted sustained subjective improvement through both five week periods (38).

4. **Clinical Evaluation of Acupuncture in Chronic Musculoskeletal Pain and Osteoarthritis**
   Teruo Matsumoto, Victor Ambruso, and Martin F. Hayes, Jr.

   Prior to acupuncture, acupuncture points for the specific pain obtained by a Chinese textbook revealed a marked decrease in skin resistance and proved to be the most tender point. Acupuncture on the specific points, once every other day, for five times, produced marked reduction in chronic pain in 40 of the 50 patients (80%) while five applications of acupuncture at non-specific points did not reduce pain at all. The best results were obtained when manual stimulation was given and (the) patient felt a "needle feeling." Electric acupuncture with 200 microamperes D.C. current, for ten seconds, which caused a deep radiating acheing, also proved to be effective (39).

5. **Evaluation of the Therapeutic Effect of Acupuncture**
   Kinichi Shibu}

   The change in blood pressure, plethysmographic pulse wave and skin temperature were observed during the treatment with acupuncture. The blood pressure was taken before and after the treatment. Usually there were reductions of systolic blood pressure in the magnitude of 10 to 30 mmHg. The reduction of diastolic pressure and pulse rate were minimal. The magnitude of the change was different from person to person. Improvement of skin temperature and plethysmographic pulse waves were observed in the extremities of patients with
poor peripheral circulation. It was common to observe the patient with rheumatoid arthritis or osteoarthritis having cold feet. Circulatory inadequacy was manifested in terms of edema, skin lesions, and capillary dilatation. During the course of the treatment with acupuncture, an improvement of the skin lesion and a disappearance of edema was noted, and the patient felt warm during the winter season. In two patients with established diagnosis of reflex sympathetic dystrophy of the upper extremities, acupuncture therapy was followed by alleviation of pain, improvement of the motion of the joints, disappearance of edema, and improvement of the demineralization pattern of the carpal bone in x-ray. The circulatory change that follows acupuncture may be partially responsible for the improvement of the pain in the patient with reflex dystrophy, rheumatism, and osteoarthritis (40).

6. Dorsal Column Electrostimulation and Changes in Somatosensory Thresholds
Paul B. Nelson, Robert W. Brennan, Lillian M. Pubols, Richard M. Bergland

Dorsal column electrostimulation is presently under clinical trial in the management of intractable pain. Stimulation of this large fiber somatic afferent system may inhibit spinal input from smaller pain carrying fibers as proposed in Melzack and Wall's gate control theory of pain. We have studied somatosensory thresholds in six patients with dorsal column stimulators. Preliminary studies of thresholds for joint position sense, two-point discrimination, and touch-pressure showed no significant change. Pain thresholds measured by a pressure-pain probe and by a thermal pain device showed no change. Cutaneous vibratory thresholds increased by 50 to 300% in four patients with dorsal column stimulation at levels adequate to modify pain. Of the two patients who showed no vibratory threshold changes, one proved to have a malfunctioning electrode; the other patient had an underlying severe diabetic neuropathy.

A significant therapeutic effect was obtained in seven of ten patients with dorsal column stimulators. Where it has been measured, the magnitude of vibratory threshold change correlates with therapeutic response. These threshold changes probably reflect partial occlusion of first order afferent activity and may be requisite for therapeutic effect. Vibratory threshold measurements provide an objective index in the evaluation of proper placement and functioning of dorsal column stimulators (41).

7. Efficacy of Acupuncture for the Treatment of Sensorineural Deaf
Frederick F. Yao, Robert H. Baker, Jr., Soon Jack Leung

Five male and female Caucasian patients of various ages with sensorineural hearing loss were treated with acupuncture according to the methodology carried out in the People's Republic of China. All patients were examined by X-ray in addition to biochemical and physical examinations. The efficacy of acupuncture lies in its ability to improve speech discrimination, as well as Spondee speech thresholds. In addition, improvement in tone decay was evidenced using the Owens tone decay results... Caution was exercised on drawing a definitive conclusion, as this study consists of only five patients. More patients are being studied and experiments are being designed to examine the mechanisms of the action of acupuncture as related to the improvement of the hearing ability of patients with sensorineural deafness (42).

Additional clinical results were established in such topics as:

"Acupuncture Anesthesia in Herniorrhaphy (43);" "Acupuncture Treatment for Pain Syndrome-Treatment for Sciatica (44)," and "Obstetric Acupuncture Anesthesia (45)." The variances of acupuncture application, as can be seen in this clinical research approach, is enormous. There is no question in this author's mind, but that the autonomic nervous system is integrally involved in all of the above cases (see section VIII).

VIII. Conclusion-Effectiveness of Acupuncture and validity of its Relationships to Dermatomes, The Autonomic Nervous System and Blocked Pain Pathways

In order to correlate this author's investigation with the expertise of physicians intimately involved in the actual application of acupuncture (as well as continued research), a list of pertinent questions was posed to 6 of these prominent men: Dr. Lester Mark (Anesthesiologist-Columbia College of Physicians and Surgeons), Dr. John W. C. Fox (Anesthesiologist-Dowstate Medical Center), Dr. Calvin H. Chen (Anesthesiologist-Northville State Hospital); Dr. Ronald L. Katz (Anesthesiologist-Columbia College of Physicians and Surgeons), Dr. Maxwell Spring (Anesthesiologist-New York City), and Dr. Patrick Wall (Research Biologist-now of university
College in London; holds medical degree. Mrs. Mark and Fox were interviewed in person, while the remaining physicians replied by mail. All of these noted authorities replied to the same series of questions. Each of the author’s questions will follow with a summary of the viewpoints enunciated by each of the respondents.

1. Do you believe that there is a relationship between acupuncture points and the autonomic nervous system?

All of the respondents answered affirmatively.

2. Do you believe that there is a relationship between acupuncture points and the dermatome chart?

All of the respondents answered affirmatively.

3. Is anesthesia caused by a "jumbling" of nerve impulses to the brain at a specific acupuncture point or is it caused by the over-stimulation of the A-beta fibers in the sensory nerves (also at a specific point), closing a hypothetical gate in the spinal cord? Or perhaps, is it a combination of both?

Mrs. Mark, Fox, Chen, Spring and Wall expressed a belief in a combination of both over-stimulation and a hypothetical gate; with the former precipitating the latter. Dr. Katz, while expressing the possible existence in both "overstimulation" and a "gate," indicated that additional possibilities should also be investigated.

4. Is there also validity in the existence of a second gate in the thalamus of the brain that closes to prevent pain sensations from reaching the cerebral cortex?

All physicians, with the exception of Dr. Spring, expressed interest in the "second-gate" theory as proposed by Mrs. Man and Chen. (Dr. Chen, of course, defended his theory.) Dr. Spring wanted more "proof."
5. Are the traditional acupuncture charts accurate or does their validity vary among different patients (especially non-Mongoloids)?
All of the respondents answered affinitively.

6. One possible explanation for the way acupuncture works to combat infectious disease has been suggested recently by studies in China, showing that needling raises the level of bacteria-fighting white blood cells. What is your comment on this development?

All physicians expressed a definite doubt about this possibility; believing that acupuncture is strictly a "neural phenomenon."

7. Is it true that acupuncture is not effective in abdominal surgery since the abdominal muscles are too tense?
All respondents agreed that although acupuncture anesthetizes abdominal muscles (if the appropriate points are utilized), it does not "relax" the muscles in the way that general anesthesia does.

8. Is it difficult to keep patients sufficiently relaxed during an operation? And won't they have a tendency to move, hampering the efforts of the surgeon? And is there a pre-operative anesthetic employed (i.e., dental)? Also, is there a possibility of an autohypnotic effect?

The general consensus of opinion was that virtually all patients seen or treated by the respondents were "quite" relaxed. In addition, the effective "numbness" of the "target area," was considered sufficient enough to prevent excess movement. Dr.'s Fox, Mark and Chen indicated that they have utilized pre-operative anesthetics with regularity preceding acupuncture; but at a much reduced level from the amount used without acupuncture anesthesia. And all respondents acknowledged that a modified, varied autohypnotic effect may exist in any given patient; however, as Dr. Fox noted: "It's actual effect is insignificant."
9. Do you employ the examination of the pulse as prescribed in the "Nei Ching"? And do you consider its use to be valid?

None of the respondents use "the pulse" and none consider it to be a valid diagnostic tool.

10. What diseases can be arrested or cured by acupuncture (before permanent damage is done)? For example: Can deafness be cured?—And, if so, how? Can arthritis be cured?—And, if so, how?

The consensus of opinion is best summed up by Dr. Spring: "I do not believe that deafness, arthritis or any disease can be cured by acupuncture—just relieved; nature will do the rest." And Dr. Fox spoke about the possibility of a direct relationship between a "reduction in pain impulses and healing."

11. Is moxibustion as effective as acupuncture and when would it be preferable to acupuncture?

All of the respondent physicians expressed skepticism about the effectiveness of moxibustion; even though all, except Dr. Katz, had utilized it at least once.

12. What is the technique of needle insertion? How long does it usually take to anesthetize the patient?

Insertion techniques paralleled the method discussed in section III. The duration of time needed to anesthetize a patient was established as 20 to 30 minutes by all the physicians except Dr. Katz, who considered it to be 20 to 40 minutes.

13. Is a constant twirling motion necessary to maintain anesthesia?—Or is an electric current as effective?

Both methods were acknowledged as equally favorable by all physicians except Drs. Katz and Fox, who considered electric current utilization to be
a more static and realistic method.

14. In all treatment, which is more effective—hand twirling of the needles or electric current?

The same opinions were presented for "all" treatment as they were for anesthesia in question 13.

15. Are skin-conductance measurements effective in locating acupuncture points? And do acupuncture points always have higher skin conductance than the surrounding area?

All of the respondents utilized (with varying frequency) skin-conductance measurements. Mr. Fox appeared to rely on its usage the most and the following information comes from a "fact-sheet" for the Royer-Anderson Skin Conductance Meter, which he gave me at the time of my personal interview with him:

Skin-conductance measurements have been applied to acupuncture in several different ways. Several sources indicate that the acupuncture points have higher skin conductance than the surrounding area. In using the instrument to find points of maximum skin conductance, one must take care not to be confused by skin-conductance variations caused by sweat-gland activity... A second application uses the numerical value of skin conductance found at acupuncture points. Some work indicates that there is a link between certain diseases and the conductance variations found at certain specific acupuncture points. The Royer-Anderson Skin Conductance Meter permits the measurement of these skin-conductance values.

Mr. Fox, as well as the other "experts" responding to my questions, all agreed that the evidence that acupuncture points have higher skin conductance is very substantial.

16. Is it valid to say that certain points (or the type or depth of the needle) stimulate particular organs or parts of the body while other points (or the type or depth of the needle) diminish the use of these same organs or parts of the body (following the ancient theories of Yin, Yang and Tao...
as expounded in the "Nei Ching."?

The respondents indicated that each individual point definitely has a particular target area or organ. However, they pointed to a lack in definitive proof as to alteration in that target area as far as stimulation or lack of normal stimulation is concerned. Dr. Mark remarked that "anesthesia is the prime effect of acupuncture and any therapeutic results of acupuncture are directly related to anesthesia." Dr. Fox expressed a definite skepticism concerning the ancient Chinese philosophy of Yin, Yang and Tao:

Every medical science must have its background philosophy and acupuncture is no exception. However, in the case of acupuncture the philosophy is not medically oriented and has no direct influence on the present application; which is a direct result of Mao's revival of acupuncture... As far as the philosophy of Tao is concerned, it is applicable only in the sense that health is achieved (whether it's in ancient or modern-day men) by a balance—a homeostasis—in the body... Acupuncture can help achieve that homeostasis by reducing pain and by treating specific ailments by reducing or eliminating the pain syndrome surrounding that ailment. (47).

17. Has acupuncture been successfully used in treating animals? And are there acupuncture charts for certain animals?

There was total acknowledgment that acupuncture is being used in research on animals and equal acknowledgment of the existence of acupuncture charts for animals. Dr. Fox best explained the existence of the animal acupuncture charts in the following:

Nerve fiber components are similar in all mammals... by locating the higher conductance areas in experimental cats and dogs, we did, in fact, locate acupuncture points... Charts are being derived from this experimentation... An elephant acupuncture chart from ancient India has recently been discovered. (47).

18. Can acupuncture be used to successfully treat certain nervous disorders?

Dr. Chen indicated that the possibility exists—via a sympathetic nervous
system component of acupuncture. All expressed interest in the possibilities of acupuncture in this area, with Mr. Spring focusing a special interest on the effectiveness of acupuncture in overcoming severe depression.

19. Can acupuncture be used effectively to treat heart disease?

No "known" treatment was reported by any of the physicians,

20. Can acupuncture be used effectively as anesthesia in childbirth?

And if so, how?

All respondents acknowledged that acupuncture has been used in childbirth, with Mrs. Chen, Spring, and Fox noting its greatest importance is in caesarean sections.

When research for this paper began, the only established theories and experimentation on acupuncture (which sought to formulate a mechanism to neurologically explain its effects) were those of Melzack and Wall, and Chen and Man. But, the fact that these theories did not fully explain the entire phenomenon of acupuncture motivated a more intricate study into the various "missing links" of the "total mechanism." It was assumed that the philosophical basis of acupuncture had no practical value (from the onset of this paper) and the subsequent investigations (including the preceding responses) substantiated this initial premise. Consequently, the focus of this author's investigation was on "methods" not previously investigated to any "noted" degree. A relationship between acupuncture points and the autonomic nervous system appears to be unquestionable; and since the responding authorities on acupuncture have agreed with this conclusion "credence" has been added to it. The same validity is quite evident as far as the dermatome chart is concerned; however, the main premise behind locating an acupuncture point within a specific dermatome is to "monitor" the pathway involved to the specific spinal segment (referred to by the
dermatome), the "new" proposal by the author is, of course, the role of the autonomic nervous system after the pathway leaves the spinal segment, which takes place in both the sympathetic and parasympathetic divisions. It is indeed the autonomic nervous system which encompasses the "missing links" which would allow for a complete "trace" of acupuncture pathways within the last two years, interest in autonomic involvement in acupuncture has grown significantly in acupuncture research. Perhaps the most important revelation is acknowledgment of the sensory role of acupuncture which may be very extensive:

...we began to wonder if our current view of the autonomic nervous system represents only the tip of an iceberg. Several decades of complacency were recently jolted when it was discovered that the "stupid" and mechanical autonomic nervous system could respond predictably to volition, and now phrases like "biofeedback," "visceral learning," and "autogenic training" have become quite popular. Even more astounding could be the realization through acupuncture investigations that the autonomic nervous system, which has always been described and defined as a purely motor system, may have a generalized role in sensory function, as well (48).

However, the fact remains that many present conclusions about the "extended roles" of acupuncture were derived from research decades old, which were previously disregarded; for example:

The existence of pain-conducting autonomic pathways in the head and neck is not as well demonstrated as in the abdomen and thorax, but significant clinical observations and experimental evidence point to the presence of afferent fibers in the autonomic nerves of these regions. Broder in 1932 and Harris in 1936 interrupted somatic sensory nerves to the head, neck, and extremities by extirpation of the splanchnic ganglion and by posterior rhizotomy, and still observed residual pain which must have been transmitted by autonomic nerves which had been left intact in these cases (31).

The above observations are interesting in view of the multiple meridian points for acupuncture on the face and ear and may well be explained
by Chusid in his 1970 book, Correlative Neuroanatomy and functional Neurology, even though he repeats the dictum that the Autonomic Nervous System "by definition" must still be considered a motor (efferent) system.

The autonomic supply to the head deserves special consideration. The skin of the face and scalp receives sympathetic innervation from the superior cervical ganglion via plexuses extending along the branches of the external carotid artery. The intrinsic muscles of the eye, salivary glands, and mucous membranes of the nose and pharynx, however, receive a dual autonomic supply. This is mediated via four pairs of cranial autonomic ganglia, each of which receives a sympathetic, a parasympathetic, and a sensory root (49).

Of further interest, is a report in late 1971 by Diamond. In that report (on "Acupuncture Anesthesia"), the noted anesthesiologist described research efforts at the Peking Medical College which had confirmed groupings of vagal nerve endings (parasympathetic fibers) in the pina of the ear by myelin sheath staining. When a localized collection of such endings was stimulated, "electrical resistance" was changed over the abdomen, perhaps suggesting for the first time a possible general neural mechanism for acupuncture anesthesia. (Note that this significant report was published for the December 6, 1971 issue of the Journal of the American Medical Association.)

As previously indicated, this author is in basic agreement with Melzack and Wall's spinal-gate theory; especially in reference to the overstimulation of the A-beta fibers. However, it is lacking in coordination with the other major influences previously discussed. In the same respect, Chen and Nan's "second-gate" theory does not acknowledge other possibilities; although their theory is extremely valid as a part of the author's "total mechanism" theory. The major "missing link" which integrates these two contributory theories and allows for coordination by the autonomic nervous system is the "highway system" discussed in detail in section VI. The tot-
al summation of the intersegmental connections which comprise the resultant “highway system” are known as propriospinal fibers.

About half of all the nerve fibers ascending and descending in the spinal cord are propriospinal fibers. These are fibers that run from one segment of the cord to another. In addition, the terminal fibrils of sensory fibers as they enter the cord branch both up and down the spinal cord, some of the branches transmitting signals only a segment or two in each direction, while others transmit signals five or more segments. These ascending and descending fibers of the cord enter into multisegmental reflexes, including many reflexes that coordinate movements in both the forelimbs and hindlimbs simultaneously (18).

A most important investigation into the very vast importance of the propriospinal fibers was recently completed by Dr. Irving Wagnan of the University of California Medical School in Davis. The results of that investigation support this author’s ultimate contentions about the presence of a continuous, interrelated “total mechanism.” In addition, Dr. Wagnan stressed that propriospinal inhibition and thalamic functioning are interrelated.

Studies on spinal cats were performed to determine the effects of single stimuli to dorsal and lateral columns of the thoracic spinal cord on the responses of single cells of the dorsal horn elicited by peripheral afferent nerve stimulation...

In every case, stimulation of the rostral cord inhibited a subsequent response to stimulation of either the same site or a peripheral afferent. A dorsal column stimulus inhibited a test response of a cell to peripheral stimulation for more than 500 msec in some cases. Lateral column stimulation also produced long lasting inhibition of dorsal horn unit responses but the effects were more variable. Prolonged discharge of the dorsal horn cells evoked by peripheral stimulation was more susceptible to dorsal column stimuli than was the initburst...

The duration and magnitude of the inhibition following single stimulation of the rostral spinal cord were greater than that reported following stimulation of peripheral A-fibers or supraspinal structures. It is proposed that much of the inhibition is mediated through propriospinal connections which may receive input from primary afferents, descending fibers, and spinal interneurons, providing for longitudinal integration of sensory infor-
mation along the spinal cord...

Inhibition of dorsal horn output can also be brought about by the presynaptic gate mechanism. Inhibition, no matter what its basis, should be reflected in thalamic responses. Furthermore, thalamic inhibition may also be mediated via a more direct dorsal column—laminar input. At present we do not know whether one or more of these mechanisms is at the basis of our further observation that those cells in the posterior group of thalamic nuclei, which respond only to noxious stimulation (i.e., skin pinch), can be inhibited significantly by stimulation of the contralateral dorsal column. Both the resting spontaneous activity of these thalamic cells and the discharge due to noxious stimulation can be inhibited for a duration of fifty msec to one second following a single shock to the contralateral dorsal column. Stimulation of the latter at frequencies of 10, 30, and 50/sec also markedly reduces the overall activity of the cells of the posterior thalamic nuclei (50).

As indicated previously, the cat spinal cord (utilized in the above experimentation) is remarkably similar to the human spinal cord.

An additional strategic experiment, again utilizing cats, was conducted recently by Linzer and Attie at Oberlin College. The results of their experimentation support this author's contention about a "pre-ordained" acupuncture pathway in effect from "start to finish", as well as show consistency with Chen and Man's "second gate" theory. Their ultimate conclusion is that a "neural code" for pain exists at the thalamic level.

Although the functional role of the thalamus in pain perception has been amply indicated by numerous investigators, single-unit analyses have located few thalamic neurons which respond exclusively to noxious stimuli. To reconcile these seemingly disjoint results, recent investigators have posited the existence of a complex neural code which would serve to distinguish perceptions of painful and nonpainful stimulation of a tactile nature. Our work has focused on describing possible neural coding mechanisms within thalamic unit discharge patterns serving to distinguish noxious from innocuous stimuli and determining acupuncture's effect upon these activity patterns...

Twelve cats were prepared under either alpha-chloralose or sodium pentobarbital; at least three hours after the administration of the general anesthetic, the animals were
given milaxedil or d-tubocurarine intravenously, artificial respiration was begun, and extracellular single-unit recording with tungsten microelectrodes was initiated. For all units located, response pattern and nature of effective stimuli was ascertained. Response to acupuncture was determined by stimulation of predetermined acupuncture sites with a train of 50 Hz square-wave pulses of up to 12 volts and 0.1 to 1.0 msec. duration, and stimulating noxiously and innocuously during and directly after the acupuncture stimulation period (up to 30 minutes). Acupuncture sites to be employed were determined anatomically transposing from the human and computer correlation of frequency of use and presumed effects for each site...

Of 66 units, 23 were responsive strictly to tap or pin-prick. No units responded uniquely to painful stimuli; furthermore, none responded uniquely to tap or pinprick. All units responsive to either form of stimulation were driven convergently by both stimuli. The response pattern of several intralaminar neurons consisted of a preliminary burst, a succeeding period of inactivity and a secondary, delayed burst of varying duration and temporal pattern. The duration and pattern of the latter burst appeared to vary directly with increasing intensity of peripheral stimulation. Acupuncture's effect appeared to be that of altering the duration and temporal relationships within the firing pattern of the secondary, delayed burst. Control experiments necessary to the determination of specificity of acupuncture sites and stimulus parameters and time-course of unit recovery following prolonged acupuncture stimulation have not yet been performed...

Somatosensory-related units (both in terminal thalamic nuclei for pain and in those not specifically for pain) transmit information concerning peripheral pain through a neural code dependent upon unit discharge patterns. The hypothesis that the somato-sensory system contributes to pain perception by means of specific patterns of afferent discharge is by no means a new one. Wall, Taub, Kestenbaum, Melzack and Casey are among those who have indicated that "massive spatial and temporal summation" as well as "pain coding" may be necessary to an explanation of pain perception on a single-unit level. However, none of them performed specific experimentation to verify their presumptions...

Our most preliminary of data suggests that acupuncture's interaction with painful codes may be that of converting them into codes for innocuous stimuli. Clinical procedures suggesting that acupuncture functions to provide analgesia without anesthesia suggest that ours is a productive line of inquiry... It is acupuncture's potential role in elucidating the neural code for pain on a thalamic level that encourages us to pursue
our present experimental design (51).

Most of the research that has substantiated the "total mechanism" theory is very recent and far from complete. This author has "waited" for much of this research in order to come to the final conclusions of this thesis. Developments are proceeding at a very high rate in determining why acupuncture works and its potential future in "established medicine." Attempts to discredit acupuncture in various medical circles are perceived by this author as being totally unwarranted. There is simply no "magic" involved in acupuncture: either the "total mechanism" theory explains its functioning or "one" very similar does.

Regardless of the "conclusive" theory which will eventually be established to explain the pathways and functioning of acupuncture, one fact is indisputable: the intricate involvement of the autonomic nervous system. Such involvement (along with concurrent pain inhibition) can be "monitored to perform various curative functions. The most recently confirmed effectiveness utilizing such involvement incorporates such fields as peripheral vascular hemodynamics, gastric and intestinal motility and sensorineural hearing impairment. The following excerpts are from research by Looney at the University of Southern California School of Medicine in Los Angeles.

Pilot studies in our laboratory have indicated that total blood flow in an extremity decreased by 25-35% during acupuncture anesthesia and this would seem to confirm clinical observations on the ability of acupuncture to alter local blood flow and diminish bleeding in surgical procedures. Acupuncture may alter peripheral and/or central autonomic motor function as well as peripheral sensory function, and it may be that a single mode of action is responsible for the many effects of acupuncture (52). . . . . . .

It certainly seems possible that acupuncture also may improve blood flow within the ear and/or alter cell membrane potentials, and it may be significant that the placement of the large electrostimulation skin electrodes in front of the ear, just anterior to the tragus,
and behind the ear, just inferior to the mastoid process, encompasses several acupuncture points used in treating hearing loss (53).

Matsumoto, Ambruso and Hayes investigated the effectiveness of acupuncture on gastrointestinal atony following vagotomy.

Acupuncture on the gastric meridian points following vagotomy increased gastric motility and microcirculatory activity significantly...
Acupuncture with or without electric current at the specific point increased intestinal motility without altering hemodynamics (54).

In addition, the effectiveness of acupuncture in the field of dental surgery was discussed at the 1974 National Institute of Health Acupuncture Research Conference. Kruperman, Chapman and Berman (at that conference) discussed the fact that the resultant mandibular anesthesia was due to "autonomic related shifts in electrical conductivity in the mandibular area (55)."

The fact remains that acupuncture research is only at the "beginning." In addition to research at medical institutions, private institutions (including the American Acupuncture Society) and by individual or "group" researchers, the National Institute of Health is totally committed to "developing" acupuncture and incorporating it as an accepted facet of American medical care. And it is, indeed, this author's view that the medical science of acupuncture will continue to be substantiated in research as a phenomenon which is entirely explainable in terms of "traditional medicine." Furthermore, the contributions of acupuncture to the field of medicine, in general, will undoubtedly continue to grow as more is known about the intricate and interrelated mechanisms involved.
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35. 7 June 1971 The Chinese surgeons, Newsweek, p. 77.


47. April 1973 Interview with J. Fox.


Fig. 1 - Lung Meridian
(from Palos: The Chinese Art of Healing. Herder & Herder)
Fig. 2 - Heart Meridian

(From Palos: The Chinese Art of Healing. Herder & Herder)
Fig. 3 - "Controller of the Heart" Meridian
(From Palos: The Chinese Art of Healing. Herder & Herder)
Fig. 4 - Small Intestine Meridian
(From Palos: The Chinese Art of Healing. Herder & Herder)
Fig. 5: "Triple Warmer" Meridian
(From Palos: The Chinese Art of Healing, Herder & Herder)
Fig. 6 - Large Intestine Meridian

(From Palos: The Chinese Art of Healing, Herder & Herder)
Fig. 7 - Spleen Meridian
(From Palos: The Chinese Art of Healing, Herder & Herder)
Fig. 8 - Kidney Meridian

(From Palos: The Chinese Art of Healing. Herder & Herder)
Fig. 9 - Liver Meridian

(From Palos: The Chinese Art of Healing, Herder & Herder)
Fig. 10 - Bladder Meridian

(From Palos: The Chinese Art of Healing, Herder & Herder)
Fig. 11 - Gall Bladder Meridian
(From Palos: The Chinese Art of Healing. Herder & Herder)
Fig. 12 - Stomach Meridian
(From Palos: The Chinese Art of Healing, Herder & Herder)
Fig. 13 - Jen-mai Meridian
(From Palos: The Chinese Art of Healing, Herder & Herder)
Fig. 14 - Muscular Meridian
(From Palos: The Chinese Art of Healing, Herder & Herder)
Fig. 15 - Dermatome Chart
(from Smith: Principles of Clinical Neurology, Yearbook Medical Publishers)
Fig. 16 - Sympathetic Nervous System
(From Guyton: Textbook of Medical Physiology, W.B. Saunders Company)
Fig. 17 - Parasympathetic Nervous System
(From Guyton: Textbook of Medical Physiology. W.B. Saunders Company)
Fig. 18 - Dorsal Column Pathway in Spinal Cord
(From Guyton: Textbook of Medical Physiology, W.B. Saunders Company)
Fig. 19 - Dorsal Column Pathway from Thalamus to Somesthetic Cortex
(From Guyton: Textbook of Medical Physiology. W.B. Saunders Company)
Fig. 20 - Transmission of Pinpoint Stimulus to the Cortex

(from Guyton: Textbook of Medical Physiology, W.B. Saunders Company)
Fig. 21 - Spinothalamic Pathway
(From Guyton: Textbook of Medical Physiology. W. B. Saunders Company)
Fig. 22 - Two Somesthetic Cortical Areas-I and II
(from Guyton: Textbook of Medical Physiology. W.B. Saunders Company)
Fig. 23 - Cross-section Through Postcentral Gyrus—with Representative Body Locations

(From Guyton: Textbook of Medical Physiology. W.B. Saunders Company)
Note: The above is a schematic diagram of the gate control theory of pain mechanisms: L, the large-diameter fibers; S, the small-diameter fibers. The fibers project to the substantia gelatinosa (SG) and first central transmission (T) cells. The inhibitory effect exerted by SG on the afferent fiber terminals is increased by activity in L fibers and decreased by activity in S fibers. The central control trigger is represented by a line running from the large-fiber system to the central control mechanism; these mechanisms, in turn, project back to the gate control system. The T cells project to the entry cells of the action system. +, Excitation; −, inhibition.

Fig. 24 - Gate Control Theory of Pain Mechanisms
(From Melzack & Wall (19 Nov. '65, Science): Pain Mechanisms: A New Theory)