"ANALGESIC EFFECTS OF ACUPUNCTURE ON THE PAIN OF ICE WATER: A DOUBLE BLIND STUDY."

by

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Abstract

Analgesic effects of acupuncture were demonstrated under double blind conditions. Thirty female subjects were randomly assigned to either an acupuncture condition, or one of two placebo conditions. Placebo 1 did not receive any needles, Placebo 2 received acupuncture at inappropriate sites. The three groups were then tested on the same standardized pain task (immersion of hand in ice water). The acupuncture group's pain ratings were significantly lower than the ratings of the placebo groups. These results are interpreted as support for the position that acupuncture analgesia has a physiological basis, and is not simply due to suggestion.

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Introduction

The present study is concerned with the analgesic effects (insensitivity to pain) resulting from the administration of acupuncture. Acupuncture is a contemporary phenomenon (in Western society) which is not easily amenable to explanation in terms of traditional theoretical frameworks. This phenomenon cannot be viewed in isolation from the pain experience and its multi-dimensional characteristics. A review of both traditional and modern pain theories and research paradigms will be presented. In addition, the possible role of psychological variables in acupuncture analgesia will be examined.

What is Pain?

Attempts to define pain have varied from Aristotle's early categorization of pain as a passion of the soul, being the opposite of pleasure (Marshall, 1894), to the turn of the century when it was considered a separate sense with its own specific receptors and nerves (Von Frey, 1895), to its present status as a complex experience (Melzack & Casey, 1968). Casey's (1973) definition characterizes this present position, "Pain is a multi-dimensional experience which involves not only discriminative capacity to identify the onset, duration, location, intensity and physical characteristics of the stimulus, but also includes the motivational, affective and cognitive functions leading to aversive behavior, the private experience of unpleasantness and the interpretation of the stimulus in terms of present and past experience." (p. 194).

The main impetus for pain research remains to find new ways of limiting human suffering resulting from the pain experience (Hilgard, 1969). Although pain is often studied with clinical patients, most pain research involves the induction of pain in the subject. A variety of techniques are available for this purpose, the choice and administration of which are governed by at least two important considerations, the first of which is ethics. How much pain and suffering is warranted on the part of the subject, and are the procedures 100% safe, so there is minimal risk of permanent damage? The second consideration is the correspondence between the experimental and the natural pain conditions. For example, electric shock probably bears little similarity to pathological pain.

Three of the more fundamental methods of inducing pain for the laboratory investigations of pain are electric shock, ischemic pain and the cold pressor. Each varies in its mode of induction, area of stimulation and similarity to pathological pain.

Electric current is often used to safely produce pain by giving very brief impulses of direct current (0.5 msec.) in trains of no more than 40 to 50 msec.). One of the major difficulties with electric current as a source of pain is that of specification within the skin tissues. Geldard (1972) emphatically labels electric current as the "nonadequate pain stimulus" (p. 324) since its effect is not at all localized. Instead, it will "arouse every sensory and motor system and affect every conductor in its path" (p. 324). Furthermore, although easy to administer, pain induced through electric current has little correspondence if any with the pains

normally experienced by chronic sufferers. However, electric current may serve very adequately as a pain stimulus when investigating different components of the pain experience, i.e. cognitive variables (see Zimbardo, 1971).

Experimental ischemic pain originated with Lewis, Pickering & Rothschild (1931) who established the paradigm of a tourniquet to the upper arm accompanied by muscle contraction, for example by squeezing a dynamometer until maximum endurance has been reached. The slowness in onset of pain intensity in this technique is advantageous for certain types of research. The pain experienced by the subject closely resembles certain clinical types of pain. Hilgard (1969) used ischemic pain with hypnotic analgesia as a comparison against the results achieved with the cold pressor test.

The cold pressor is a standardized technique which generally involves immersing a limb, hand or foot in ice water. For more intense controlled pain it is advantageous to keep the water circulating rapidly in order that a warmer layer of water cannot be formed between the skin and the ice water. There is a dual stress present when using this apparatus: that arising from the experience of coldness and that arising from the experience of pain. A deep aching pain is usually achieved, the intensity of which varies almost in a linear relationship to the coldness of the water. In an attempt to separate the components of pain and coldness Wolf and Hardy (1943) suggested that cold pressor pain resulted from severe vasospasm and was transmitted over C fibres. When they attempted to decrease the

pain experienced through chemical analgesics, while holding water temperature constant, not only did the verbal reports change but the physiological indicator - blood pressure - also supported the conclusion that pain was being blocked. Sternback (1968) also contends that the observed cold pressure effects are primarily pain and not cold responses. Melzack (1970) has stated the chief advantages of this technique are its easy administration and the control one gains over the temporal qualities of the stimulus.

There is not an experimental technique available which fully simulates the conditions of pathological pain. However, there is still a definite obligation by the researcher to both investigate and delineate components of the pain experience in the hope that human suffering will be more fully understood and subsequently decreased (Hilgard, 1969). Wolf (1973) has thoroughly reviewed many of the difficulties of pain research. His main point is that it is unethical to fully simulate both the intensity and duration of pain commonly experienced in clinical cases. In spite of this barrier, Wolf (1973) still considers laboratory research well worthwhile since the correspondence and relationships already discovered have facilitated a more accurate comprehension of the pain experience.

How is Pain Measured?

Fechner (1860) stated that "Sensation is a mental magnitude that one is not able to measure directly." (p. 36). One is able to measure stimuli and their differences which give rise to different sensations; similarly, one may measure sensitivity but the sensation itself is still not being measured directly.

Irrespective of the category of pain; surgical, clinical or experimental, there are three fundamental methods of measurement: Overt Behavioral Signs; Psychophysiological Methods and Verbal Reports.

Overt behavioral signs are most readily observed and although they are probably the grossest measure, they still could be classified as the most common clinical indicator of pain. Is the patient yelling or screaming in agony? Is he flinching, grimacing or in a cold sweat? In the experimental situation is the subject attempting to withdraw and escape the stimulus? Responses of this nature usually appear at the extremes of the pain experience, that is when the stimulus conditions are extremely intense. Therefore, they are only adequate to ascertain presence or absence of the sensation or pain experience. Similarly, in this category of measurement differences in frequency of responding are relatively easy to observe. This category of measurement is most commonly applied both by the clinician and the animal researcher who is unable to rely on language. However, when more sensitive measures are needed for the broad area between the extremes, this method of measurement is limited. For example, the qualitative differences between a few beads of sweat on the forehead and a flushed damp forehead are difficult to standardize. Similarly, each of the above responses is usually integrated into a more complex series of behavior. To isolate a specific response from the overall behavior pattern is not only difficult but questionable in terms of validity.

A great deal of research has been conducted investigating the relationship between pain and psychophysiological changes. These changes involve measures of heart rate, blood pressure, EEG activity, muscle tension, etc. Sternback (1968) considers these measures advantageous since they are less susceptible to deliberate alterations or control by a subject than are verbal reports or overt bodily responses. Another reason for using these measures is the correspondence and direction of change observed with similar changes in the stimulus intensity. For example, heart rate and blood pressure both tend to change in a linear fashion in the cold pressor varying with both coldness of the water and duration of exposure (Hilgard, 1969). However, as Hilgard states, there is not one of these measures that can individually determine the presence of pain. Instead these indicators are all correlational in nature, and are easily altered by events which may be non-painful in nature but induce anxiety, stress, fear or emotional arousal. Wolf (1973) concludes that although these measures may be worthwhile indicators of pain when paired with verbal reports they are insufficient by themselves as a basis for any conclusions about the subject's pain.

Verbal reports are probably the most frequently used measurement method. Verbal reports are usually standardized in the form of classes of sensory scales. (1) Discriminability scales - Usually some measure of just noticeable differences or variability is employed as a unit. Then a scale is derived by counting off a specific number of units. (2) Category scales (partition scales) - The subject is required to

partition a section of a continuum into equal appearing intervals. (3) Magnitude scales - These are usually ratio scales of apparent magnitude constructed by four basic methods, the main one of which is magnitude estimation, (Stevens, 1959). All of these are used to quantify verbal information into meaningful measurements. The method of magnitude estimation usually requires the subject to estimate the apparent strength or intensity of his impression against some scale (often numerical) which is predetermined by himself or the experimenter. For example, a subject can be presented with an electric shock and be asked to rate it: 1. not painful; 2. moderately painful; or 3. extremely painful. The most common criticism of verbal report data is that it is arrived at through highly cognitive processes. These processes may easily be influenced by other factors resulting in a gap between what the subject reports he feels and what he actually feels. Another factor which must be considered is that in some clinical settings there is a strong motivation on the part of the patient to deny pain whereas with the experimental subject the opposite motivation is often present.

Hilgard (1967, 1969, 1971) adopts methods of magnitude estimation with both cold pressor and ischemic pain. He requires his subjects to report the pain felt on a simple numerical scale. He states that, "the reported pain yields not only orderly results but valid results, in the sense that the reported pain corresponds in a systematic relationship to the temperature of the water and to the time of exposure to the noxious stimulus." (p. 107). These data can be fitted to power functions similar to those

which are applied in research involving the other modalities (Hilgard, 1969; p. 107). Measurement through verbal reports has certain limitations i.e. cognitive contamination. However, its merits still outweigh its disadvantages when viewed in comparison to overt behavioral signs or psychophysiological measures. Hilgard (1969) supports this position, "I wish to assert flatly that there is no physiological measure of pain which is either as discriminatory of fine differences in stimulus conditions, as reliable upon repetition, or as lawfully related to changed conditions as the subjects verbal report." (p. 107).

What is the current status of Pain Theory?

Pain is an experience, the parameters and mechanics of which are still to be fully understood. Different select aspects of this experience viewed in isolation have given rise to pain theories. Three of these traditional approaches will be reviewed before dealing with more modern theoretical formulations.

The specificity theory originated prior to the beginning of the twentieth century with Von Frey. This theory viewed pain as a sensation mediated by specific nerves each with its own specific receptor (Dallenbach, 1939). Not only did it assume separate nerves and nerve endings for pain but also for cold, warmth and pressure. This theory was consistent with Muller's 1840 doctrine on "specific nerve energies" which stated that the quality of a sensation depended mainly on the fibre and receptor stimulated, not the type of stimulus (Boring, 1942). The idea of specific fibres mediating pain is still relatively popular. However, the existance

of individual receptors (free nerve-endings) and their role in the sensation of pain, as stated in the theory was ruled out very early.

A position offered at approximately the same time was Goldscheiders Intensive Theory. This position held that pain was neither a specific sensation, nor was it mediated by its own specific nerves. Instead, pain was regarded as the logical outcome arising from overstimulation of the pressure or feeling nerves, or from a hypernormal condition of the gray substance of the cord (Luckey, 1895). The main phenomenon contributing to this theory is the increased sensitivity of any skin surface after prolonged stimulation. However, it fails to account for pain triggered by shorter latency and lesser intensity stimuli (Geldard, 1972).

A third major theory was offered by Nafe (1929) which focussed on the spatio-temporal patterns of impulses over routes which generally served other specific modalities. The contention of this Pattern Theory is that it is specific spatio-temporal patterns which trigger pain, not specific receptors or fibres. Nafe speculated that, "the specific accompaniment of sensory excitation is correlated with the number of nervous impulses and their temporal spatial relations." More specifically, Sinclair (1955) states that according to this theory, each fibre may in its time serve a number of different functions. The select piece of information transmitted by a specific fibre has little significance unless it is integrated with the information provided by every other activated fibre. Therefore, "activity in a given fibre could at one time contribute to an experi-

ence or sensation of touch at another moment to an experience of pain, cold or warmth." (p. 16). This theory is primarily different from the two former theories in that it takes the level of explanation one step further, dealing with processing and transmission of information in a neural network rather than assuming a one to one stimulus-receptor type of onset as in the specificity theory or accounting for the phenomena totally in terms of stimulus duration and intensity as in the case of the Intensive or Summation Theory. Sternbach (1968) contends that "a viewpoint accounting for pain only in terms of patterning ignores the data arising from specialization and localization" (p. 40). Furthermore, as Deutch (1973) points out the Pattern Theory may be useful for explaining fibre activity where a specific fibre responds to several or all modalities, however, when a fibre responds to only one modality this interpretation cannot hold.

Melzack & Wall (1965) formulated the Gate Control Theory in an attempt to integrate findings which were not adequately accounted for by any of the earlier mentioned theoretical positions. The Specificity Theory failed to match end organs with sensations and research failed to establish "any direct invariant relationship between a psychological sensory dimension and a physical stimulus dimension" which is implied by the theory (Sinclair, 1967; p. 11). The Intensive Theory of pain failed to account for pain triggered by relatively small amounts of stimulation, while the original Pattern Theory failed to consider fibre specifity or the relationship between fibres.

Melzack and Wall's (1965) theory is premised on the relationship between large and small fibre activity in the peripheral nervous system. The theory postulates a gate mechanism at the spinal level which can be closed by large fibre activity thus preventing pain signals arising from small fibre activity from being transmitted further. Activity in the larger fibres appears to close the gate while activity in small fibres tends to open it. They consider the gate like mechanism to serve a function of modulation for any incoming activity. Whatever information is transmitted further is dependent on total fibre stimulation. If large fibres are stimulated the information is either sent directly to the brain or through special transmission "T" cells which are the main component of the gate mechanism. Whereas small fibres discharge to the "T" cells directly, "T" cell activity is dependent on the relationship between large and small fibre activity. In an elaboration of how information is transmitted from the spinal mechanism to the brain and consequently influenced by higher order processes, Melzack & Casey (1968) have proposed that: Selection and modulation of sensory input from "T" cells through neurospino-thalamic projection provides some basis for the sensory-discriminative aspect of pain; activation of reticular and limbic structures through the paramedial ascending system (activity also initiated by "T" cells) underlies the powerful motivational drive and unpleasant effect that triggers the organism into action while neocortical or higher processes exert control over activity in both the discriminative and motivational systems. It is assumed that these three categories of activity interact to provide perceptual information,

motivational tendency, cognitive information and together influence motor mechanisms responsible for complex behavior patterns of pain.

The Gate Control Theory provides plausible explanations for pathological syndromes which all of the aforementioned theories failed to adequately account for. For example in: the causalgia syndrome (a sensation of burning pain often observed accompanying lesions of the median or sciatic nerve); hyperalgesia (extreme sensitivity to pain); neuralgia (severe pain along the course of the nerve often produced by weak stimulation of special areas - trigger zones); and phantom limb pain (the continuation of aching in a limb once it has been removed) the explanation offered is similar. For in each case structural damage to large fibres of the spine could create an imbalance of large and small fibre activity. This would result in small fibre activity summating on "T" cells without the necessary large fibre activity present to close the gate. In each case activity in small fibres may be initiated by normally non-noxious stimuli or the ongoing cell activity. Postulation of the central control mechanism and motivational affective process also makes it possible to speculate on the dynamics of placebo effects and hypnotically induced analgesia. What appears to happen in both of these cases is disappearance or failure of the motivational-affective component without any sensory loss.

The Gate Control Theory accounts for more of the available data than any of the previously mentioned theories. It allows for fibre specificity and the interrelationships between fibre types, and additionally considers the reciprocal influence of the brain on sensory processes. And

as Sinclair (1967) states, "this theory appears to hold out the greatest promise as a stimulus to future investigation" (p. 228).

What Psychological Variables Influence Pain?

Pain may be considered either an experience or a category of experiences. In either case a number of different processes, including discriminative and motivational-affective are influential in evaluating any painful stimulus and determining the resulting experience. Several aspects of a psychological nature have been shown empirically to influence the perception of pain. Among these are: past history and exposure, expectation, anxiety and stress, motivation, instructions and suggestion as well as distraction.

Hypnosis and Suggestion:

Hypnotic induction procedures have been successful in attenuating pain. This finding has been reported in literature dating back 2,000 years, yet, the key variables of this phenomena have never been effectively delineated. Hypnosis is often mystified by the layman thereby adding to the complexity.

Experimentally, Hilgard (1967 & 1969) has demonstrated that, "The suggestion of hypnotic anesthesia or analgesia results in a marked reduction in felt pain, honestly reported, and the amount by which quantitatively estimated pain is reduced is positively correlated with hypnotic susceptibility as measured on standardized scales." (Hilgard 1973, p. 396). Hilgard's results leave little doubt that hypnotic analgesia definitely aids the subject in enduring the painful stimulus with less discomfort than that experienced by normal or control

subjects. However, Hilgard (1973) points out two observations of importance to understanding hypnotic analgesia.

(1) Although the hypnotic subject reports less pain, the physiological correlates for him are the same for him as control subjects.

(2) Hypnotic suggestion clearly reduces the pain reported whereas hypnotic induction does only if the suggestion is also present.

Chaves and Barber (1973) strongly support this second point. They cite evidence indicating that suggestion for pain relief given without hypnosis is often as effective as suggestion for pain relief given with hypnosis in producing a tolerance for surgical pain. Hilgard (1973) also has data supporting this contention. He used both high and low hypnotizable subjects, each divided into three groups: waking; hypnosis only; and hypnotic analgesia. Hypnotic analgesia, that method which included suggestion of relief, was found to be the most effective in attenuating ice-water pain. The analgesic effect was far stronger when the suggestion component was present, even among highly hypnotizable subjects, than hypnosis by itself. Similarly, Evans and Paul (1970) tested the magnitude of suggested analgesia with ice-water pain. Suggestions of "your hand has no feeling at all" were given to two groups, one of which had been exposed to hypnotic induction, the second of which had not. A third group received neither, serving as a straight control. The two treatment groups reported less pain than the control, but in terms of differentiating the two treatment groups hypnotic induction failed: there was not a significant difference between the two groups. From the data presented it would appear that suggestion of

analgesia is one of the primary methods of reducing pain through manipulation of psychological variables.

Placebo Effects.

"A placebo is a pharmacologically inert substance used primarily to please patients rather than help them." (Sternbach, 1968; p. 141). Beecher (1960), using patients with pathological pain, found that 64-70% obtained relief from morphine whereas 35-40% gained relief from placebos. Although morphine is 70% effective in a clinical setting for providing pain relief, in the laboratory it is not as effective as aspirin in altering pain thresholds (Beecher, Keats, Mosteller & Lasagna, 1953). However, Beecher (1966) points out that it is tenuous to attempt to investigate either placebo effects on the attenuating properties of morphine experimentally with thresholds as the primary measurement. Instead of a linear relationship between onset of pain and pain relief through these agents, Beecher found both the effect of morphine and placebos to be insignificant until pain reached the level of being very distressing or unbearable. Once the pain experienced by his subjects reached these intense levels the subjects responded to both morphine and placebos in a similar fashion to clinical populations. His main conclusion is that crucial psychological variables such as stress and anxiety are not present until the pain experienced is intense. Therefore, if stress and anxiety are not present it is no great mystery why placebos and morphine are ineffective, since their main source of relief is in reduction of anxiety and stress (Beecher, 1966).

Sternback (1968) perceives a close parallel between placebo

reactions and attenuation or relief from pain gained through suggestion. In other words the physician who obtains the full compliance of the patient and then instructs him, "Take this, it will help" relies on the full power of both phenomena.

Cognitive Variables.

The potential influence of cognitive variables on the experience of pain are exemplified by an experiment by Zimbardo (1966). This experiment involved three phases, precommitment, commitment and postcommitment, and the variables of shock, justification for commitment and choice were manipulated. After all subjects received 2 shocks per trial while learning a word list, they were split into five groups. Three groups had no choice but to continue, with 3 variations of shock received by these groups; high, moderate and low. The other two groups were given a choice whether or not to continue. For one group, low dissonance, justification (the good of science) was supplied, while the other (high dissonance) chose to continue without any discernable rationale. Zimbardo measured verbal ratings, number of trials to learn a word list and skin resistance. His high dissonance group reported the greatest drop in shock intensity, and their measures of skin resistance also dropped. Their ratings under these conditions matched closely with those groups which received much less intense shock. In summary, the reported sensation of pain and the measure of skin resistance were both decreased by altering the cognitive state of commitment and dissonance of the subjects.

Distraction and Counter Irritation:

The redirection of attention away from the painful area (distraction) and the "stimulation of other parts of the body surface" (counter irritation) are two of the most frequently used methods to combat pain. The physician giving a child a needle may slap the lower part of his arm at the same moment the needle is inserted, resulting in the child focussing on the slap not the needle and consequently feeling less pain. Counter irritation is probably the ingredient in "methods of folk medicine including mustard plasters, ice packs and hot water bottles applied to various parts of the body" from which some relief is gained (Melzack, 1973; p. 6). Further evidence of this phenomena has been observed:

"(1) Brief mildly painful stimulation is capable of bringing about substantial relief of more severe pathological pain, for durations that long outlast the period of stimulation.

(2) Vigorous massage of the sensory nerve which innervates the lower head and jaw may permanently abolish the pain of tic douleureux, which is characterized by painful, convulsive spasm of the face and mouth.

(3) The injection of hypertonic saline into the tissues of the back may produce a sharp brief pain, followed by prolonged relief of phantom limb pain. Saline injections into the stump may have the same effect.

(4) Application of painful cold to the skin of either leg brings about a 30% rise in threshold to pain produced by electrical stimulation of the teeth." (Melzack, 1973; p. 5-6).

The pain attenuating properties of distraction are demonstrated

by Barber & Calverley (1969). Female subjects listened to a tape recording of an interesting erotic escapade while pain was induced through a heavy weight on their finger. Subjects were required to identify characters in the escapade and retain as much information as possible. Prior to the induction of pain the subjects were assigned to a hypnotic induction group and a group receiving no prior treatment. Listening to the tape resulted in similar (significant) decreases in reported pain in both groups. As Chaves and Barber (1973) point out distraction can operate in various forms. The subjects attention may be captured by a novel unexpected stimulus or as in the case previously mentioned the subject may consciously direct his attention to some other task or event. Furthermore, distraction and counter irritation may at times act in an additive manner to attenuate pain, (Chaves and Barber, 1973) whereby the combined effect is stronger than that resulting from applying either individually.

The previous section reviewed the affective component of pain and its numerous components. The evidence is in agreement with Melzack's (1970) contention that, "Pain perception is not simply a function of amount of physical damage alone. Rather it is also determined by expectation, suggestion, level of anxiety, the meaning of the situation in which the injury occurs, competing sensory stimuli and other psychological variables." (p. 272).

What is Acupuncture?

The present interest in acupuncture has been facilitated by recent cultural exchanges with the Orient. Only in the last thirty years

have detailed English translations become available which give specific descriptions of the various techniques. With the more recent cultural exchanges, numerous observers have visited the mainland of China returning with reports sensational by Western standards (i.e. Jain, 1971; Dimond, 1971; Reston, 1972; Brown, 1972; Shute, 1972). The observations and reports have initiated speculation and reactions as to the efficacy and mechanisms for its effect. The search for explanation of the phenomena has been confounded by, "cultural, scientific and political biases." (Wall, 1972; p. 131). In the following section the development of acupuncture analgesia will be reviewed and, where possible, the more common misconceptions presented by the media will be corrected.

Traditional acupuncture is derived from the ancient system of folk medicine developed in China and practised in many countries of the world. In antiquity as well as today, its philosophy is based on a unique way of looking at life. The theoretical framework of this philosophy is somewhat similar to those used in Western ecology, only it is applied to the human organism and its various organs. This is the Yin-Yang theory. It assumes the presence of two universal forces which are represented in the body. Twelve meridians (Chinglo) which run down the body on a vertical plane carry a life energy, Chi, which is believed to maintain a harmonious balance between these two forces. The theory is more dynamic in nature than fixed or static. In other words, the assignment of Yin or Yang in various organs depends on which organ is being considered, and whether the force is inner or outer. Generally, Yin is viewed as the weak negative female force

while Yang is the strong male positive force. Any state of harmony is contingent upon a balance of the two forces. If an imbalance arises, a particular organ becomes malfunctioning and simultaneously creates a state of imbalance in the interrelated organs of the system. Restoration of harmony is brought about through needle stimulation of the appropriate meridian which governs the malfunctioning organ and thereby increasing the lesser component. In the case of analgesia presumably a converse technique would be used. An imbalance would be intentionally created in order that the organ would be numbed in time of surgery.

Acupuncture medicine was derived through the aforementioned philosophy and theoretical framework. It is a traditional method of therapy used in the Orient to treat disorders of internal organs through stimulation of the body surface by needles. The therapeutic value of acupuncture medicine has been observed in the treatment of diseases often considered to be endocrine disorders or neurovegetative in character. Among these diseases are hypertension, Cushing's syndrome, rheumatism, asthma and peptic ulcers. Acute infectious diseases such as tonsillitus, nephritus and hepatitus have also been treated with good results. Chronic organic diseases are more resistant to treatment and have not been subject to the same success (Mann, 1972).

Although acupuncture medicine is indisputably of ancient origin, acupuncture analgesia is a very recent phenomena in the orient. As Chaves and Barber (1973) point out, acupuncture analgesia was not used to produce analgesia in surgery until 1958. However, since that time, in excess

of 400,000 operations have been completed in Mainland China using acupuncture analgesia (Peking Acupuncture Coordinating Group, 1972). It was initially applied for post-operative pain and then later applied for surgery itself.

Explaining acupuncture analgesia in terms of the Yin-Yang theory and evaluating its efficacy on the merits of the theory is not a fair interpretation. First of all, translating material between two totally different cultures often leaves a huge margin of error open to the translator. Most of the information available is of this secondary source nature. Secondly, contrary to the contention of some authors, Yin-Yang is not a scientific theory but an ancient Chinese philosophy of the universe. It predates Acupuncture Medicine and was not formulated for either empirical verification or literal translation. Instead, it was a construct which offered a tentative view of the universe and was applied to the smaller universe of the human body. Similarly, although the ancient sites may have been explained through this loosely construed doctrine, the recent phenomenon of acupuncture analgesia probably has the same relationship to the doctrine as our own modern surgical techniques do to the primitive art of blood-letting. It would appear acupuncture analgesia has a closer resemblance to techniques derived in western medical science than the ancient doctrines. Research institutes have been established in China since 1949 to research different methods and applications of acupuncture analgesia, and although one traditional school of Chinese medicine holds that connections of sites are effected by means of Chinglo (meridians), modern Chinese physiology maintains that these connections are primarily

effected through nerves (Peking Acupuncture Coordinating Group, 1972). This is consistent with the interpretation offered by Melzack (1973) who states that the sites used may show some correspondence to: "the sites at which peripheral sensory and motor nerves emerge from muscles and other deep tissues and come to lie just below the skin" (p. 11) thereby providing full input to the central nervous system.

The main applications of acupuncture analgesia are two-fold. One application is to eliminate the use of general anesthetic in surgery, thereby allowing the individual to remain conscious throughout surgery with a minimal amount of discomfort. By itself this technique is a major discovery, since much of post-operative nausea is directly linked to the anesthetic. Similarly it allows the surgeon to proceed when the patient's heart or general health is incapable of coping with the effects of general anesthesia. The second major application of acupuncture analgesia is to bring about relief (not cure) in chronic clinical pain.

The technique of acupuncture analgesia generally involves the strategic placement of four to six needles at depths ranging from 2 or 3 mm to 2 cm below the epidermis. Depending on the specific technique they are either twirled or vibrated by the acupuncturist or electric current is passed through them. Reports on the electric current again vary considerably. The Chinese acupuncturist generally has a Sui generator which looks like a table model transistor radio. Most of these units have 3 to 6 channels, with each channel having a capacity to pass a different wave form and current through any 2 sets of needles. In the field reports a six or

nine volt battery delivering a phasic direct current as high as 6 volts at 100-300 cycles/minute is most common (Babich, 1973).

How Do We Investigate Acupuncture and Why?

Western Scientists, politicians and public are faced with a phenomenon, on acupuncture analgesia, for which there is no traditional theoretical rationale. Its potential application is obvious. Therefore, the questions requiring answers are rather straightforward.

(1) Is it a psychological or a physiological phenomenon?

(2) Will it only work for certain types of people or cases?

(3) What are the parameters of its possible success?

Chaves and Barber (1973) are of the opinion that acupuncture analgesia can be totally explained in terms of six psychological factors which are:

(1) Strong belief and lack of anxiety: as shown by Beecher, anxiety adds to the intensity of any pain experience.

(2) Use of local anesthetics: placed at the sites of stimulation may facilitate a general numbness.

(3) General overestimation of surgical pain: cutting the skin is not as painful as distension of a nerve or organ.

(4) Special indoctrination prior to surgery: could insure maximum belief in the procedure.

(5) Distraction produced by acupuncture needles: having the patient concentrate on the needles rather than the incision.

(6) Suggestions for pain relief: could reduce the pain similar to indoctrin-

ation if the patient believes the suggestion, it may work.

Similarly, Wall (1972) speculates that when acupuncture is tested through well controlled, double blind procedures, "it will emerge that acupuncture does not generate the specifically pain inhibiting barrages, previously claim, due to the bizarreness of the location of the exact points into which the needles have to be inserted. Although there are some strange sites of interaction which we know about and partly understand such as the heart and left arm; and the diaphragm which interacts with the epaulette region of the shoulders, the sites for acupuncture insertion based on the now abandoned and non-existant tubular system fit no known pattern of nervous or other interactions so far discovered. Therefore, my own belief is that acupuncture is an effective use of hypnosis." (p. 130).

When this research commenced there was not one published article in any Western scientific journal involving an empirical test of acupuncture analgesia. The present study was largely concerned with testing, under double blind conditions, whether or not acupuncture analgesia can attenuate pain when the psychological variables are held constant.

METHOD

Subjects: Thirty female subjects were selected from a subject pool at the University of Manitoba Health Sciences Center. The majority were involved with the center through their education or employment. The criteria on which subjects were selected was: that the subject be between 18 and 25 years of age; have no history of underlying disease; not presently be on any medication; have no previous history of injury or operations on the upper extremities; have no prior history of acupuncture treatments and be available and willing to participate. The reward offered for participation in the research was a luncheon, explanatory lecture and question period upon completion of the project.

Apparatus: The cold pressor apparatus was a styrofoam cooler containing a water-ice mixture precooled to 1°C. The water was kept swirling by a Precision Scientific Company Vari-Speed Stirrer, set at 500 r.p.m.

The acupuncture needles were 28 gauge stainless steel. A Sui Wai "6.26" stimulator manufactured in Canton, People's Republic of China was used to pass electric current between the needles. The current used was approximately 5 millivolts D.C.[1]

Procedure: The research was conducted in a 6th floor treatment room in the Manitoba Rehabilitation Hospital. Prior to testing each subject waited in the hospital lounge, being exposed to the daily routine of the 6th floor hospital personnel.

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[1] This value was provided by Dr. Man on the basis of information accompanying the machine. However, Babich (1973) has accurately traced the current parameters of this unit and reports the current ranges from 4.0 to 1.8 ma with a mean peak to peak voltage from 360-600 mv with impedance ranging from 150-200 ohms.

Each subject entered the treatment room and introduced herself to both experimenters (E_1 and E_2). After removing her coat and jewelry she was requested to rate on a ten point scale her preconceived estimation of the efficacy of acupuncture as well as her previous exposure to the phenomena through the media. Upon completion of the questionaire E_2 left the room and E_1 (Dr. Man) presented the subject with the following written instructions (a):

> In the second phase of this research, I will be administering acupuncture to you. It is difficult for me to say whether you will or will not have discomfort from this procedure.
>
> One reason is that people vary in what they experience. Another reason is that discomfort also varies with different acupuncture sites.
>
> I have selected a site for acupuncture. Following the procedure, we wish to test you again. This will complete your participation in our project.
>
> Other than giving you this information, we cannot answer <u>any</u> of your questions at this time. We will later arrange to give you the results of the research only after all work has been completed. This will be accomplished through a special class or by newsletter.
>
> Besides the cooperation which you have extended already, I must ask you to cooperate in several other ways.
>
> First, you must not tease or in any other way indicate to the other experimenter where you have had acupuncture.
>
> Second, I must ask you not to talk to anyone about what has been done to you here. Other girls who will be here for testing would probably hear and this would most definitely affect our research outcome, so, again, you must not discuss this with anyone until you hear from us.

I will now begin the procedure if you
have no questions about what I have said.

The examiner then ascertained whether each subject understood the instructions and after confirmation proceeded with phase 2. Each subject was blindfolded and the dorsal surface of her right arm was scrubbed with alcohol at the acupuncture sites. The examiner then opened an envelope to determine which treatment condition the subject had previously been assigned to; acupuncture, placebo 1 or placebo 2.

Assignment of subjects to groups, schedules for testing, and placing the appropriate card in each envelope was completed the week preceeding the research by a third independent party employed in the computer center. Subjects in the acupuncture group had needles inserted at 4 points on the right arm; 2 near the wrist and 2 near the elbow. These sites are designated Li 11, Li 5, Si 5 and Si 8 in the Chinese Literature (e.g. Mann 1972). After the needles were inserted they were connected to the electrical stimulator and the current was passed for 15 minutes. The placebo 2 group received the identical treatment only the needles were each inserted one inch away (on a horizontal plane) from their appropriate sites. Although subjects in the placebo 1 group expected to receive acupuncture they did not receive any needles or electrical stimulation. After being blindfolded these subjects only received the alcohol swab and the same fifteen minutes of auditory stimulation with the stimulator set at the same frequency as for the two previous groups. The research was conducted every day between 5-8 p.m. for two weeks. Subjects were not tested on the weekend. Each night 3 subjects

were tested.

After phase 2 was completed the needles were removed and then the blindfold. Experimenter 2 then entered the room and presented each subject with the following set of written instructions re: the cold pressor task, instructions (b):

> You are participating in an experiment which will involve some physical discomfort to yourself.
>
> What we are interested in measuring is your perception of that discomfort or pain. After you have submerged your wrist and forearm in the ice water tank please rate the pain you perceive when I tap my pen against the tank. "0" will signify no pain, "10" will mean that you are in so much pain that you do not feel you can keep your hand in the water any longer. "5" is the half-way point on the scale. You will not be expected to leave your hand in the water longer than 1 minute.

Each subject then received a pin prick on each wrist (order randomized) with a sterilized pin embedded in plastic and was asked to rate the pain in accordance to the previous instructions. This procedure provided information on both whether or not the subjects understood the procedure for rating pain and the intensity of pain caused by the pin prick.

Each subject was then requested to walk over and stand in front of the ice-water tank, which had previously been obscurred from vision. Each subject immersed her right hand and forearm upon request. Experimenter 2 tapped his pen on the side of the tank every ten seconds and recorded the numerical rating given by the subject. Those subjects who removed their hand before the 60 seconds had expired were assigned ratings of 11 for the missing cells. This assignment was premised on the argument that

a large difference exists between rating a stimulus as so painful you cannot stand it, but nevertheless tolerating it; and actually feeling so much pain that withdrawal becomes necessary. After the trial was over each subject was allowed to wrap her hand in a towel and sit resting for three minutes. The procedure was then repeated for the left hand (trial 2) and after a second rest period, a second trial (trial 3) of the right hand was completed.

When this phase of the research was over each subject was required to complete a second scale (identical to the first) rating efficacy of acupuncture. E_2 then collected additional demographic information and recorded general comments made by the subjects.

Two orthogonal comparisons were of interest: c_1 between the treatment group and the two placebo groups evaluated any effects of acupuncture specific to the site of stimulation; c_2 between the two placebo groups evaluated any nonspecific effects.

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[1] Planned orthogonal comparisons, Hays, W. L. Statistics for Psychologists. New York: Holt, Rinehart & Winston, 1963, p. 462.

RESULTS

Ice Water Trial 1, the first trial with the treated hand, is of particular interest since all psychological variables (i.e. expectations) were constant across groups. Therefore, one would not expect the pain ratings on this trial to be influenced by any contrast or order effect. On this trial the mean pain rating of the acupuncture group was significantly lower than those of the placebo groups. ($F = 9.75$; 1, 27 df., $p < .01$) (see Table 1). The means of the two placebo groups did not differ significantly ($F < 1.0$). The pain ratings increased significantly over time in the ice water ($F = 45.59$, 5, 150 df, $p < .01$); while the interaction of groups by time was not significant ($F < 1.0$).

As can be seen from Figure 1, the mean ratings of the two placebo groups are above the maximum rating of 10 at 60 seconds. This resulted from 4 subjects in placebo 2 and 5 subjects in placebo 1 removing their hands before the trial was completed, thus they had to be assigned ratings of 11 for the missing cells. In contrast, only one subject in the acupuncture group removed her hand. Three subjects in the acupuncture group gave the maximum rating of 10, indicating extreme pain. While this is significantly lower than the 8 subjects in placebo 2 giving ratings of 10, ($p < .05$, Fisher Exact Test) and the 9 subjects in placebo 1 ($p < .01$), it nevertheless indicates that analgesic effects did not appear uniformly for all subjects in the acupuncture group.

On trial 2, in which the left (untreated) hand was immersed, the acupuncture group's mean pain rating did not differ significantly from

those of the placebo groups ($F = 3.78$ n.s.), and the means of the placebo groups were not significantly different ($F < 1.0$). In addition, only the acupuncture group's mean pain rating varied significantly from their pain rating in trial 1 ($t = 2.33$, 9 df, $p < .05$). The two placebo groups gave similar ratings to those of trial 1 ($t = .6$, $t = .5$, n.s.).

On trial 3, the second trial with the right (treated) hand the same treatment differences were observed as in trial 1. Again the acupuncture group reported significantly ($F = 9.65$, $p < .01$) less pain than the placebo groups. All three groups gave significantly lower pain ratings than reported on trial 2 ($t = 3.82$; $t = 2.68$; $t = 4.34$; 9 d.f. $< .05$). Only in the case of the acupuncture group was this difference observed between trials 1 and 2. All three groups lowered their pain ratings on trial 3 as compared with trial 1 (see table 1). Only in the case of the placebo 2 group was this change significant ($t = 3.24$; 9 d.f., $p < .02$) whereas the other two groups' change in this same direction was not significant ($t = 1.9$; 9 d.f., $p < .10$).

Pinprick. There were no significant differences between the ratings of the three groups on the pain from pinpricks in either the right hand ($F < 1.0$) or the left hand ($F < 1.0$) (see table 2). Nor were there any significant differences between the left and right hands for any of the groups ($t = .74$, $t = 1.27$, $t = .57$, 9 d.f., n.s.).

Ratings of Effectiveness of Acupuncture.

The mean ratings of the effectiveness of acupuncture before and after the experiment decreased in all three groups (see table 3). The

differences between groups in the estimated effectiveness of acupuncture were not significant before or after treatments ($F = < 1.0$). Only in the case of placebo 1 was the decrease significant while the decrease for placebo 2 approached significance.

Figure 1 MEAN RATINGS OF PAIN AFTER IMMERSION OF RIGHT (TREATED) HAND IN ICE WATER ON TRIAL I FOR THE ACUPUNCTURE AND PLACEBO GROUPS

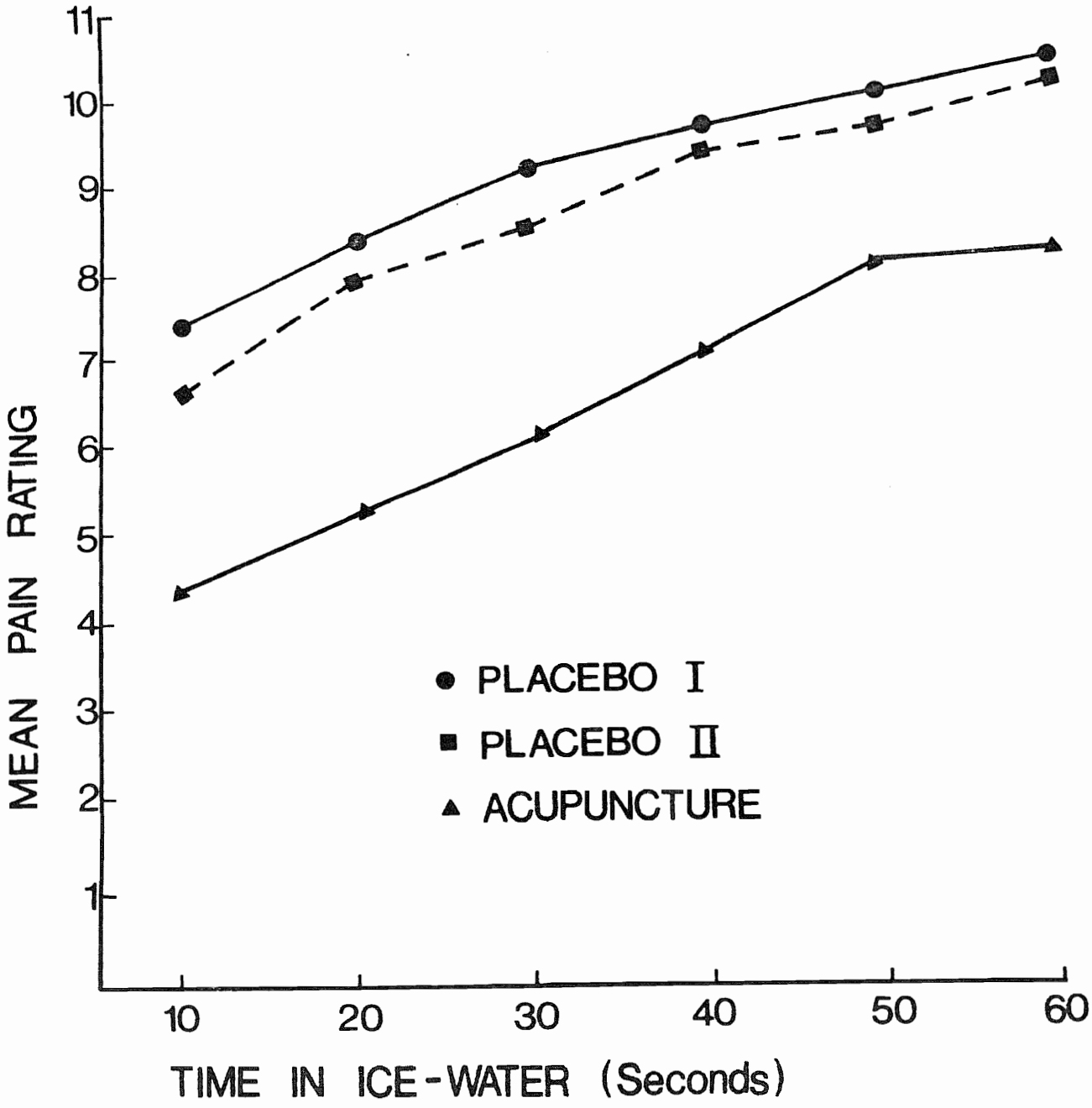
MEAN PAIN RATING
11
10
9
8
7
6
5
4
3
2
1
PLACEBO I
PLACEBO II
ACUPUNCTURE
10
20
30
40
50
60
TIME IN ICE-WATER (Seconds)

TABLE 1

Mean Ratings of Pain of Ice Water

Group	Trial 1	Trial 2	Trial 3
Acupuncture	6.6	7.8	5.9
Placebo 1	9.1	9.0	8.5
Placebo 11	8.7	8.9	7.8

TABLE 2

Mean Ratings of Pinprick Pain

Group	Right Hand	Left Hand
Acupuncture	1.7	3.4
Placebo 1	2.2	2.4
Placebo 11	2.1	2.9

TABLE 3

Ratings of Effectiveness of Acupuncture

Group	Before	After	t 9 df.	
Acupuncture	6.5	5.3	1.57	N. S.
Placebo 1	7.7	5.5	2.01	< .10
Placebo 11	6.7	4.5	2.50	< .05

DISCUSSION

On trial 1 the acupuncture group reported significantly less pain than the placebo groups. The acupuncture treatment appears to have produced analgesia for the pain of ice water. The differences in reported pain cannot be attributed to suggestion since the same preconditions existed for each group, identical in every form except placement of needles. Nor can this difference be attributed to counter irritation since the needles were removed prior to testing and removal of the blindfold. In addition, the acupuncture group reported less pain than the placebo 2 group who received needles inappropriately placed and the same electrical stimulation.

On this first trial six subjects of the acupuncture group demonstrated very clearcut analgesic effects. In the remaining four subjects the analgesic effect did not appear to be present as determined by their pain ratings. The reasons accounting for their failure to demonstrate analgesia are debateable. It is possible that longer periods of stimulation, or perhaps leaving the needles in during testing, may have produced the desired effect. In other words, the tolerance level they initially had for ice water pain may have been much lower. If these subjects had not received the acupuncture treatment they may have all withdrawn their arms after 30 seconds rather than 60 seconds (only one of these 4 subjects removed her arm and that was after 50 seconds, whereas 3 subjects in each of the other two groups had removed their arms after 40 seconds). Alternatively, anatomical differences between subjects might also account for the differences

observed with these four subjects. In either case the analgesic effect demonstrated by the six subjects was of sufficient strength to significantly lower the mean for the entire group.

On trial 2 the acupuncture group did not report significantly less pain than either of the placebo groups. The finding that the groups did not differ significantly on this trial eliminates the possibility of a randomization error (all high tolerance subjects ending up in the acupuncture group). Furthermore, the finding that only the acupuncture group reported significantly more pain on this trial than on trial 1 may be interpreted as evidence that the analgesia was specific to treated limb.

On trial 3 each group reported less pain than on trial 1, and significantly less pain than on trial 2. An explanation of the lower ratings on trial 3 is difficult. It is possible that a placebo effect was starting to appear for the two placebo groups, whereas a contrast effect (treated vs untreated arms) might account for the difference with the acupuncture group. Alternatively a practise or habituation effect may have developed in each group, thereby lowering the overall pain ratings.

Analgesic effects were not observed for the pain of pin prick. There are two possible reasons for this failure. First of all, acupuncture may not be effective in attenuating pin prick pain. Secondly, the pain caused by the pin prick may not have reached sufficient intensity or duration for one to discriminate the presence or absence of analgesia. Mann (1973) tested over 100 subjects for acupuncture analgesia and failed to find

attenutation for pin prick pain. Becher (1966) found that in order to demonstrate analgesic effects experimentally that were similar to those observed clinically it was necessary to apply a source of pain which would be eventually rated by the subject as "distressing or unbearable." Once this criterion was reached analgesic effects observed experimentally corresponded very closely with those observed clinically. In the case of the present pin prick data it would appear that the resulting pain was not sufficient in duration or intensity to establish whether or not there was any analgesia. In either case the pin prick pain still proved useful in ascertaining whether or not the subject understood the rating scale, without exposing them to or influencing their later ratings of ice-water pain.

The finding that the pre-ratings of acupuncture were very close among all three groups and the finding that the acupuncture group's rating was initially the lowest weakens the possibility that there were any significant differences in expectation of the groups. Moreover the significant decrease in the ratings of acupuncture by the placebo 1 group suggests that subjects in this group believed they had received an acupuncture treatment. Presumably their ratings decreased because they believed they had received acupuncture yet it was ineffective in blocking their pain. Similarly, the placebo 2 group's change approached significance thereby demonstrating the same effect. These results appear to indicate that each subject believed she was part of the treatment group.

The acupuncture group's ratings of ice-water pain, when the

treated hand was immersed, were consistently lower than the ratings given by the placebo groups. The expectations of all three groups were similar, and as indicated by the post ratings on the effectiveness of acupuncture each group thought they had received acupuncture. Therefore, these results support the conclusion that the lower pain ratings of the treatment group did not result from psychological factors. Instead, these results support an explanation in which acupuncture is viewed as producing a neurophysiological effect which attenuates the pain signal.

Melzack (1973) has recently suggested that his Gate Control Theory of pain (Melzack & Wall, 1965) can explain the effects of acupuncture. According to this theory, activity in large myelinated A fibres operates to close a "gate" located in the spinal cord, preventing pain signals from passing to the brain. If acupuncture activates A fibres, the gate would be closed and analgesia observed. In a study supporting the Gate Control Theory, Wall and Sweet (1967) applied electrical stimulation to the sensory nerves supplying an area of the skin from which chronic pain was reported. In four patients they found that stimulation for only two minutes eliminated pain for a period greater than 30 minutes. Since large diameter A fibres have the lowest electrical threshold, Wall and Sweet suggest that the stimulation activated these fibres and closed the gate. While the results of Wall and Sweet (1967) are similar to those found here it should be noted that the needles in the present study did not appear to be located near sensory nerves. However, it is possible that the same mechanism underlies both effects.

The phenomena demonstrated by Wall and Sweet and that of the present study can be interpreted as proximal effects within the Gate Control Theory. That is, pain resulting in a limb from small fibre activity is inhibited by stimulating the large fibres of the same limb, with the assumption that the pain signal is blocked where both networks enter the spine. However, distal effects have also been demonstrated for blocking pain. Man (1973) needled and electrically stimulated the ear lobe of subjects resulting in reports of analgesia in the opposite knee. This finding and others like it are difficult to explain in terms of only a spinal mechanism since the stimulation and pain signals enter the cord at different places, thereby not affecting the same "T" cells.

Melzack (1973) reviews findings dealing with the interaction of distant body sites in perceived pain. Slight stimulation of specific zones, (trigger areas) may cause pain which is intense and prolonged, where "injection of an anesthetic into the trigger area" has on occasion stopped the pain for days. Melzack (1973) states unequivocally that, "There is still no satisfactory explanation of these prolonged effects" (p. 9). The explanation that Melzack does offer is based on the postulation of a further control mechanism in the brain stem capable of a descending inhibitory effect. Evidence for this descending effect was obtained in research involving electrical stimulation in specified areas of the brain stem in both the cat and rat. This stimulation resulted in analgesia over a major portion of the body surface. Perhaps, acupuancture analgesia produced through stimulation of distal sites results first of all in a

signal being projected to this mechanism thereby triggering the descending effect.

After the present study was completed Clark and Yang (1974) reported that the analgesic effects of acupuncture on pain induced through radiant heat are restricted to suggestion, not physiological attenuation of the pain signal. This result is not surprising since the Shanghai First Medical College (1973) reported that acupuncture does not block heat induced pain. Furthermore, the duration of their pain stimulation was only 3 seconds thereby being inappropriate as a simulation of pathological pain (Beecher, 1966; Wolf, 1973).

Evaluation of acupuncture and its clinical effectiveness is possible. Asking the question, "Is acupuncture effective?" is somewhat similar to asking, "Is Psychotherapy effective?" Neither question offers any criterion to the individual attempting an answer. Instead, one might more productively ask, "What specific acupuncture treatments produce what specified changes in subjects or patients under what specific conditions." These questions constitute fertile territory for future research which will hopefully not only provide information on the not yet understood aspects of acupuncture, but will also provide a more complete understanding of the nature of pain.

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APPENDICES

Appendix Page

Appendix A

Ice Water Analysis: Trial 1

Source	DF.	S.S.	M.S.	F
Treatments	2	225.41	112.70	5.01
Error Between	27	607.45	22.50	
Trials	5	272.83	54.57	45.74
Trials x Treatments	10	7.32	0.73	0.61
Error Within	135	161.06	1.19	

Appendix B

Ice Water Analysis: Trial 2

Source	DF.	S.S.	M.S.	F
Treatments	2	55.89	27.95	1.91
Error Between	27	395.45	14.65	
Trials	5	311.38	62.28	65.25
Trials x Treatments	10	2.97	0.30	0.31
Error Within	135	128.86	0.95	

Appendix C

Ice Water Analysis: Trial 3

Source	DF.	S.S.	M.S.	F
Treatments	2	209.88	104.94	3.94
Error Between	27	718.92	26.63	
Trials	5	336.76	67.35	80.05
Trials x Treatments	10	3.86	0.39	0.46
Error Within	135	113.58	0.84	

Appendix D

Pin prick Analysis: Right Arm

Source	DF.	S.S.	M.S.	F
Between	2	1.4	0.70	0.21
Within	27	90.6	3.36	
Total	29	92		

Appendix E

Pin prick Analysis: Left Arm

Source	DF.	S.S.	M.S.	F
Between	2	1.8	0.90	0.25
Within	27	95.4	3.53	
Total	29	97.2		

Appendix F

Analysis of Effectiveness Ratings

of Acupuncture Pre-test

Source	DF.	S.S.	M.S.	F
Between	2	1	0.50	0.21
Within	27	64	2.37	
Total	29	65		

Appendix G

Analysis of Effectiveness Ratings

of Acupuncture Post-test

Source	DF.	S.S.	M.S.	F
Between	2	5.9	2.95	0.44
Within	27	183.1	6.78	
Total	29	189		