Comparison of the effects of deep manual acupuncture and acupressure on regional pressure pain threshold

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CERTIFICATE OF AUTHORSHIP/ORIGINALITY

I certify that the work in this thesis has not previously been submitted for a degree nor has it been submitted as part of requirements for a degree except as fully acknowledged within the text.

I also certify that the thesis has been written by me. Any help that I have received in my research work and the preparation of the thesis itself has been acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis.

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Abstract

Background: The two separate studies reported in this thesis represent the third and fifth in an ongoing series that commenced at the College of Traditional Chinese Medicine (TCM), University of Technology Sydney (UTS) in 1999 into the effect of acupuncture on regional pressure pain threshold (PPT). The studies extended manual acupuncture research and were the first to include a study involving acupressure.

Aims: Study I: To compare the effects of unilateral and bilateral needling of the same acupoint on regional PPT. In addition the effects of individual and combined needling of two distinct acupoints on regional PPT were examined. Study II: To compare the effects of manual acupuncture and acupressure on regional PPT.

Methods: The design was used in both studies that were dual blind within subjects experimental design with randomised repeated measures. There were 22 healthy subjects (11 males and 11 females) in study I and 24 healthy females in study II, and all subjects completed the four interventions used in their study. For Study I, the same needle application technique was used in four manual acupuncture interventions: Large Intestine 4 (LI4) unilaterally; LI4 bilaterally; Large Intestine 11 (LI11) unilaterally; and LI4 in conjunction with LI11 both unilaterally. For Study II, unilaterally applied manual acupuncture to LI4; to Spleen 4 (SP4); unilaterally applied acupressure to LI4 and to a nonacupoint (NAP) used in two previous studies at UTS. PPT was measured at ten regional measurement sites across the body before and after each intervention; the change was expressed as mean percentage change in PPT from preintervention to post intervention. Both within and between intervention comparisons were examined; visual analogue scales were used to measure participants' perceptions of pain; needling or acupressure sensations; tension, and anxiety; and changes in acupuncturist's behaviour.

Results: Study I: following all four interventions, statistically significant increases in mean PPT were observed. These occurred at nine sites following LI4 either unilaterally or bilaterally; at six sites for the LI11 intervention; and at five sites following the combined LI11 and LI4 intervention. These increases were significantly greater for the bilateral LI4 intervention than the unilateral LI4 intervention at only two sites. There were no statistically significant differences in the subjective perceptions among the four interventions. Study II: statistically significant increases in PPT were elicited by both acupressure interventions and acupuncture to SP4. There was minimal difference in the effectiveness of these three interventions. Surprisingly, acupuncture to LI4 was significantly less effective and only produced statistically significant elevations in mean PPT at three sites. The data and design were examined extensively to identify a cause for this finding which was at odds with those from study I and also from the four related studies of PPT and acupuncture to LI4 conducted at UTS. No source of bias was identified and again, no statistically significant differences in the subjective perceptions among the four interventions were identified.

Conclusion: Study I: Needling of LI4 both unilaterally and bilaterally produced similar generalised increases in regional PPT. There was some evidence that the bilateral intervention was marginally more effective than the unilateral one. This provides limited support for the assumption from acupuncture theory that bilateral needling of the same point enhances the treatment effect. Needling of LI11 alone and in combination with LI4 however, both produced significantly weaker effects than either of the LI4 interventions. The latter effect was not expected in view of the assumption from acupuncture theory that combined needling of points from the same channel should enhance the treatment effect. Since the effect observed was weaker than that for LI4 alone, this suggests that there is some form of interaction occurring as a result of the combined needling. The finding supports a similar interaction reported for a previous related UTS study involving the points LI4 and Liver 3 (LR3). Study II: While the study findings suggested that acupressure to either LI4 or the NAP produced similarly generalised and strong effects on mean PPT and which were also comparable to

acupuncture to SP4; the anomalous results for acupuncture to LI4 suggests that all the study findings be treated with caution. Since no source of bias could be identified to explain the relative ineffectiveness of the LI4 acupuncture intervention, a likely conclusion is that an atypical sample was involved in the study: an outcome that is always possible when relatively small samples of volunteers (ie 24 subjects) are drawn from the wider population. Replication of study II is strongly recommended.

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Chapter I: Introduction

1.1 Background to the study (study aims)

The earliest evidence of the development of acupuncture relates to the scrolls found at the *Ma Wang Dui* tombs believed to have written in the 3rd century BC (Harper 1998). These scrolls show 11 channels, which were stimulated with heat, rather than needled at discrete acupoints with needles. By the time the *Huang Di Nei Jing Su Wen* (*Yellow Emperor's Classic of Internal*) was first collated in approximately 206BC-24BD, the theory involved bloodletting as well as needling at specific acupoints, the first documented practice of acupuncture (Bai 2001). This medical text contains valuable and empirical knowledge that has been applied and passed down through generations of acupuncture practitioners in China and other Asian countries and is still used today (Unschuld 2003).

Acupuncture has continued to flourish and its clinical practice has been always based on traditional Chinese medical (TCM) theory and untested assumption. Sometimes even experienced Chinese acupuncturists expressed confusion when attempting to follow these concepts. With the development of evidence based practice in western medical science in China, practitioners and researchers sought to evaluate the effectiveness of acupuncture. Health professionals, who use conventional medical treatment based on evidence, also required proof of acupuncture's effectiveness, but traditional Chinese concepts could not adequately explain the "acupuncture effect" that was commonly observed in clinical practice. In the late 1960s and early 1970s, Chinese researchers began to explore the scientific basis of acupuncture using scientific research methods.

Interest by the west in acupuncture gathered momentum following the United States President Nixon's visit to China in 1971, when the New York Times reporter James Reston wrote a graphic account of his experience of an appendectomy under acupuncture analgesia. Since then, scientific researchers from all over the world have shown increasing interest in studying the clinical efficacy and mode of action of acupuncture. They used conventional medical disciplines, such as neurophysiology and neuropharmacology, applied scientific methodology and a growing body of literature has begun to emerge. Among all these works, the major research focus has been upon pain and acupuncture's reported ability to modify pain perception (Han 1982). The first scientific paper that demonstrated that acupuncture could elicit physiological effects came from the observation that acupuncture could increase pain threshold (Chiang et al 1973). A possible mode of action was later revealed when it was shown that needling caused the release of several neurotransmitters including the opioid peptides (Pomeranz 1977). This finding then initiated a series of studies that were to partially explain the neurophysiological mechanisms, and a deeper understanding of acupuncture was facilitated by the further findings of segmental sensory, autonomic modulation and variety of neurotransmitters, including enkephalins, endorphins, dynorphins, sertonin, oxytocin, calcitonin gene-related peptide (CGRP), nerve growth factor (NGF), cholecystokinin (CCK), which have been shown to be involved during acupuncture. Acupuncture began to gain scientific credibility and became a popular modality in the West for treating pain.

Although over the years, many hundreds of research reports on acupuncture have been published, there has been a somewhat shortsighted approach concerning which aspects of acupuncture require scientific scrutiny. That is, the major focus of research efforts has tended to test claims of acupuncture's therapeutic efficacy and or to elucidate its mode of action; by contrast, research has typically failed to examine the basic elements and assumptions, which were not clearly defined in ancient Chinese medical texts but are crucial to any evaluation of acupuncture's clinical efficacy. For example, do acupoints

exist? If so, can their physical locations be detected reliably? What are the dimensions (depth and surface area) of acupoints? Do these dimensions change from point to point, or with state of health? What parameters of needling should be applied? What specific functions do point possess? How can we evaluate the principles applied in point combination? How do we describe the relationship and difference between acupuncture, laser acupuncture, electro acupuncture, acupressure, etc.?

Since 1998, research within the College of TCM at the University of Technology, Sydney (UTS), has focused on a series of research studies evaluating some of these fundamental aspects of acupuncture. These included an examination of the reliability of the traditional *cun* measurement system (Coyle et al 2000), reliability of methods of acupoint location (Aird et al 2000), the role of specific needling parameters on pressure pain threshold (PPT) (Zaslawski and Cobbin 2001 and 2003), the site specificity (acupoint or nonacupoint) on PPT (Yuan 2003), and reliability of method for tongue diagnosis (Kim 2003). In the first of the series of studies that used PPT, Zaslawski et al examined the effects of site specificity: acupoint or nonacupoint, and the presence or absence of manual needle manipulation with shallow or deep needle penetration on PPT. Possible effects due to subjects' outcome expectations and their perception of the acupuncturist's behavior were also measured. Results showed that deep manual needle insertion unilaterally and the application of vigorous needle manipulation to the fourth point of the Large Intestine channel (LI4) achieved the most significant effects on PPT, and the distribution of these effects was generalised. In addition, this initial PPT study at UTS demonstrated a reliable research method that could be applied to many related studies, including the second UTS research project (Yuan 2002). This study involved needling of a second acupoint, which was the third point on Liver channel (LR3), as well as simultaneous needling of LI4 and LR3. The acupoint LR3 was included because it is traditionally thought to be an important acupoint in the treatment of pain syndromes and LI4 and LR3 are often needled together as a simple TCM prescription for pain and related disorders. The results showed that needling of LI4 alone replicated the findings

from the previous study by Zaslawski and colleagues; as well as demonstrated the effects on pressure pain threshold to be generalised bilaterally; the other two interventions (LR3 alone and LR3 in combination with LI4) achieved weaker effects on PPT than LI4 alone. The third study (present Study I) in this series was undertaken by the present researcher and was conducted to both partially replicate and extend the previous studies as follows:

1. it provided an essential replication of the study into the effects on regional PPT of deep manual needling of LI4 with vigorous needle manipulation;
2. it included needling of a new acupoint of the eleventh point on Large Intestine channel (LI11), for the following reasons:
   i. in view of the effects on PPT of needling a site designated as a nonacupoint (NAP) reported by Zaslawski and colleagues, inclusion of a further needling site would provide information concerning whether this is a general effect on PPT elicited by the deep needling technique, irrespective of site of needle insertion;
   ii. LI11 lies in the same channel as LI4, and in view of TCM channel theory, the points from the same channel have similar functions. Clinically, LI11 is commonly used with LI4 in combination for variety of disorders, including pain syndrome. While there has been no research data published that relate to effect of LI11 on experimental pain threshold, it is possible that this therapeutic effect on clinical pain may be linked to effects on experimental pain threshold;
   iii. needling of LI11 alone provided a control condition for the third intervention condition examined, this was the simultaneous needling of LI4 and LI11;
3. it examined the effects on regional PPT of the combined needling of LI4 and LI11. This was included because in Chinese acupuncture the combined use of individual acupoints from the same channel forms a prescription and represents a stronger acupuncture effect. LI11 was chosen because this point has similar function with LI4, and LI4 and LI11 in combination is often used in clinic for pain and other problems. Despite this usage, no well-controlled study has been published that has tested this assumption;

4. it examined the effects on regional PPT of the combined needling of LI4 bilaterally. According to acupuncture theory, needling an acupoint bilaterally is more effective than unilaterally. Currently, no research work concerning PPT has been reported that scientifically supports this traditional acupuncture concept.

Study I therefore aimed to examine:

1. effects on PPT of the four interventions independent of measurement sites;
2. effects of acupuncture on PPT of the four interventions (acupuncture at LI4 both bilaterally and unilaterally, acupuncture to LI4 and LI11 simultaneously and at LI11 alone) by individual measurement sites;
3. the distribution of regional PPT effects of the four interventions;
4. subject perceptions of the acupuncture experience among interventions.

A second study (present Study II) was also undertaken as part of this research program. Again, using the same PPT experimental model, it was designed to compare the effects on PPT of acupuncture and acupressure applied to the same point of LI4. The impetus for this study has been the observation that acupuncture can be unpleasant for some subjects since needling sensation (the heavy numbing sensation that acupuncture elicits at needling) is often quite intense, and some patients ask for acupressure instead of acupuncture. While the situation is that research in acupressure has been neglected in China for quite a long time, acupuncture practitioners are increasingly becoming interested in developing modern methods for point stimulation such as electricity and laser. Recently a number of studies have been published that evaluated the effectiveness of acupressure. This renewed interest lead the research team to explore the effects of acupressure and the relationship between acupuncture and acupressure reported in Study II.

Acupressure is based on the same theory, uses the same acupoints and has similar indications to acupuncture. Given the absence of any skin penetration, it is inherently safer and is more readily accepted. It is one of a number of TCM treatment methods

regularly used in practice and has been incorporated into many Chinese massage techniques. The origin of acupressure is not known, but it is possible that the Chinese discovered that pressing certain points on the body, not only relieved pain in the local region but also benefited distant parts of the body. In addition, people may have started to realise that pressing on some points could not only reduce pain but also influence the function of certain internal organs (Veith 1949). In 1973, Leng et al confirmed these clinical observations by conducting some initial research on acupressure. This early research finding supported the "Gate Control Theory", which had been introduced to partially explain acupuncture and mentioned that acupressure, similar to acupuncture, could modulate pain signals sent to the brain through a mild, relatively painless stimulation by closing the "gates" of the pain-signaling system (Leng 1973). In 1974, Han gave details about his findings that strong pressure on muscles and tendons has an inhibitory effect on neural discharge in the non-specific nuclei of the thalamus in rats and rabbits and the reticular formation in guineapigs (Bahr 1983). Later research found several naturally occurring opiates such as enkephalin and β -endorphin; and identified opiate receptor sites in the brain, spinal cord and other tissues; these findings were able to explain acupressure's function more completely (Beggs 1980). In 1984, Han also pointed out that needle manipulation manoeuvres stimulated the sensory fibres deep in the muscle and muscle tendon, and postulated that similar neural mechanism occurred for both acupuncture and acupressure (Han 1984). There was also unsubstantiated claims that acupressure is particularly good for health preservation. For example, when a point is pressed, the muscle tension under the finger pressure enables the fibres to elongate and relax; subsequently, blood can flow freely; toxins would be released and eliminated; and increased circulation brings more oxygen and other nutrients to supply the affected areas. Therefore, the body resistance to illness is promoted; a longer, healthier and more vital life is achieved and a greater sense of harmony, health and well being is achieved (Gach 1990). However such assumptions are mere speculation. At best it is true that acupressure is a noninvasive form of sensory stimulation that is relatively painless, is low-risk and requires no special equipment. In addition to these, there is little risk of

transmitting infectious disease, such as HIV, hepatitis and resistant bacteria, which remain a risk with invasive techniques like acupuncture (Felhendler et al 1996). In conclusion, acupressure is a well received therapy in clinical practice and is used widely now although evaluation of its efficacy is wanting.

Despite there being considerable reports and scientific data that demonstrated the efficacy of acupressure, there is a paucity of well controlled studies that could show that acupressure produces similar effects to traditional deep needling. Since different techniques are used in the two modalities, research findings for one may not fully explain the other. Uncertainties about the difference as well as the therapeutic relationship between acupuncture and acupressure have led to such clinical questions as: could hand manipulation achieve the same effects but with less pain comparing to needling stimulation? It is because of this question that Study II was designed to examine: the relative effectiveness of the noninvasive technique of acupressure compared with needling with strong manipulation, in order to determine if a more comfortable and acceptable method of achieving a significant increase in PPT can be obtained for the patient.

Previous research data have demonstrated that needling of the acupoint LI4 has been able to produce a general analgesic effect or a significant increase in skin pain threshold (Research Group of Acupuncture Anesthesia 1973; Chiang et al 1973; Stacher et al 1975; Brockhaus and Elger 1990; Mayer et al 1997; Han 1997; Zaslawski et al 2001 and 2003; Yuan 2002); the analgesic effect following acupuncture of LI4 was generalised and was not consistent with a distribution pattern that would be predicted by either western neural segment theory or TCM channel theory (Zaslawski et al 2001; Yuan 2002). However, further questions arose such as: does the induced analgesia by acupuncture on LI4 occur because of site specificity (Acupuncture Anesthesia Theory Research Group 1973; Soper et al 1982; Takeshige et al 1993; Han 1997); or do other acupoints, such as the fourth point of Spleen channel (SP4), have similar effects? SP4 is a classical acupoint on the

Spleen channel and has traditionally been used to treat digestive disorders. It is reported to reduce pain and blood stasis by regulating an extraordinary channel (*Chong mai*) and *Qi* (energy) circulation, therefore, can be used for general pain control. Currently there has been little rigorous research to evaluate clinical observations such as these. Obviously, further research on the effect on modulating pain threshold was needed; as a result, SP4 was introduced in the current research as a possible needling site for affecting PPT.

The aims of study II were to:

1. compare effects on PPT of the four interventions independent of measurement sites;
2. compare effects of acupuncture on PPT of the four interventions (acupressure on LI4, acupuncture at LI4, acupressure on NAP and acupuncture at SP4) by individual measurement sites;
3. examine the distribution of regional PPT effects of the four interventions;
4. examine subject perceptions of the acupuncture/acupressure experience among interventions.

1.2 Format of the thesis

Since the research has two distinct studies, literature review, methods, results and discussion and conclusion for each have been presented separately.

Chapter II: Literature review

This chapter includes an evaluation of previous research into the effects of acupuncture and acupressure on experimental pain threshold, the methods used to measure pain threshold and the needle prescription. Since little research evidence is available concerning the clinical effectiveness of LI11 and SP4 in general, information from TCM textbooks has been reported.

Chapter III: Methods

Chapter III describes the experimental design and procedures for the two studies (Study I and II). It includes a justification of the statistical model and analyses applied to the data.

Chapter IV: Results

The results are presented separately for the two studies: Part A presents Study Ⅰ; Part B presents Study Ⅱ. In general the presentation of results follows the same order as the above statement of research aims. To assist in flow of content, result tables of the analysis of variance have been placed in Appendix II and only the 95% simultaneous Confidence Intervals (CI) and associated *post hoc* significance levels reported in the tables and text.

Chapter V: Discussion and Conclusion

In keeping with Chapter IV, the findings for the two studies are discussed separately and then in combination. This chapter then examines implications arising from the results of the two studies and includes future research directions.

Appendices

Appendix I: comprises a copy of the information sheet provided to subjects and the consent form they completed when entering the study (for both studies).

Appendix II: presents the statistical analysis tables from the General Linear Model (GLM) applications to the data. These are presented under the same headings as those shown for the relevant sections in Chapter IV (for both studies).

Chapter II: Literature review

2.1 Acupuncture and pain threshold

This review focuses on research concerning acupuncture's effects on pain threshold, and in particular on studies: (1) that used manual acupuncture rather than other modalities; (2) that included a control intervention.

A systematic search for controlled studies using manual acupuncture for experimental pain was completed at the library of UTS through the following electronic databases: Medline, AMED, Google, Health Star, Current Contents and CINAHL. "Acupuncture" and "experimental pain threshold" were entered as the key words. Search findings revealed that there have been very few controlled studies about the effect of manual acupuncture on pain threshold. Indeed, an extensive literature review identified only 15 papers for which the methods included a control condition. In these studies, pain threshold was measured using a variety of pain challengers, including dental electrical pain, thermal pain, cold pain and chemical pain due to tissue hypoxia. Both human and animal studies are reviewed.

The earliest report was from China by Chiang et al (1973), who measured six sites located on different parts of the body. This study used a crossover design with 11 men and 10 women participating; pain threshold was measured before and after 16 minutes of administration of acupuncture at LI4 and the tenth point on Large Intestine channel (LI10) unilaterally; and needles were manipulated strongly. Pain threshold was found to increase significantly at all six measurement sites. However, there was a failure to blind the subjects and insufficient details of the method were reported to permit the study to be replicated.

It was also reported by Bahr in 1983 that dating back to 1974, Han et al already demonstrated on ten rabbits, the ability of acupuncture therapy to reduce pain and the acupoint selected was the thirty sixth point on Stomach channel (ST36). At the same time another control group of ten rabbits was tested to measure variations in the threshold. The pain challenger was strong thermal heat applied to the nostrils of the blindfolded rabbits. A stopwatch was used to measure the length of time before the animal moved its head to one side to avoid the heat stimulus, and this length of time was used to measure pain threshold. It was observed that acupuncture raised the pain threshold by 128 percent. The small sample size (N=10) and inadequate description of the acupuncture manipulation make replication difficult.

In 1972 the National Institutes of Health (NIH) in USA gave its first grant to acupuncture study which reported that effects observed following acupuncture were not due to hypnosis that acupuncture alone could increase pain threshold (Ulett et al 1998). In addition, during the last three decades numerous related research were reported by international scientists, among which three studies of pain threshold in 1975 used electrical stimulation of the skin on the forearm as the pain challenger. Saletu et al (1975) had a crossover design study involving 20 subjects to compare four different modes of acupuncture: manual acupuncture and electro acupuncture were administered at two acupoints of LI4 and the seventh point on Large Intestine channel (LI7); sham acupuncture and sham electro acupuncture were at two unspecified sites; the control used an injection of saline. The result indicated that pain threshold increases were observed only following electro acupuncture. Design limitations included failure to blind the subjects and nonrandomisation of the sessions, possibly leading to order bias. The lack of similarity between saline injection and acupuncture intervention may also have contributed to subject bias.

Stacher et al (1975) used 12 healthy subjects and the pain challenger of electrical stimulation of the skin overlying the thyroid (neck) in a single session crossover design.

The control involved needling arbitrary chosen points located on the forearm and the active acupuncture consisted of needling the acupoints LI4 and the sixth point on Pericardium channel (PC6). They observed an increase in pain threshold following needling of the acupoints compared to the control nonacupoints. However, the validity of the results is questionable since the entire study did not allow for wash out of treatment effects and it was completed in a single session.

A study by Li et al (1975) used a different pain challenger (electrical stimulation to the supra orbital branch of the left trigeminal nerve) and 14 subjects received acupuncture to LI4, LR3 and some other acupoints. Needling a nonacupoint three to four cm away from LI4 was applied in the control group. Significant increase was reported in neither pain threshold nor pain tolerance following either intervention. The failure to blind the subjects and the haphazard treatment protocol again make the results difficult to interpret and the validity questionable.

In 1976, Croze and colleagues measured thermal pain threshold on the thenar eminence of the palm. Eight subjects were randomly ordered to receive two separate interventions, either acupuncture at two classical points (LI10 and ST36) or needling at nonacupoints located one cm away from these two classical points mentioned above. Results were variable since four subjects achieved significant increases in pain threshold and the other four showed no any change.

In a study conducted by Mayer et al (1977), electrical stimulation was applied to the upper canine tooth as the pain challenger and 35 subjects received acupuncture to LI4. There were two control groups consisting of a no treatment group (40 subjects) and a placebo control group (31 subjects) who received an intravenous injection of saline and told that they were receiving a powerful analgesic drug. Only in the acupuncture intervention group was a significant increase in pain threshold induced. It was possible that the control condition lacked credibility in view of its lack of resemblance to

acupuncture intervention, therefore possibly introducing subject bias. Replication of the study is not possible since insufficient details were given concerning the allocation of subjects to groups.

Effect of acupuncture on experimental pain has also been measured in animals. In 1978, Ha and Tan applied electrical stimulation to the upper or lower canine tooth pulp of three adult monkeys (*Macaca cyclopis Swinhoe*). They implanted two electrodes, which were connected to terminals fixed to the skull by means of wires buried beneath the mucosa of the gingival and subcutaneous tissue of the neck and scalp, into two small holes two to three mm apart on the buccal aspect of the canine tooth. The effect of electrical stimulation to the tooth pulp was evaluated by the Jaw-Opening-Reflex (JOR) and the minimal electrical current required for producing JOR was referred to as the pain threshold. The points needled were LI4, ST36 and the forty fourth point on Stomach channel (ST44) which commonly used for dental pain; needles were manipulated manually in the traditional way by rotating or lift and thrust. The effects of acupuncture on JOR were compared with those of narcotic analgesic drugs (morphine-HCI, meperidine-HCI), sodium pentobarbital and with a saline control, all administered intravenously. The saline injection resulted in no change in the threshold of tooth pulp stimulation; acupuncture produced a gradual elevation of the tooth pulp threshold at all three acupoints, reaching a value of 75% to 120% greater than the control after a period of induction of 15 to 20 minutes; the drugs all produced marked increases in pain threshold levels. In 1982, similar research was conducted on four Taiwan Rock monkeys by Ha and his colleague Tan, and the main points used included the above mentioned three points (LI4, ST36 and ST44), as well as the third point on Large Intestine channel (LI3), LI10, LI11 and the sixth point on Spleen channel (SP6) for comparison. The results showed that adequate stimulation to particular acupuncture points in upper or lower limb in the monkey produced a reliable increase in tooth pulp pain threshold, and acupuncture to LI4 and ST36, produced a better analgesic effect than to other points.

In 1982, Lin and colleagues evaluated the effects of needling two acupuncture points (SP6 and LI11) bilaterally on thermal pain threshold, measured on the palm of the hand or the sole of the foot. Needling right SP6 produced a significant increase on the sole of the right foot only; and needling the left LI11, only a significant increase on the palm of the left hand. The variability of responses may have resulted from the small sample size, and significant design weaknesses included non-randomization, inadequate details of the allocation procedure and failure to blind subjects.

Another study used the pain challenger of immersion of the hand into iced water, to measure cold induced pain threshold (Ashton et al 1984). The 46 subjects were randomly allocated to one of four treatment groups: one group received acupuncture to a nonacupoint; two groups received TENS at 100Hz and 8Hz respectively; the fourth group acted as a control one, in which subjects received a placebo pill and were told it could be either aspirin or a placebo. In both the acupuncture and 8Hz TENS group, pain threshold increased; however, small numbers in each group and the use of a poorly defined needling site limit the value or even interpretation of the findings.

In 1989, Lundeberg et al studied the effect of acupuncture on sensory thresholds on six healthy volunteers (four female and two male). The aim was to compare the possible mechanisms producing modulation in pain-mediating pathways during different modes of acupuncture (manual acupuncture, electrical stimulation at 2 HZ, electrical stimulation at 80 Hz and superficial acupuncture as placebo). Insertion of needles or application of electrodes were applied bilaterally at the seventh point on Stomach channel (ST7) (intrasegmental) or LI4 (extrasegmental) for 40 minutes; thresholds were measured 10 minutes before, 10 and 30 minutes after start of treatment, and 20 minutes after the end of treatment. The results of this study showed that acupuncture applied within the same neural segment (ST7) as the test stimulus, resulted in a marked elevation of dental pain threshold; other sensory thresholds (thermal, vibrotactile and electrotactile) were unaffected by such conditioned stimulation; superficial acupuncture had no significant

effect on the sensory threshold. This experiment, however, was flawed due to the small sample size, lack of details on randomization of the different modes and failure to blind subjects.

A later study by Brockhaus and Elger (1990) measured thermal pain threshold at the ventral side of the forearm. Forty subjects were randomly assigned to either an acupuncture group (bilateral needling of LI4) or a placebo group (needling of a nonacupoint located one cm away from LI4). It was found that a significant increase was achieved in the group that received the needling at LI4 whilst the placebo group failed to reach any significance.

Johnson et al (1996) measured electrical pain threshold at the left index finger in a well designed single blind study. One group received acupuncture at PC6; the second group received acupuncture at the twentieth point on Gold Bladder channel (GB20); the third group received sham acupuncture at GB20 with no needle inserted; and the fourth group was a situation control that received no acupuncture; and 24 subjects were randomly allocated to one of them. Although an increase in pain threshold was reported for both the PC6 and GB20 groups, these changes failed to reach significant level when compared to either the sham group or the control group. The weakness of this study is still the small group number which may preclude a definitive conclusion.

More recently, the effect of both manual acupuncture and low frequency TENS on electrical tooth pulp stimulation was evaluated by using PPT in a crossover design study (Widerstrom-Noga et al 1998). The pain challenger was electrical tooth stimulation to the incisor tooth. The 21 subjects randomly received both acupuncture to a variety of facial acupoints and to LI4, as well as low frequency TENS to the upper limbs and the infra orbital foramina on the face. Subjects were allowed to rest between each intervention. Results indicated a significant increase in pain threshold following acupuncture treatment but not TENS, and the research noted that the analgesic effect of acupuncture did not

return to baseline even after a 20 minutes rest between each intervention. Therefore, it casts a doubt on the appropriateness of a 20 minutes washout period, as well as the validity of the study findings.

In summary, despite using a variety of pain challengers, the present evidence as it stands does not demonstrate convincingly that manual acupuncture increases pain threshold reliably. However, this may well reflect the methodological inadequacy of much of the research rather than lack of actual physiological effects of acupuncture. The above mentioned studies had a variety of methodological problems which included insufficient study numbers, inappropriate crossover design, poor choice of a credible control intervention, etc..

2.2 Acupressure and pain threshold

Upon reviewing the literature, there was little information on acupressure on pain threshold. A review of electronic databases using the terms "acupressure" and "experimental pain" was completed at the library of UTS. Only three controlled studies were found; two of these have already been mentioned in relation to the effects of acupuncture on pain threshold (Han 1974, Ha and Tan 1982) and the details on acupressure on pain threshold from these two studies are included in this section.

In 1974 Han demonstrated using a rabbit model that acupressure to the sixtieth point on Bladder channel (BL60) at a frequency of two movements per second was observed to increase pain threshold by 133 percent; a control group was tested at the same time to measure variations in the threshold; each group consisted of ten rabbits. The method of applying and measuring pain was to direct a strong heat ray at the nostrils of a blindfolded rabbit. The length of time (measured by a stopwatch) before the rabbit moved its head to one side was used as the pain threshold. Unfortunately, there were no

other details mentioned in this study and the lack of detail makes reproduction unfeasible.

In 1982 a study by Ha and Tan of tooth pulp pain threshold, was conducted in four adult Taiwan Rock monkeys. Heavy finger pressure was applied to LI4, ST44, ST36, LI3, LI10, LI11, SP6, as well as some muscle sites, and acupuncture was used on the same points for comparison. Results showed that pain threshold in the acupressure group was significantly increased across all the points mentioned after two to three minutes finger stimulation; this effect was characterised by a shorter induction period and higher elevation of threshold, especially at the point ST44, compared to acupuncture.

In 1996, Tekeoglu and colleagues reported their study on experimental pain. In this study auricular pressure was applied to the toe somatic point on the ear, with pressure sensitivity being measured on the skin of the toe before and 30 minutes after the treatment with an algometer. They allocated 60 healthy student volunteers alternatively, in order of arrival, to one of two groups of 30. No volunteer was taking analgesic or tricyclic drugs that might have interfered with the measurement of pain sensation. The assessor was blind to the form of treatment, and student *t* test was used for statistical evaluation. For the study group, the ear point was pinched by thumb and index finger until the subject felt pain at a just bearable level, then the pressure was applied for 15 minutes and the increase in pain threshold was statistically significant ($p=0.0001$); for the placebo group, the thumb and index finger were touched on the ear point for the same period of time without pinching to induce pain and there was no significant change in pain level. Failure to randomise makes the study's finding questionable.

Since the theoretical basis of acupuncture and acupressure both derives from a common source of traditional Chinese medicine, the abundant acupuncture literature can be used to provide the theoretical and research foundation of acupressure. Caution must be used, however, in attempting to apply research findings regarding acupuncture techniques

directly to acupressure, since different techniques are used in the two treatment methods and research findings for one may not be applicable for the other.

2.3 Measuring pain threshold

Whilst there is no objective measure of pain, the response to a painful stimulus can be assessed in normal individuals by two qualitative descriptors, namely pain threshold and tolerance. Pain threshold is defined as the lowest level at which the individual perceives the stimulation as painful; pain tolerance is the highest level tolerated of a perceived painful stimulus (Weisenberg 1977). These two variables are dependant on a variety of factors, such as sexual, social, cultural, ethnical and psychological factors. Since each of them has its own advantages and limitations, the ethical concern that pain threshold causes no potential tissues damage to subjects determined the choice of pain threshold in the present study.

2.3.1 Experimental models

Earlier experimental pain models often only involved induction of cutaneous pain, while recently new experimental models have been developed eliciting deep muscle and visceral pain that may more closely resemble the clinical pain condition. No matter which type of pain model it considered, the ideal pain challenger exhibits the following qualities: 1) non invasive: produce no tissue damage; 2) specific: measure pain and not other sensations; 3) sensitive: be able to measure pain within a range which is ethically acceptable and physiologically relevant; 4) measurable: show a relation between stimulus and pain intensity; 5) variable: from zero to maximal tolerable levels; 6) reproducible: frequently repeatable with no change in the response over time (Arendt-Nielsen 2002). However, no single experimental pain stimulus possesses all these qualities, and the aim and the type of the experiment determines the selection of the stimulus (Gracley 1999). The most common experimental pain models can be classified into three main groups

according to the stimulus modality, namely chemical, thermal and mechanical. Further, an additional stimulus, electrical, is often mentioned.

2.3.2 Electrical pain threshold

Electrical stimulation has been widely used to evoke a painful sensation in both human subjects and animals to measure pain threshold (Carlin 1962; Bromm 1980; Chudler 1986; Drewes 2002). The most commonly used model involves the electric stimulation to the dental pulp. This method is easy to apply, has a fast onset and offset, and shows a relationship between the perceived pain and the magnitude of the electric stimulus (Carlin 1962; Morosko 1966; Dworkin 1982; Fernandez de Lima 1982; Leavitt 2002). In addition, electrical stimulation can also be applied to the skin (eg with potassium ionophorese), to which a potassium chloride gel is applied, and K+ ions passed through the skin. When a current passes through the gel, this produces a painful sensation. This method produces a linear relationship between the perceived pain and the magnitude of the current (Johnson 1998). However, this technique has a number of disadvantages: 1) it requires a sophisticated and isolated power source; 2) sites at which thresholds are to be measured must be marked accurately and require skin preparation to ensure reliable electrical contact; 3) this form of stimulation is not a natural stimuli, therefore subjects may have negative associations concerning pain and electrical stimulation; 4) it diffusely stimulates several sensory modalities other than nociception. Other methodological problems concern the wide variability in electrical tooth pulp thresholds, the requirement to have healthy amalgam free teeth, and the assumption that tooth pulp stimulation only induces pain despite the abundance of other types of myelinated sensory fibres present in tooth pulp (Sessle 1979, Matthews 1979). A recent study found that electrical tooth pulp stimulation is far less sensitive in detecting changes in threshold and the authors related this to the likelihood that other additional mechanisms are brought into play by electrical tooth pulp stimulation (Olausson 2000). In conclusion, there is a need for further refinement in regard to choice and use of an instrument, such as electrical stimulation, to measure pain threshold.

2.3.3 Chemical pain threshold

Chemical stimulation is widely used and can produce very severe localised pain (for example, burning or deep pain). The injection of capsaicin, hypertonic saline and potassium chloride solution has been used in experimental pain models (Simone 1989; Jensen 1992; Svensson 1998; Graven-Nielsen 2001; Arima 2001). Unfortunately, this chemical stimulation can only be applied once.

2.3.4 Thermal pain threshold

Thermal stimulation can be performed by using either a heat or cold pain stimulus. Heat pain can be evoked by argon laser stimulation, which is safe and reproducible in pain measurement (Olausson 2000). This form of stimulation is quite unique since laser stimulation can activate only nociceptive afferents without simultaneously activating the mechano-sensitive afferents (Arendt-Nielsen 1988). In addition, some other methods and devices for heat stimulation of the oesophagus have also been developed recently (Drewes 2002). Submerging a limb into ice cold water (1-2^{o} C) is another method used to evoke cold pain, however it is unable to show spatial summation and its onset is rather slow (Walsh 1989).

2.3.5 Mechanical (pressure) pain threshold

Pressure pain, a familiar sensation experienced in daily life, is a commonly used method for assessing musculoskeletal pain (Fischer 1998). Pressure pain can be evoked by mechanical stimulation, such as impact, puncture, brush and pressure, and commonly used instruments include algometer, brush and Von Frey filaments. The Von Frey filament consists of a single nylon fibre or monofilament, which is pressed incrementally against the subject's skin causing a pressure sensation and finally pressure pain. In an experimental situation, the load is gradually applied on the filament until the filament bends at a certain point, then the pressure stabilises and does not increase further. As a widely used standardised way, this method is not only cheap and easy, but also reliable and reproducible between and within examiners (Bell-Krotoski 1987; Voerman 1999).

2.3.6 Algometry

More recently, the technique of pressure algometry has been well appreciated by the medical community as a valid and reliable measure of local PPT in subcutaneous and underlying tissues. The hand held algometer is a simple spring loaded pressure (force) gauge with a rubber plunger. The researcher holds the algometer against the skin of the subject, pressure is applied gradually until the subject "perceives" the initial pressure change to a distinct sensation of unpleasantness or discomfort. At this point in time the pressure is terminated and is defined as the PPT. This technique has been studied widely and is being increasingly used as a diagnostic tool for many painful musculoskeletal conditions, as well as in related research (Fischer 1986). It may give a well defined pressure at a constant rate; repeated algometry does not change PPT in healthy muscles over three consecutive days; reliability is improved if the same person completes all of the measurements; if the initial measure of trials is discarded; if adequate rest time between repeated trials is included and if the pressure gauge is advanced at the rate of 1Kg of pressure per second (Nussbaum 1998). Higher reliability is also achieved between and within experimenters when measuring marked point locations (Reeves 1986). Algometry also has several advantages over other pain stimulation techniques, especially if pain threshold is measured at a variety of sites on the same subject. Therefore, algometry is both a suitable and reliable method for measuring PPT under both experimental and clinical situation (Fischer 1987; Ohrbach 1989; Brennum 1989; Antonaci 1992; Kosek et al 1993). For these reasons, algometry was used to measure PPT in the present research. In addition, normal pain free individuals were selected as subjects because it allowed precise control of experimental condition.

Does algometry produce an "acupressure like" effect? Given that both studies examines experimental PPT and study II includes an evaluation of possible effects on PPT by acupressure, it is essential to first establish that the actual measurement of PPT by algometry does not affect PPT. That is, that the measurement method is not introducing an uncontrolled extraneous variable that could significantly affect findings. Fortunately,

previous research at UTS (Zaslawski & Cobbin 2001), which is the first study in this series at UTS that utilized the same experimental model from the following studies and included a sham inactive laser intervention in 31 subjects, has already demonstrated that this does not occur in the experimental paradigm used in the present research. This first research found that there was no any treatment effect from continuously using the algometer and the inactive laser did not cause any effects on PPT; it did achieve some increase in PPT on ten measurement sites used but not significant.

2.4 Prescription needling

The needling of a single acupuncture point is rarely used in a clinical situation and there are a number of traditional methods for combining acupoints to form a prescription (O'Connor 1981). Experimental pain studies have been conducted, both in China and overseas, on the effect of a single acupoint, yet little attention has been directed to the effect when two or more acupoints are used as a prescription. The use of the two acupoints in one treatment has been documented in classical medical literature in ancient China, as well as in clinical situations. According to acupuncture theory, points from the same channel have similar effects and are commonly used together to strengthen the treatment effect. Both LI4 and LI11 are commonly used acupoints on the LI channel, and have been indicated for pain syndrome (eg tennis elbow, diffuse arm pain) (Mok 2000; Tariq 2000; Webster-Harrison et al 2002; Yen 2003).

Chapter III: Methods

Study I

3.1 Subjects

Subjects were recruited from noticeboards at UTS and by word of mouth. Table 3.1 shows that 22 healthy subjects (11 male and 11 female) were recruited for the study. Table 3.2 summaries the related data (age, weight, height and left/right hand) by gender for the subjects, as well as their responses to the questions shown in Figure 3.1. Ethical clearance was obtained form the UTS Human Research Ethics Committee prior to commencing the study (see Appendix I for a copy of the information sheet and consent form given to the subject). Subjects were required to abstain from taking medication such as analgesics on the day of experimentation. If they reported having taken medication, they were rescheduled to another day.

	Numbers
Males	11
Females	11
Total	22

Table 3.1: Basic data for subjects in Study I.

Personal details	Female		Male		Total	
	mean	sd	mean	sd	mean	sd
Age in years	29.6	8.7	28.6	10.8	29.1	9.6
Weight in kg	61.5	16.2	71.8	6.2	66.7	13.1
Height in cm	165.8	6.8	175.2	6.5	170.5	8.1
Left or right handed (right=1/ left=2)	1.2	0.6	1.0	0	1.1	0.4
Belief score %VAS	92.2	8.8	85.3	15.6	88.8	12.9
Receive therapy score %VAS	98.2	2.9	86.3	20.9	92.3	15.8

Table 3.2: Demographic data collected for subjects in Study I (sd = standard deviation).

PLEASE INDICATE BY MARKING SOMEWHERE ON THE LINE YOUR ANSWER TO THE FOLLOWING QUESTIONS

1. Do you believe in acupuncture?

0 100

It certainly has no effect — It is certainly effective

2. Would you be willing to receive acupuncture as a form of therapy?

0 100

Never — Anytime

Figure 3.1: The 100mm Visual Analogue Scale (VAS) for recording subjects' beliefs in the effectiveness of acupuncture and their willingness to receive acupuncture as a therapy, completed during the first session (after Roth et al 1997).

3.2 Methods

3.2.1 Subject allocation

Subjects were allocated using an envelope method, to receive all four interventions in a random sequence. Twenty two different intervention sequences were written on a slip of paper and each inserted into a separate envelope respectively. On commencing the study, each subject selected one envelope and this determined the sequence of interventions for that particular subject. At no time was the subject, or the researcher measuring the PPT with the algometer or the researcher recording the measures onto the record sheet, aware of which intervention the subject received.

3.2.2 Intervention procedure

Subjects were blinded throughout all interventions by drawing a curtain between the line of vision and the intervention sites. Each intervention was administered once with at least one week between sessions. For Study I, the interventions were:

1. acupuncture at LI4 on the right arm;
2. acupuncture at LI4 and LI11 simultaneously on the right arm;
3. acupuncture at LI11 on the right arm;
4. acupuncture at LI4 on both arms of the body.

3.2.3 Location of intervention sites

LI4: on the dorsum of the hand, between the first and second metacarpal bone, in the middle of the second metacarpal bone on the radial side. It is at the highest point of the adductor pollicis muscle when the thumb is adducted.

LI11: the point of the lateral end of elbow crease, midway between biceps brachii tendon and the lateral epicondyle of the humerus.

3.2.4 Intervention technique

For each needling session, a single 30mm sterile stainless steel disposable needle (Viva USA) with a gauge of 0.22mm was inserted into each of the designated sites. Each needle was inserted to a depth of 15 to 20 mm (ie deep needle insertion), then a standardised manual rotation technique was applied. This consisted of rotating the needle between the fingers through a large (540°-720°) angle in a bi directional manner (first clockwise and then anticlockwise) for nine times, each manipulation procedure lasted approximately five seconds and was applied every three minutes over a period of 21 minutes. According to traditional Chinese acupuncture theory, this manipulation technique would be appropriate for treating pain syndrome (Auteroche et al 1992). After 21 minutes, the needles were withdrawn.

3.2.5 Regional PPT measurement sites

During each experimental session, subjects remained lying in a supine position on a treatment couch. Prior to receiving each intervention, PPT was measured at ten regional sites that had been marked with a felt pen. These measurement sites included acupoints and nonacupoints situated variously on the same or different neural segments and/or

TCM channels from the intervention points. The sites are shown in Figure 3.2 and Table 3.3, which list their location and rationale for inclusion in the study (adapted from Rogers, Point Location and Point Dynamics Manual 1999). The location of all measurement sites in all subjects was completed by the same researcher I, an acupuncturist with nine years' experience. These regional sites were chosen in order to determine whether the distribution of intervention effects on PPT would be generalised or in keeping with either neural segment theory or TCM channel theory.

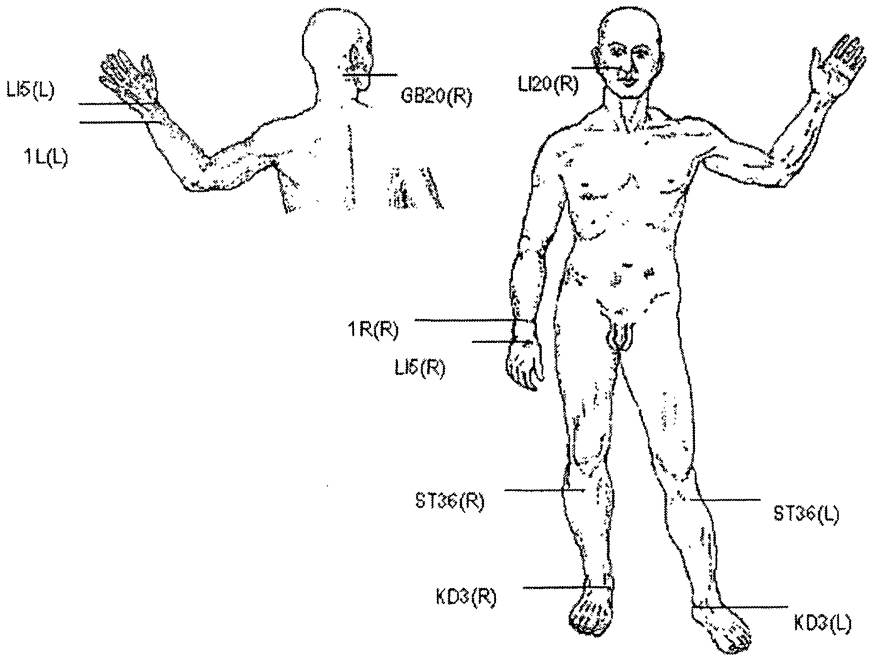

Figure 3.2: Anatomical location of ten regional body sites at which PPT were measured. Order of measurement site used: LI5R, LI20R, GB20R, 1R, ST36L, KD3L, LI5L, 1L, ST36R and KD3R.

Site	Method of location	Anatomical location	Neural segmental and/or TCM channel region
(1) Acupoint			
LI5R	Anatomical landmark	On the right arm, in the anatomical snuffbox at the wrist, which forms when the thumb is adducted.	Dermatome: in the same segmental region (C5) as LI4; Channel: 5th point on LI channel
LI20R	Anatomical landmark	On the right face, between the naso-labial groove and the midpoint of the lateral border of the nasal ala.	Dermatome: in a distal segmental region (maxillary branch of the trigeminal nerve) to LI4; Channel: 20th point on LI channel
GB20R	Anatomical landmark	On the right neck, in the depression between sternocleido-mastoideus muscle and trapezius muscle, on the level of 1 cun directly above the posterior hairline	Dermatome: in the segmental region of C3; Channel: 20th point on Gold Bladder channel
ST36L	Proportional (ruler)	On the left leg, 4cm from the joint line of the knee, approximately 2 cm lateral to the tibial shaft, level with the tibial tuberosity.	Dermatome: in the distal segmental region of L5; Channel: 36th point on Stomach channel
KD3L	Anatomical landmark	On the left foot, in the excavation between the medial malleolus and achilles tendon, parallel to the medial malleolus.	Dermatome: in the segmental region of L4-S3; Channel: 3rd point on Kidney channel
LI5L	Anatomical landmark	On the left arm, in the anatomical snuffbox at the wrist, which forms when the thumb is abducted.	Dermatome: in same segmental region (C5) as LI4; Channel: 5th point on LI channel
ST36R	Proportional (ruler)	On the right leg, 4 cm from the joint line of the knee, approximately 2 cm lateral to the tibial shaft, level with the tibial tuberosity.	Dermatome: in the distal segmental region of L5; Channel: 36th point on Stomach channel
KD3R	Anatomical landmark	On the right foot, in the excavation between the medial malleolus and achilles tendon, parallel to the medial malleolus.	Dermatome: in the segmental .region of L4-S3; Channel: 3rd point on Kidney channel
(2) Nonacupoint			
1R	Directional metric	On the right arm, 4 cm proximal to the wrist crease on the dorsal surface, just on the medial border of the radius.	Dermatome: in the same adjacent segmental region (C5) as LI4; Channel: no acupuncture channel
1L	Directional metric	On the left arm, 4 cm proximal to the wrist crease on the dorsal surface, just on the medial border of the radius.	Dermatome: in the same adjacent segmental region (C5) as LI4; Channel: no acupuncture channel

Table 3.3: Ten regional body sites at which PPT was measured. The body sites, their anatomical locations and relations to neural segmental regions and/or TCM channels are reported.

3.2.6 Measurement of PPT

PPT was measured by researcher I with an algometer (Activator Methods Phoenix USA) using the method described by Fischer (1986). Throughout the study, PPT measurements were applied by the same researcher using the same algometer and calibration was checked at interval. Note that at no stage was any recalibration required. Subjects were instructed at the beginning of the measuring that PPT would be reached at the stage when *the pressure first becomes uncomfortable or the first sensation of pain* and were asked to indicate as soon as the level was perceived, then the algometer was handed to researcher II to record the measurement (all algometer measurements were recorded in Kg/cm^2). The same order of measurement of PPT at ten sites in each measurement cycle (taking approximately two minutes) was used throughout and the sequence was as follows: LI5R, LI20R, GB20R, 1R, ST36L, KD3L, LI5L, 1L, ST36R, KD3R (Figure 3.2). The first cycle of measurements that subjects received was used to familiarise them with the procedure and discarded later on, then readings were recorded for a further three measurement cycles. Both researchers I and II then left the room, and researcher III (the acupuncturist) entered in order to initiate the designated intervention that then continued for 21 minutes. Immediately following removal of needles, the practitioner left the room and researcher I and II returned in order to complete further five PPT measurement cycles. Both researcher I, who applied the pressure, and the subject were blinded to the readings throughout; researcher III at no stage of the data collection was aware of the algometer readings. Figure 3.3 shows the sequence of the procedure in each session.

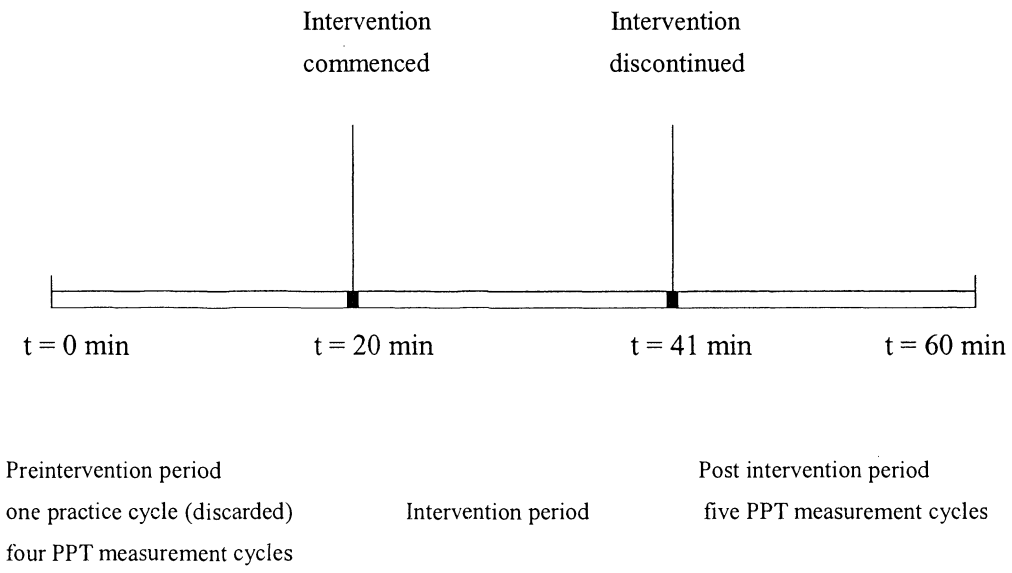

Figure 3.3: Timeline showing experimental procedure.

3.2.7 Subject perceptions concerning each intervention period

At the completion of each session, subjects were requested to mark their responses to the questions shown in Figure 3.4 on a 100mm VAS. The first four questions assessed subjects' experience of pain; of sensations associated with the intervention (ie soreness, numbness, heaviness, distension around the intervention point, or transmission upward and downward along the channel) (subjects were encouraged to describe such sensations if the descriptors had not been provided); of tension during; and of anxiety prior to the 21 minutes intervention session. The final question provided an assessment by the subjects of the change in practitioner's behaviour during each session, compared with the initial session.

PLEASE INDICATE BY MARKING ON THE LINE YOUR ANSWER TO THE FOLLOWING QUESTIONS

1. How did you experience the intervention today?

Absolutely painless — Extremely painful

2. Did you have a special feeling during the treatment?

Nothing at all — Intense prickle, feeling of warmth, heaviness, electricity etc. (please describe)

3. How did you feel during the treatment?

Completely calm and relaxed — Extremely tense

4. Were you anxious about feeling pain from the intervention today?

No, not anxious at all — Yes, extremely anxious

5. Did the practitioner behave differently today compared to the first session?

No, no difference at all — Yes, very differently

If yes, in what ways?

Figure 3.4: The 100mm VAS used to record subject perceptions relating to the 21 minutes intervention period for each experimental session (after Roth et al 1997).

3.3 Statistical analysis

3.3.1 PPT analysis

In each subject and intervention session, all PPT values were described as a percentage of the mean preintervention value and calculated using the following formula:

$$\text{PPT value as \% of preintervention mean} = \frac{\text{PPT value (Kg/cm}^2\text{)} \times 100\%}{\text{Mean preintervention PPT (Kg/cm}^2\text{)}}$$

The above data transformation was applied in view of the wide range of base line PPT measures encountered not only among subjects, but within the same subject among the ten regional measurement sites. Extensive checking of the appropriateness of both the transformation and the model tested in General Linear Model (GLM) was completed. In addition, it has been shown in a related study that base line PPT is not a useful predictor of the percentage change following an active intervention (Yuan 2002). Data were entered into Minitab for Windows version 12.1 and a GLM was used to obtain analysis of variance with Tukey *post hoc* analyses. It should be noted that these analysis employed 95% CI among all pair wise comparisons testing significance of difference of means with p values. Comparisons were made both within each intervention across all ten sites, and between the four interventions for each individual measurement site.

3.3.2 Subject perceptions concerning each intervention period

Each subject's perception was expressed in millimetres distance of the mark on the 100mm VAS measured from the left of the scale. Analysis of variance of the VAS score with factors of question and intervention were made through a GLM as well. Both 95% CI and probability values were reported as were correlations for pain, intervention sensation, tension, anxiety and practitioner's behaviour change.

Study II

In Study II, most of the methods applied were identical to those described for Study I. Therefore, in this section, only differences are detailed.

3.4. Subjects: for Study II, 24 healthy subjects (all female) were recruited, and details are shown in Table 3.4 and Table 3.5.

	Numbers
Females	24
Total	24

Table 3.4: Basic data for subjects in Study II.

Personal details	Mean	sd
Age in years	28.2	9.1
Weight in kg	56.8	9.5
Height in cm	161.1	7.0
Left or right handed (right=1/ left=2)	1.0	0.2
Belief score %VAS	93.4	9.3
Receive therapy score %VAS	85.1	23.7

Table 3.5: Demographic data collected for subjects from Study II (sd = standard deviation).

3.5 Methods

3.5.1 Intervention procedure

For Study II the interventions were:

1. acupressure on LI4 on the right arm;
2. acupuncture at LI4 on the right arm;
3. acupressure on NAP on the right arm;
4. acupuncture at SP4 on the right foot.

3.5.2 Location of intervention sites

NAP: within the same dermatome as LI4, on the dorsal aspect of the hand, midway along the medial shaft of the second metacarpal bone. No reference to a classical acupoint at this site has been documented (Li 1976; Cheng 1987).

SP4: in the depression distal and inferior to the base of the first metatarsal bone on the foot, at the junction of the red and white skin.

3.5.3 Intervention technique

The two acupuncture procedures were administered in the same way as in Study I, while the two acupressure treatments were administered using the algometer. The algometer was pressed perpendicularly to the skin surface for a period of 10 seconds and maintained at a constant pressure of 4.5kg/cm^2. This was repeated every three minutes over the duration of the 21 minutes treatment time.

Chapter IV: Results

The study results are presented in relation to each research aim in turn. Findings for Study I are presented first and then those for Study II. Tables with associated analysis of variance are presented in Appendix II.

Study I

4.1 Aim one: comparison of the effects on PPT of the four interventions (ie en block, independent of measurement site)

An initial analysis was completed, independent of measurement site, to compare the effects on post intervention PPT among the four interventions (Table 4.1).

Intervention	Mean % change in PPT post intervention	F	p	sd
LI4	10.0	$F_{1,1973} = 165.0$	< 0.0001	18.2
LI4 + LI11	8.7	$F_{1,1972} = 130.9$	< 0.0001	19.6
LI11	9.3	$F_{1,1952} = 145.0$	< 0.0001	19.7
LI4 bilaterally	13.4	$F_{1,1980} = 249.1$	< 0.0001	21.5

Table 4.1: Mean percentage change in PPT from preintervention mean, independent of measurement site, following the four interventions.

Independent of measurement site, all four interventions significantly elevated mean percentage PPT from base line ($p<0.0001$). The mean increases for the three unilateral interventions were very similar, ranging from 8.7% to 10.0%, with the highest mean elicited by bilateral needling of LI4 (13.4%). When the effects of the four interventions were compared, the only significant difference among them was that the bilateral needling of LI4 produced a statistically significantly greater increase in mean PPT ($p<0.0001$) than any of the other three interventions.

4.2 Aim two: comparison of the effects on PPT of the four interventions by individual measurement site

4.2.1 Within intervention comparison

Results of analysis of variance are summarised in Table 4.2 and also displayed as bar graphs in Figure 4.1.

	LI4		LI4+LI11		LI11		LI4 bilaterally	
Site	mean	95%CI	mean	95%CI	mean	95%CI	mean	95%CI
(1) Acupoint								
LI5R	**10.9****	**4.0 to 17.8**	5.7	-1.2 to 12.6	6.1	0.8 to 13.0	**10.3****	**3.4 to14.2**
LI20R	**8.3****	**2.6 to 14.0**	**10.4*****	**4.7 to 16.1**	4.7	-1.1 to 10.4	**8.5****	**2.8 to 16.3**
GB20R	**14.3*****	**6.4 to 22.2**	**1.1 ***	**3.1 to 19.0**	**14.4*****	**6.4 to 22.3**	**17.1*****	**9.2 to 25.1**
ST36L	**7.2 #**	**0.3 to 14.2**	**9.7 ***	**2.7 to 16.7**	**9.9 ***	**2.9 to 16.9**	**10.4****	**3.4 to 17.3**
KD3L	**12.2*****	**4.7 to 19.8**	**11.2****	**3.7 to 18.7**	**8.5 #**	**0.9 to 16.1**	**18.0*****	**10.5 to 25.5**
LI5L	**7.9 #**	**0.8 to 15.0**	3.1	-4.0 to 10.1	7.0	-0.1 to 14.1	6.4	-0.6 to 13.5
ST36R	**6.5 #**	**0.3 to 12.8**	5.9	-0.4 to 12.2	6.0	-0.3 to 12.3	**12.7*****	**6.5 to 19.0**
KD3R	**10.4 #**	**2.1 to 18.7**	6.2	-2.1 to 14.6	**12.3****	**4.0 to 20.7**	**13.6*****	**5.2 to 21.9**
(2) Nonacupoint								
1R	**9.0 #**	**1.5 to 16.5**	**10.2 #**	**2.7 to 17.6**	**9.7 #**	**2.2 to 17.2**	**11.5****	**4.0 to 18.9**
1L	6.1	-1.0 to 13.2	5.9	-1.2 to 13.0	**8.3 #**	**1.2 to 15.5**	**16.9*****	**9.8 to 24.0**

Table 4.2: Mean percentage change in PPT from preintervention mean for the ten regional measurement sites, following interventions of acupuncture at LI4, LI4 and LI11 in combination, LI11 alone and LI4 bilaterally. Statistically significant increases and their 95% CI are shown in bold, and the adjusted p values are indicated as: *** $p < 0.0001$, ** $p < 0.0005$, * $p < 0.001$ and # $p < 0.05$.

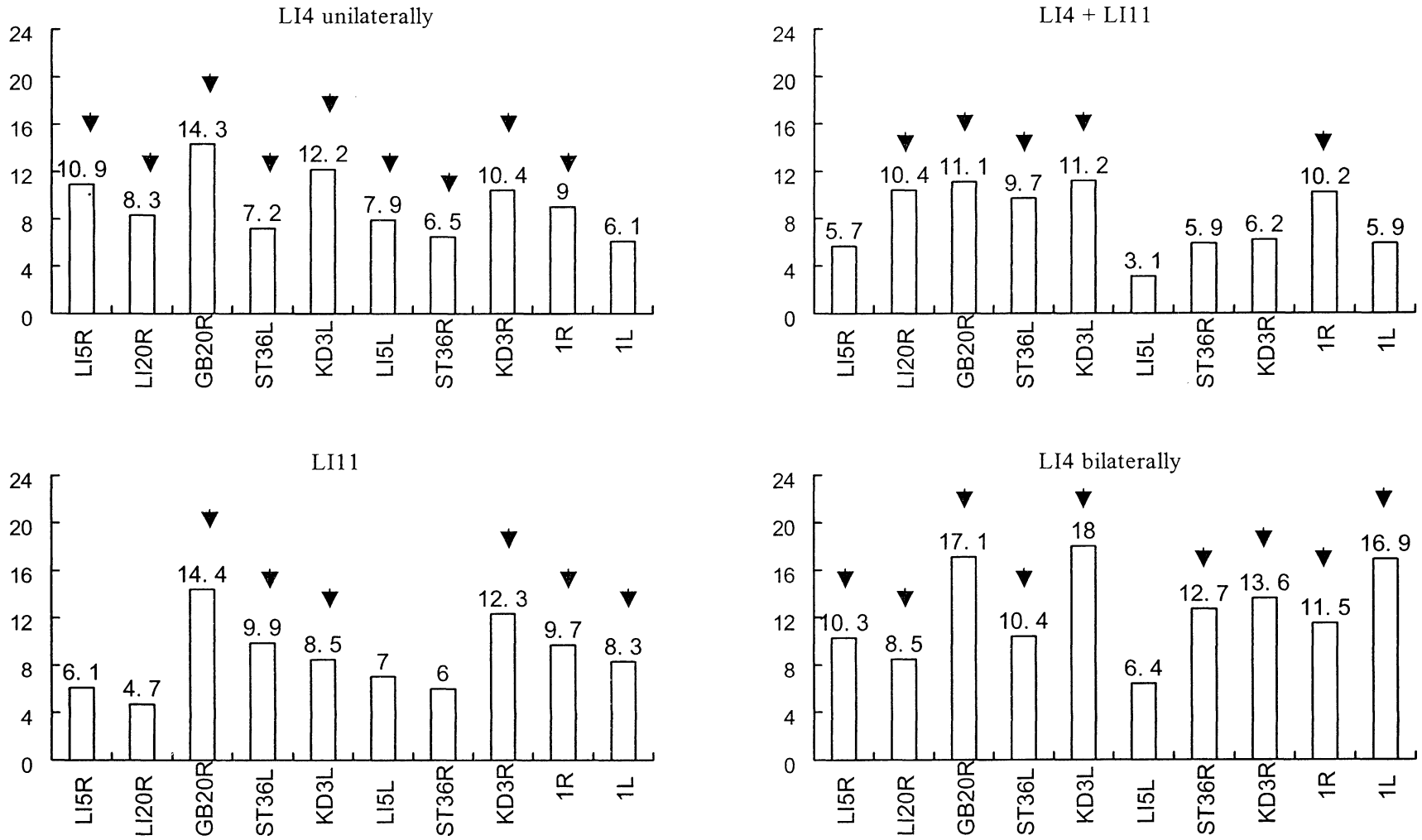

Figure 4.1: Mean percentage change in PPT from preintervention mean, for the ten regional measurement sites, following needling of LI4 alone, LI4 and LI11in combination, LI11 alone and LI4 bilaterally (the vertical axis indicates the mean percentage change in PPT and the horizontal axis indicates measurement sites) (▼ indicates the significant increase from preintervention mean).

When effects on mean percentage PPT were compared at ten individual measurement sites, again bilaterally needling of LI4 generally produced the greatest mean increase. However, as Table 4.2 shows, the percentage changes in PPT produced by the various interventions did not necessarily reach statistical significance. For both needling LI4 bilaterally and unilaterally, increases were statistically significant for nine of the ten measurement sites; they were statistically significant at six sites for needling LI11 alone and at five sites for combined needling of LI 4 and LI11. Of the 11 occasions (among interventions and sites) where statistically significant increases were not achieved, five of these involved the site LI5 (two on right and three on left side); two involved ST36R; two involved the nonacupoint 1L; and one involved LI20R and KD3R. There were four sites (GB20R, ST36L, KD3L and 1R) for which statistically significant increases were observed following all four interventions. They are not on LI channel, but are variously located from the back of the skull to the contra lateral heel and to the unilateral wrist (for unilateral interventions), thereby illustrating a generalised effect on PPT.

4.2.2 Between intervention comparison (ie examination of the relative effects on PPT of the four interventions by site)

Further analysis was completed to determine whether changes in PPT obtained at individual sites, following the different interventions, differed significantly from one another. Results are shown in Table 4.3 and 4.4 and Figure 4.2; only comparisons that involved statistically significant difference have been reported.

Comparison		Acupoint				Nonacupoint
		LI20R	KD3L	ST36R	KD3R	1L
LI4 × 2 (T4) compared with	LI4 (T1)			**6.2 p= 0.012 T4 >T1**		**10.8 p< 0.0001 T4 >T1**
	LI4+LI11 (T2)		**6.8 p= 0.033 T4 >T2**	**6.8 p= 0.003 T4 >T2**	**7.3 p= 0.044 T4 >T2**	**11.1 p< 0.0001 T4 >T2**
	LI11 (T3)		**9.5 p= 0.0003 T4 >T3**	**6.7 p= 0.005 T4 >T3**		**8.6 p= 0.0007 T4 >T3**
LI4+LI11(T2) compared with	LI11 (T3)	**5.8 p= 0.01 T2>T3**				

Table 4.3: Significant differences in the effects of the four interventions on post intervention mean percentage change in PPT, by regional measurement site (p = adjusted probability value calculated from Tukey simultaneous test).

Site	Significantly different effects between interventions
(1) Acupoint	
LI5R	None
LI20R	LI4 with LI11 significantly greater than LI11 (p = 0.01)
GB20R	None
ST36L	None
KD3L	LI4 bilaterally significantly greater than LI4 with LI11 in combination (p = 0.033) or LI11 (p = 0.0003)
LI5L	None
ST36R	LI4 bilaterally significantly greater than the other three interventions: LI4 alone (p = 0.012), LI4 with LI11 (p = 0.003) and LI11 alone (p = 0.005)
KD3R	LI4 bilaterally significantly greater than LI4 with LI11 (p = 0.044)
(2) Nonacupoint	
1R	None
1L	LI4 bilaterally significantly greater than the other three interventions: LI4 alone (p< 0.0001), LI4 with LI11 (p< 0.0001) and LI11 alone (p = 0.0007)

Table 4.4: Summary of significant differences among interventions presented in Table 4.3.

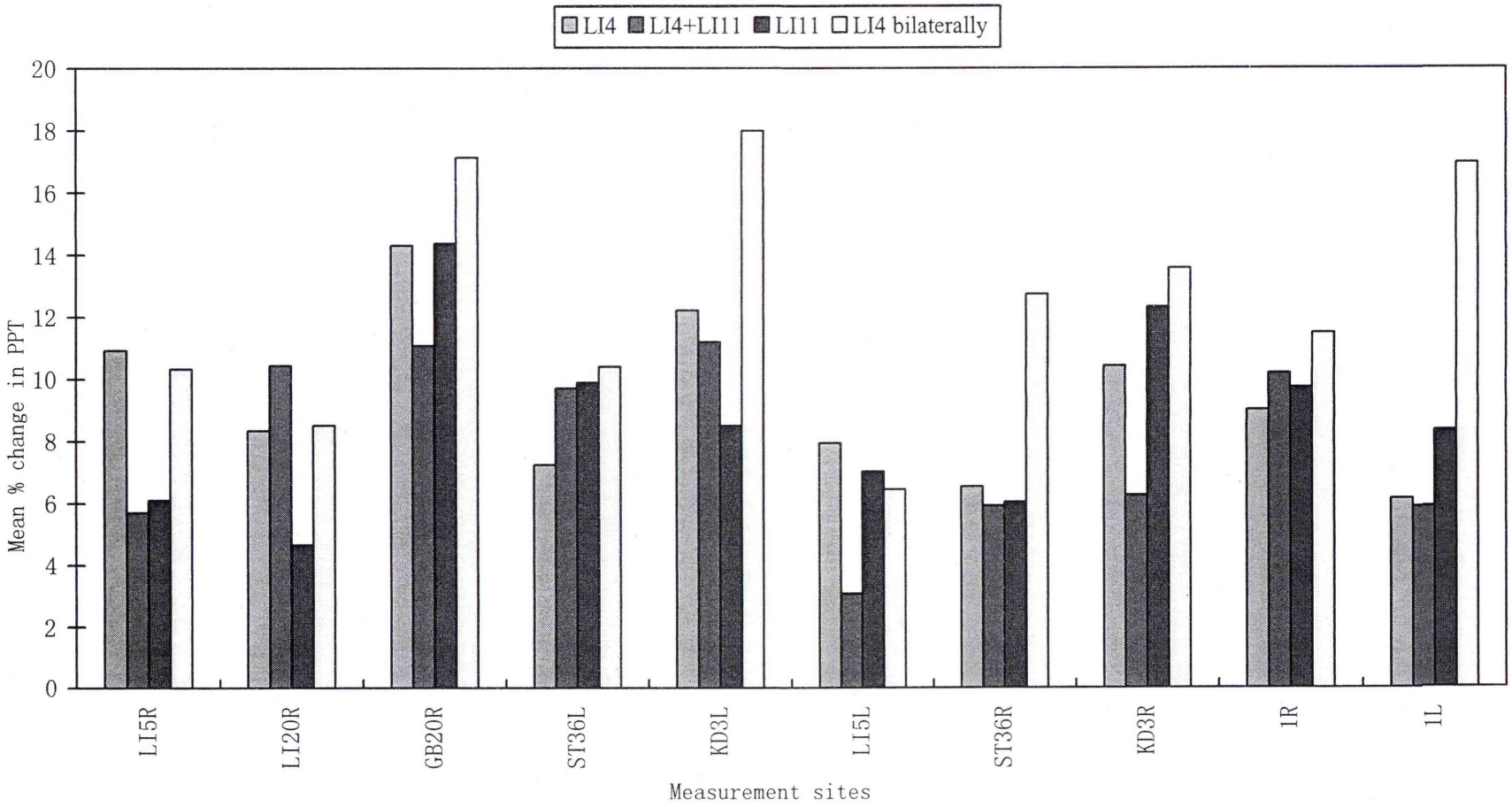

Figure 4.2: Comparison of the relative effects on PPT of the four interventions by site.

When the effects on PPT of the four interventions were compared with each other at each measurement site, there were only ten statistically significant differences achieved and nine of these involved needling LI4 bilaterally. This intervention was more effective than the other three interventions at site ST36R and 1L; more effective than needling LI4 with LI11 in combination and LI11 alone at site KD3L; and more effective than needling LI4 alone and needling LI11 alone at site KD3R. The only other statistically significant difference was at site LI20R, where needling of LI4 together with LI11 was more effective than needling of LI11 alone. Clearly, the intervention of needling LI4 bilaterally was the most effective one among four interventions.

4.3 Aim three: comparison of distribution of regional PPT effects by intervention (in Table 4.5)

The distribution of significant PPT effects among the ten regional sites shown in Table 4.5 indicates that poor agreement in general was achieved with prediction either by neural segment theory or by TCM channel theory and a far wider distribution of effects was obtained than predicted by either theory. An explanation based on generalisation of effect provides a closer match to the findings following needling LI4 alone and bilaterally. Indeed significant effects on PPT were elicited at nine of the ten sites for both LI4 interventions; at five following LI4 and LI11 in combination and at six following LI11 alone. With such widespread effects, it would be expected that sites predicted by one or other theories, would be represented among the significant ones. However, this was not necessarily the case: (1) for neural segment theory, of the 12 sites predicted for the various interventions, significant effects were not obtained at five of these; (2) TCM channel theory also predicted 12 sites, among of these significant effects were not obtained at six. It should be noted that while LI4 alone produced a statistically significant increase at nine sites; when combined with LI11, this occurred at only five sites. However, even this reduced effects on PPT extended to sites located from the head to the feet and across the body bilaterally.

Intervention	Observed and predicted (P) distribution of effect	Measurement site									
		LI5R	LI20R	GB20R	ST36L	KD3L	LI5L	ST36R	KD3R	1R	1L
LI4	Observed	√	√	√	√	√	√	√	√	√	
	Neural segment theory (P)	√					√			√	√
	TCM channel theory (P)	√	√				√				
LI4 + LI11	Observed		√	√	√	√				√	
	Neural segment theory (P)	√					√			√	√
	TCM channel theory (P)	√	√				√				
LI11	Observed			√	√	√			√	√	√
	Neural segment theory (P)										
	TCM channel theory (P)	√	√				√				
LI4 Bilaterally	Observed	√	√	√	√	√		√	√	√	√
	Neural segment theory (P)	√					√			√	√
	TCM channel theory (P)	√	√				√				

Table 4.5: Summary of observed distribution of significant changes to regional PPT by intervention, and the distributions predicted by neural segment theory and/or by TCM channel theory.

4.4 Aim four: evaluation of subject perceptions between interventions

4.4.1 Comparison of subject perceptions during acupuncture interventions

The perceptions of subjects of pain, needle sensation, tension, anxiety and changes in acupuncturist's behavior from the initial intervention session were compared among intervention conditions, and the results of analysis are displayed in Table 4.6 and Figure 4.3. There was no any statistically significant difference observed among the four interventions for any of the five subject's variables (p value ranging from 0.21 to 0.93).

VAS scale	LI4 mean (sem)	LI4+LI11 mean (sem)	LI11 mean (sem)	LI4 (bilat) mean (sem)	F
Pain	36 (5.1)	41 (5.0)	29 (4.9)	43 (5.6)	$F_{3,84} = 1.42$
Intervention sensation	66 (6.4)	67 (5.6)	57 (7.3)	73 (5.9)	$F_{3,84} = 0.70$
Tension	25 (4.7)	24 (4.3)	17 (3.9)	29 (5.7)	$F_{3,84} = 1.06$
Anxiety	20 (5.1)	23 (5.0)	15 (4.1)	30 (6.4)	$F_{3,84} = 1.52$
Acupuncturist's behaviour change	6 (1.7)	5 (2.0)	5 (1.3)	6 (1.8)	$F_{3,62} = 0.15$

Table 4.6: Comparison of mean percentage scores for pain, needle sensation, tension, anxiety and changes in acupuncturist's behaviour, each recorded on 100mm VAS by subjects for the 21 minutes of each intervention. The F statistic from Tukey simultaneous test is included (sem = standard error of the mean).

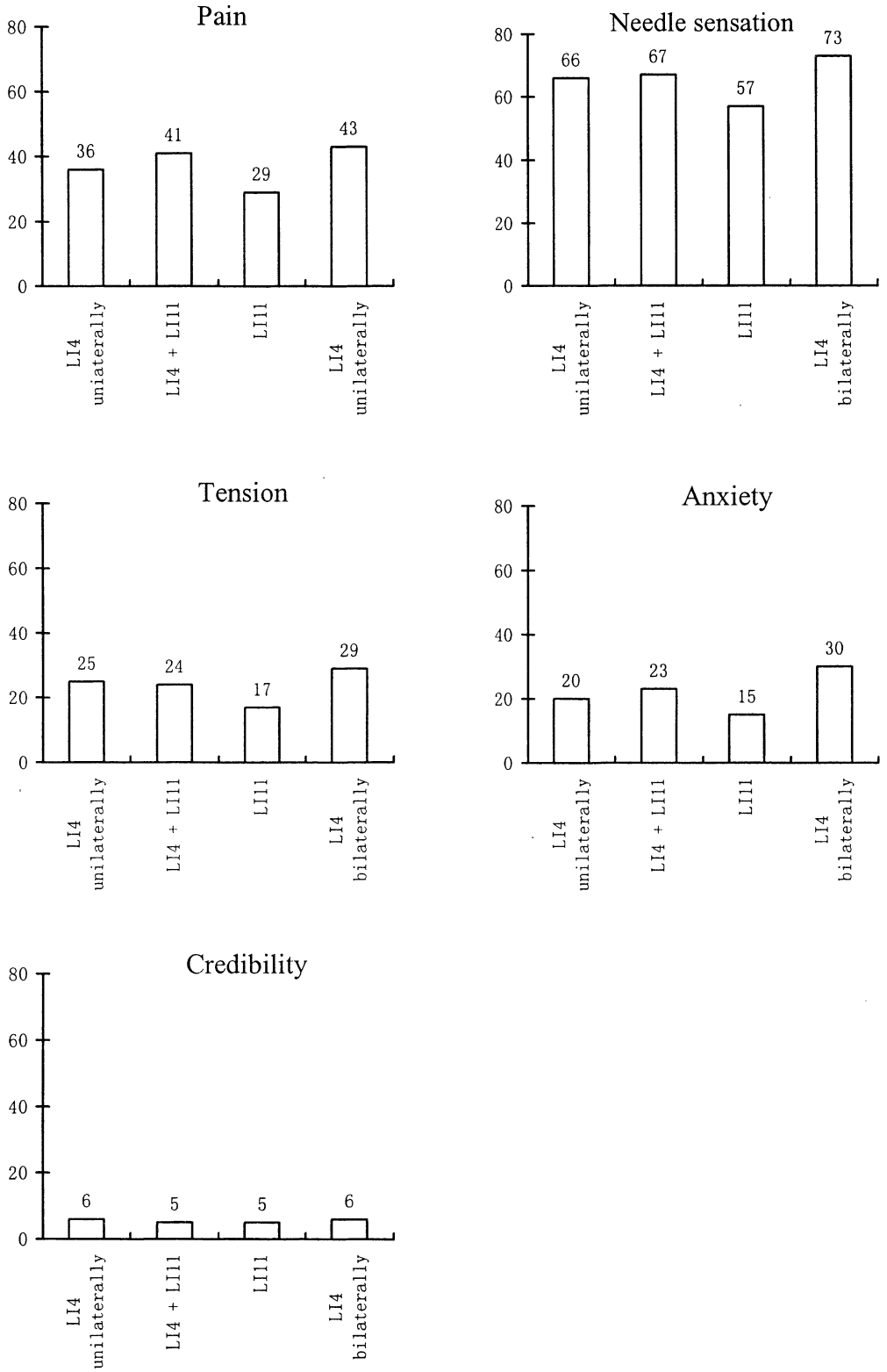

Figure 4.3: Comparison of the pain experienced, needle sensation, feeling of tension, anxiety and acupuncturist's behaviour change between interventions (the vertical axis indicates the mean percentage VAS score and the horizontal axis indicates four interventions), with no any statistically significant difference among interventions for any of these subjective variables.

The four interventions did not differ significantly in relation to the reported perceptions of subjects of pain, needle sensation, tension, anxiety, or the acupuncturist's behavior change. Strong needle sensations were reported for all four interventions and the mean sensation scores ranged from 57% for needling LI11 alone to 73% for LI4 bilaterally. The quality of the sensation was described as cold, electricity, heaviness, itching, numbness, pain, prickle, spasm or warmth; and for the four interventions, it showed similar characteristics. Mean pain scores for the four interventions ranged from 29% to 43% of the scale, these indicated that on average the intervention produced more than simply mild pain. However, the mean level did not differ significantly among interventions. Mean tension and anxiety scores were lower, ranging from 17% to 29% and 15% to 30% respectively. Again, the lack of significant differences between interventions suggests that neither of these factors contributed significantly to the differences in effects elicited on PPT by the four interventions. The acupuncturist's credibility scores were all similarly low (5% to 6% of VAS scores), suggesting a lack of bias produced by this researcher's behaviour.

4.4.2 Comparison of relationships between pairs of subject variables

Another avenue explored was the possibility that there were relationships between pairs of these subjective variables associated with needling that may have contributed to the overall effect on PPT. Subjects' responses to the questions concerning perceptions of pain, needle sensation, tension, anxiety and acupuncturist's behaviour change were examined for possible relationships using Pearson product moment r, and results are shown in Tables 4.7 (significant relationships are in bold).

Intervention		Pain		Sensation		Tension	
		r	p	r	p	r	p
LI4	Sensation	0.24	0.29				
	Tension	**0.55**	**0.01**	0.16	0.47		
	Anxiety	0.29	0.20	- 0.06	0.78	**0.69**	**0.00**
LI4 + LI11	Sensation	0.40	0.07				
	Tension	**0.51**	**0.02**	0.24	0.29		
	Anxiety	0.08	0.72	0.22	0.33	**0.54**	**0.01**
LI11	Sensation	0.39	0.07				
	Tension	0.39	0.07	0.20	0.37		
	Anxiety	- 0.07	0.75	- 0.16	0.48	**0.62**	**0.00**
LI4 bilaterally	Sensation	0.08	0.72				
	Tension	**0.58**	**0.01**	0.15	0.50		
	Anxiety	**0.60**	**0.00**	0.18	0.43	**0.85**	**0.00**

Table 4.7: Correlation matrix of Pearson product moment r for VAS scores for pain, needle sensation, tension, anxiety and acupuncturist's behaviour change, recorded for the 21 minutes procedure in four interventions.

In all, there were only eight statistically significant relationships found among the pairs of subjective variables. None involved needle sensation, although, as previously noted, levels of needle sensation were high for all four interventions. Tension was involved in all but one of the eight significant relationships; and linked with anxiety in four of these; and with pain in the remaining three. Anxiety was involved in five; pain was related to tension for three interventions and anxiety once. None of the four interventions was obviously different from any other with respect to these significant relationships; LI4 bilaterally was involved three times; LI4 unilaterally and LI4 with LI11 in combination were each involved twice; and LI11 was involved once.

4.5 Summary of results

The study findings are summarised below in relation to the study aims.

4.5.1 To examine effects on PPT among four interventions independent of measurement site

When the effects of the four interventions were compared regardless of measurement site, the bilateral needling of LI4 produced a greater increase in mean PPT (13.4%) than any of the other three interventions.

4.5.2 To examine effects of four interventions upon PPT by measurement site, within and between interventions

LI4 alone elicited some elevation of mean PPT at all regional measurement sites and at nine, the increases were statistically significant, ranging from 6.5% to 14.3%. These nine sites involved all eight acupoints and one of the two nonacupoints. Effect was not significant at only one site (1L).

For intervention of LI4 and LI11 in combination, statistically significant effects were observed at five regional sites including both acupoints and nonacupoints and these were LI20R, GB20R, ST36L, KD3L and 1R, with mean increases of 10.4%, 11.1%, 9.7%, 11.2% and 10.2% respectively. The regional PPT did not alter significantly from preintervention at the other five sites: LI5R, LI5L, ST36R, KD3R and 1L.

At four of the regional sites needling LI11 had little effect on PPT with mean increases ranging from 4.7% to 7.0%. For the other six sites, mean elevations were statistically significant, with increases from 8.3% to14.4%.

Like needling LI 4 alone, the elevations in mean percentage PPT at nine regional sites elicited by needling LI4 bilaterally were statistically significant, ranging from 10.3% to 18.0%. These sites included seven of eight acupoints and two nonacupoints. The effect was not significant at LI5L.

LI4 bilaterally was more effective in raising mean regional PPT than LI4 alone at two sites, and than the combined intervention of LI4 and LI11 at four sites and than LI11 alone at three sites. The intervention effects of LI4 unilaterally did not differ significantly

from those of LI4 and LI11 in combination or LI11 alone in elevating mean PPT. At one site only (LI20R) did the effects of LI4 and LI11 in combination or LI11 alone differ significantly from each other: LI11 was less effective than needling of LI4 and LI11 in combination.

4.5.3 To compare the distribution of regional PPT effects of the four interventions

The distribution of significant effects on PPT by regional site bore little relation to predictions by either neural segment or TCM channel theory. The explanation based on generalisation of effect provides a closer match to observed effects following needling LI4 unilaterally and bilaterally, while it does not really support for either LI4 with LI11 in combination or LI11 alone interventions, where only five and six sites respectively showed statistically significant increase in PPT.

4.5.4 To compare subject perceptions of the acupuncture experience among interventions

Among the four interventions, there was no statistically significant difference for each mean level of pain experienced, needle sensation experienced, for level of tension reported, level of anxiety and acupuncturist's behaviour change reported. However, all four interventions were reported to elicit quite intense needle sensation, ranging from 57% to 73% of the 100mm VAS score. Among the five subject variables, no significant relationship was observed that involved needle sensation, even though reasonable levels of needle sensation were elicited for all interventions. The main relationships involved tension and anxiety in all four interventions; pain and tension in three interventions; pain and anxiety in one intervention only; but were not specific to any interventions.

Section two (Study II)

4.6 Aim one: comparison of effects on PPT of the four interventions (ie en block, independent of measurement site)

An initial analysis of the effects on post intervention PPT among the four interventions was completed independent of measurement site and results are summarised in Table 4.8.

Intervention	Mean % change in PPT post intervention	F	p	sd
Acupressure on LI4	11.0	$F_{1,2158} = 232.0$	< 0.0001	20.8
Acupuncture at LI4	4.7	$F_{1,2158} = 47.9$	< 0.0001	18.8
Acupressure on NAP	11.6	$F_{1,2158} = 258.5$	< 0.0001	20.4
Acupuncture at SP4	11.0	$F_{1,2158} = 179.8$	< 0.0001	23.3

Table 4.8: Mean percentage change in PPT from preintervention mean, independent of measurement site, following the four interventions.

All four interventions statistically significantly increased mean percentage PPT ($p<0.0001$), independent of measurement site. The mean increases for three of the interventions (acupressure on LI4, acupressure on NAP and acupuncture at SP4) were very similar (11.0%, 11.6% and 11.0% respectively), and were over twice that elicited by acupuncture at LI4 (4.7%). It should be noted that the mean increase in PPT following acupuncture at LI4 was typically small when compared with the effects elicited for Study I (see Table 4.1 in section one) and also for three separate research studies reported previously by the UTS study group.

4.7 Aim two: comparison of effects upon PPT of the four interventions, measured at ten regional sites

4.7.1 Within intervention comparison

The results of analysis of variance are summarised in Table 4.9 and also displayed as bar graphs in Figure 4.4.

Site	Acupressure LI 4		Acupuncture LI4		Acupressure NAP		Acupuncture SP4	
	mean	95%CI	mean	95%CI	mean	95%CI	mean	95%CI
(1) Acupoint								
LI5R	**15.6*** **	**8.8 to 22.5**	5.3	-1.6 to 12.1	**14.3*** **	**7.4 to 21.2**	**11.0*** **	**4.1 to 17.9**
LI20R	**13.6*** **	**8.1 to 19.1**	3.0	-2.5 to 8.5	**9.0*** **	**3.5 to 14.5**	**8.2 ** **	**2.7 to 13.7**
GB20R	**11.5*** **	**4.6 to 18.5**	**7.2 #**	**0.3 to 14.2**	**14.8*** **	**7.8 to 21.7**	**12.1*** **	**5.1 to 19.1**
ST36L	**11.6*** **	**4.4 to 18.9**	5.2	-2.0 to 12.5	**10.3** **	**3.1 to 17.6**	**12.5*** **	**5.2 to 19.8**
KD3L	**13.1*** **	**5.0 to 21.2**	7.2	-0.9 to 15.4	**13.2*** **	**5.1 to 21.4**	**14.3*** **	**6.2 to 22.5**
LI5L	**9.4** **	**3.0 to 15.9**	**7.3 #**	**0.9 to 13.8**	**12.2*** **	**5.8 to 18.7**	**11.1*** **	**4.6 to 17.5**
ST36R	**11.1** **	**3.5 to 18.8**	3.3	-4.4 to10.9	**11.1** **	**3.5 to 18.8**	**11.2 ** **	**3.6 to 18.9**
KD3R	**11.0 ***	**3.1 to 19.0**	4.3	-3.7 to 12.3	**14.4*** **	**6.4 to 22.4**	**12.1*** **	**4.1 to 20.0**
(2) Nonacupoint								
1R	**11.9*** **	**5.0 to 18.7**	6.4	-0.5 to 13.3	**13.1*** **	**6.3 to 20.0**	**13.1*** **	**6.3 to 20.0**
1L	**11.4*** **	**4.8 to 18.1**	**8.2 #**	**1.5 to 14.9**	**13.7*** **	**7.1 to 20.4**	**15.3*** **	**8.6 to 21.9**

Table 4.9: Mean percentage change in PPT from preintervention mean, for the ten regional measurement sites, following interventions of acupressure on LI4, acupuncture at LI4, acupressure on NAP, and acupuncture at SP4. Statistically significant increases and their 95% CI are shown in bold, and the adjusted p values are indicated as:
*** $p < 0.0001$, ** $p < 0.0005$, * $p < 0.001$ and # $p < 0.05$.

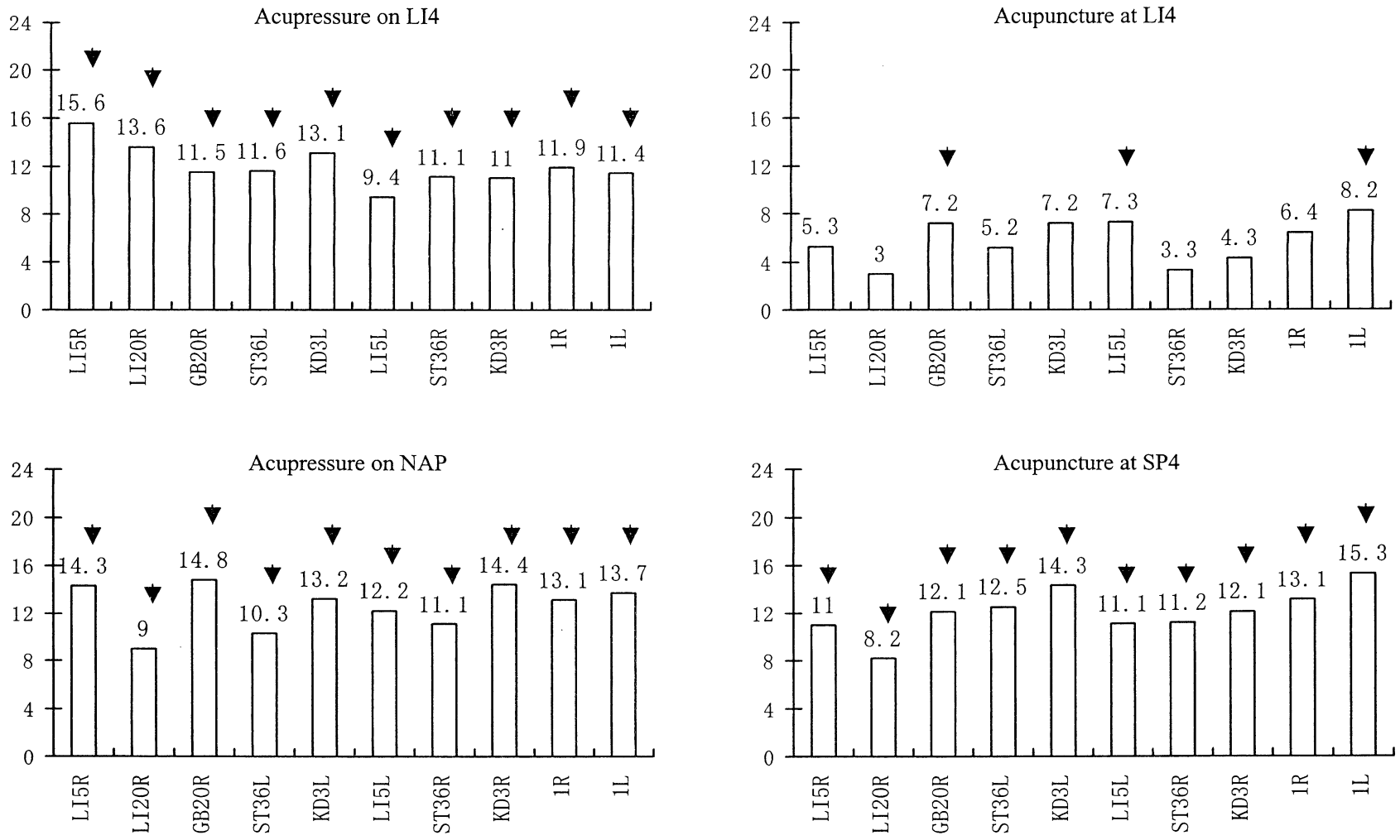

Figure 4.4. Mean percentage change in PPT from preintervention mean, for the ten regional measurement sites, following acupressure on LI4, acupuncture at LI4, acupressure on NAP and acupuncture at SP4 (the vertical axis indicates the mean percentage change in PPT and the horizontal axis indicates measurement sites) (▼ indicates the significant increase from preintervention mean).

At all ten regional measurement sites, the mean percentage PPT showed statistically significant elevation ($p<0.001$ or lower) from preintervention level following three of the interventions (acupressure on LI4, acupressure on NAP and acupuncture at SP4). These mean percentage elevations (ranging from 8.2% to 15.6%) were observed across the body from face (LI20R), to foot (KD3L and KD3R), and across the midline to the contra lateral side to the intervention point. Acupuncture at LI4 was the only intervention where statistically significant effects on PPT were achieved at only three sites of GB20R, LI5L and 1L (ranging from 7.2% to 8.2%). Therefore, the mean percentage increases in PPT following acupuncture at LI4 were typically less than following the other three interventions.

4.7.2 Between intervention comparison (ie examination of the relative effects on PPT of the four interventions by site)

For each site, further analyses among interventions were completed to determine whether there were any significant differences in PPT effects. The results are shown in Table 4.10 and 4.11 and Figure 4.5 (only shows statistically significant differences).

Comparison		Acupoint						Nonacupoint	
		LI5R	LI20R	GB20R	ST36L	ST36R	KD3R	1R	1L
Acupuncture LI4 (T2) compared with	Acupressure LI4 (T1)	**- 10.4 p< 0.0001 T1>T2**	**- 10.7 p< 0.0001 T1 >T2**			**-7.9 p = 0.020 T1 >T2**			
	Acupressure NAP (T3)	**- 9.1 p =0.0006 T3 >T2**	**- 6.0 p = 0.011 T3 >T2**	**- 7.6 p = 0.012 T3 >T2**		**- 7.9 p = 0.020 T3 >T2**	**- 10.1 p = 0.001 T3 >T2**	**- 6.7 p = 0.034 T3 >T2**	
	Acupuncture SP4 (T4)		**- 5.2 p = 0.047 T4 >T2**		**- 7.3 p = 0.028 T4 >T2**	**- 8.0 p = 0.018 T4 >T2**	**- 7.8 p = 0.036 T4 >T2**	**- 6.7 p = 0.034 T4 >T2**	**- 7.1 p = 0.015 T4 >T2**
Acupressure LI4 (T1) compared with	Acupuncture SP4 (T4)		**5.4 p = 0.032 T1>T4**						

Table 4.10: Significant differences in effects of the four interventions on post intervention mean percentage change in PPT, by regional measurement site. Adjusted probability values (p) calculated from Tukey simultaneous test are shown (note: in Table 4.10 all mean differences involving comparison with acupuncture at LI4 were negative because acupuncture at LI4 was the least effective intervention).

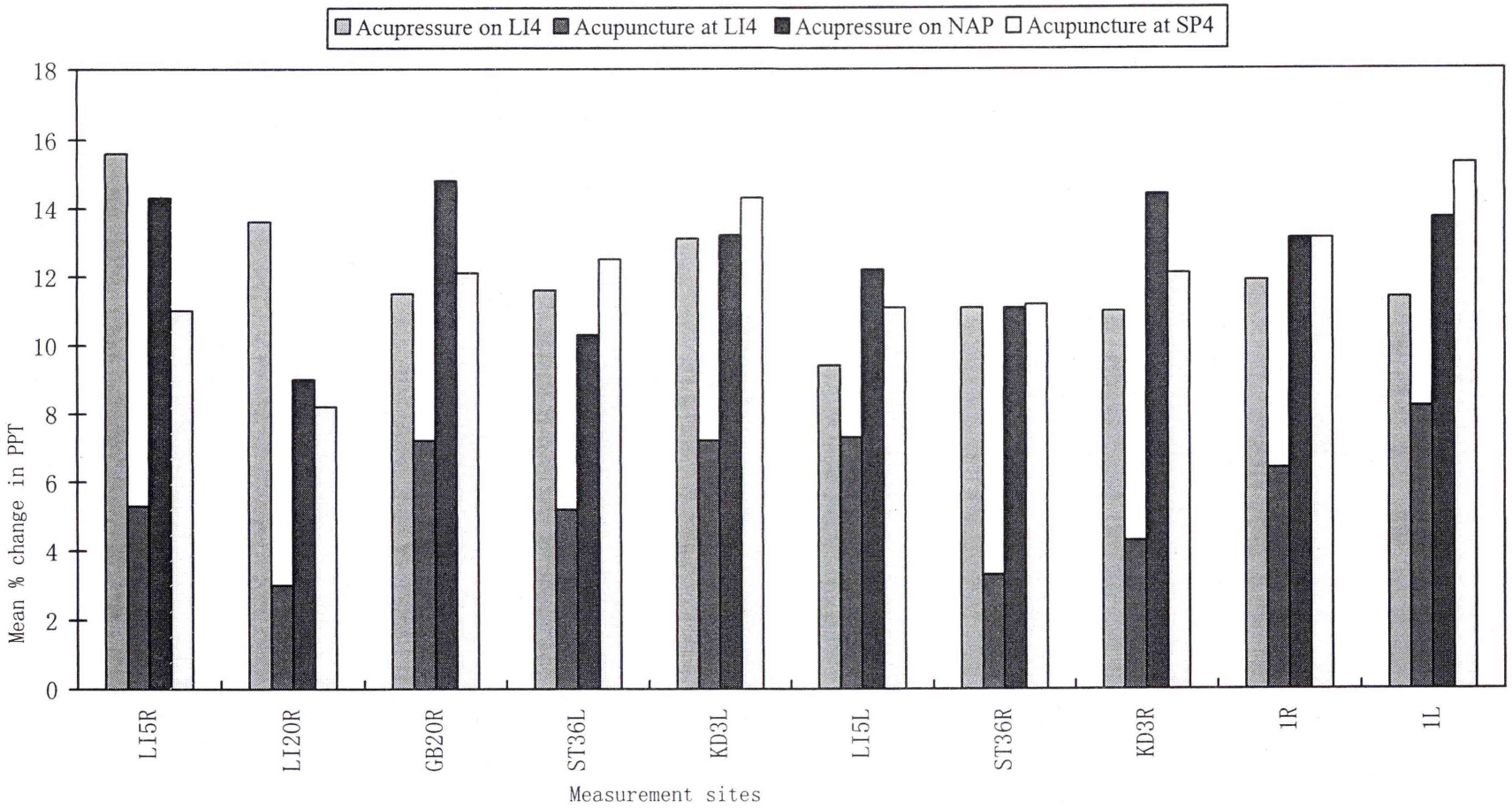

Figure 4.5: Comparison of the relative effects on PPT of the four interventions by site.

Site	Significantly different effects between interventions
(1) Acupoint	
LI5R	Acupressure on LI4 ($p < 0.0001$) and NAP ($p = 0.0006$) significantly greater than acupuncture to LI4
LI20R	Three interventions of acupressure to LI4 ($p < 0.0001$), acupressure on NAP ($p = 0.011$) and acupuncture to SP4 ($p = 0.047$) significantly greater than acupuncture to LI4; acupressure on LI4 also significantly greater than acupuncture to SP4 ($p = 0.032$)
GB20R	Acupressure on NAP significantly greater than acupuncture to LI4 ($p = 0.012$)
ST36L	Acupuncture to SP4 significantly greater than acupuncture to LI4 ($p = 0.028$)
KD3L	None
LI5L	None
ST36R	Three interventions of acupressure on LI4 ($p = 0.02$), acupressure on NAP ($p = 0.02$) and acupuncture to SP4 ($p = 0.018$) significantly greater than acupuncture to LI4
KD3R	Acupressure on NAP ($p = 0.001$) and acupuncture to SP4 ($p = 0.036$) significantly greater than acupuncture to LI4
(2) Nonacupoint	
1R	Acupressure on NAP ($p = 0.034$) and acupuncture to SP4 ($p = 0.034$) significantly greater than acupuncture to LI4
1L	Acupuncture to SP4 significantly greater than acupuncture to LI4 ($p = 0.015$)

Table 4.11: Summary of statistically significant differences among interventions presented in Table 4.10.

There were 16 statistically significant differences in effectiveness among four interventions. All but one involved acupuncture at LI4 since this was the least effective intervention. However, only four differences involved comparisons where both interventions produced statistically significant increases in mean PPT; these were acupressure to LI4 and acupuncture to SP4 at the measurement site LI20R, acupressure on NAP and acupuncture at LI4 at the site GB20R, acupuncture at SP4 and acupuncture at LI4 at site ST36L and 1L. The remaining statistically significant differences involved acupressure on LI4, acupressure on NAP, and acupuncture at SP4, each compared with acupuncture at LI4 at sites where acupuncture at LI4 did not significantly increase PPT from base line. While, as previously shown, the other interventions did. Surprisingly the mean difference in effectiveness among interventions found was the unexpectedly diminished effect produced by acupuncture at LI4.

4.8 Aim three: comparison of the distribution of regional PPT effects by intervention

Table 4.12 shows that the distribution of significant PPT effects among the ten regional sites bore little relation to that predicted by either neural segment theory or TCM channel theory. The observed effects following acupressure on LI4 and NAP and acupuncture at SP4 showed generalisation of acupressure/acupuncture effect across the body, with all the ten measurement sites achieving statistically significant increases in PPT in these three interventions. Surprisingly, the intervention of acupuncture at LI4 did not elicit a generalised effect (as it had in Study I), with only three of ten sites showing statistically significant increases in PPT. However, even in the case where generalised effect was not seen, the distribution obtained did not support the prediction of either neural segment or TCM channel theory.

Intervention	Observed and predicted (P) distribution of effect	Measurement site									
		LI5R	LI20R	GB20R	ST36L	KD3L	LI5L	ST36R	KD3R	1R	1L
Acupressure LI4	Observed	√	√	√	√	√	√	√	√	√	√
	Neural segment theory (P)	√					√			√	√
	TCM channel theory (P)	√	√				√				
Acupuncture LI4	Observed			√			√				√
	Neural segment theory (P)	√					√			√	√
	TCM channel theory (P)	√	√				√				
Acupressure NAP	Observed	√	√	√	√	√	√	√	√	√	√
	Neural segment theory (P)	√	√				√				
	TCM channel theory (P)										
Acupuncture SP4	Observed	√	√	√	√	√	√	√	√	√	√
	Neural segment theory (P)				√			√			
	TCM channel theory (P)										

Table 4.12: Summary of observed distribution of statistically significant changes to regional PPT by intervention, and the distribution that would be predicted by neural segment theory and/or by TCM channel theory.

4.9 Aim four: comparison of subject perceptions of acupuncture or acupressure experience by interventions

4.9.1 Comparison of subject perceptions during interventions

Table 4.13 and Figure 4.6 display the comparison of subject perceptions of pain, intervention sensation, tension, anxiety and acupuncturist's behaviour change from the initial intervention session among four interventions. No statistically significant difference was observed for any of the five subject variables (p value ranging from 0.06 to 0.73).

VAS scale	Acupressure LI4 mean (sem)	Acupuncture LI4 mean (sem)	Acupressure NAP mean (sem)	Acupuncture SP4 mean (sem)	F
Pain	60 (4.7)	45 (4.7)	64 (4.7)	49 (4.7)	$F_{3,92} = 2.62$
Intervention sensation	56 (4.1)	67 (4.2)	54 (4.2)	73 (4.3)	$F_{3,87} = 2.26$
Tension	24 (3.9)	29 (3.9)	30 (3.9)	31 (3.9)	$F_{3,92} = 0.43$
Anxiety	16 (3.6)	21 (3.7)	21 (3.6)	25 (3.6)	$F_{3,91} = 0.55$
Acupuncturist's behaviour change	8 (5.0)	11 (5.8)	5 (3.5)	3 (1.5)	$F_{3,67} = 0.73$

Table 4.13: Comparison of mean percentage scores for pain, intervention sensation, tension, anxiety and acupuncturist's behaviour change, each recorded on 100mm VAS by subjects for the 21 minutes of each intervention. The F statistic from Tukey simultaneous test is included (sem = standard error of the mean).

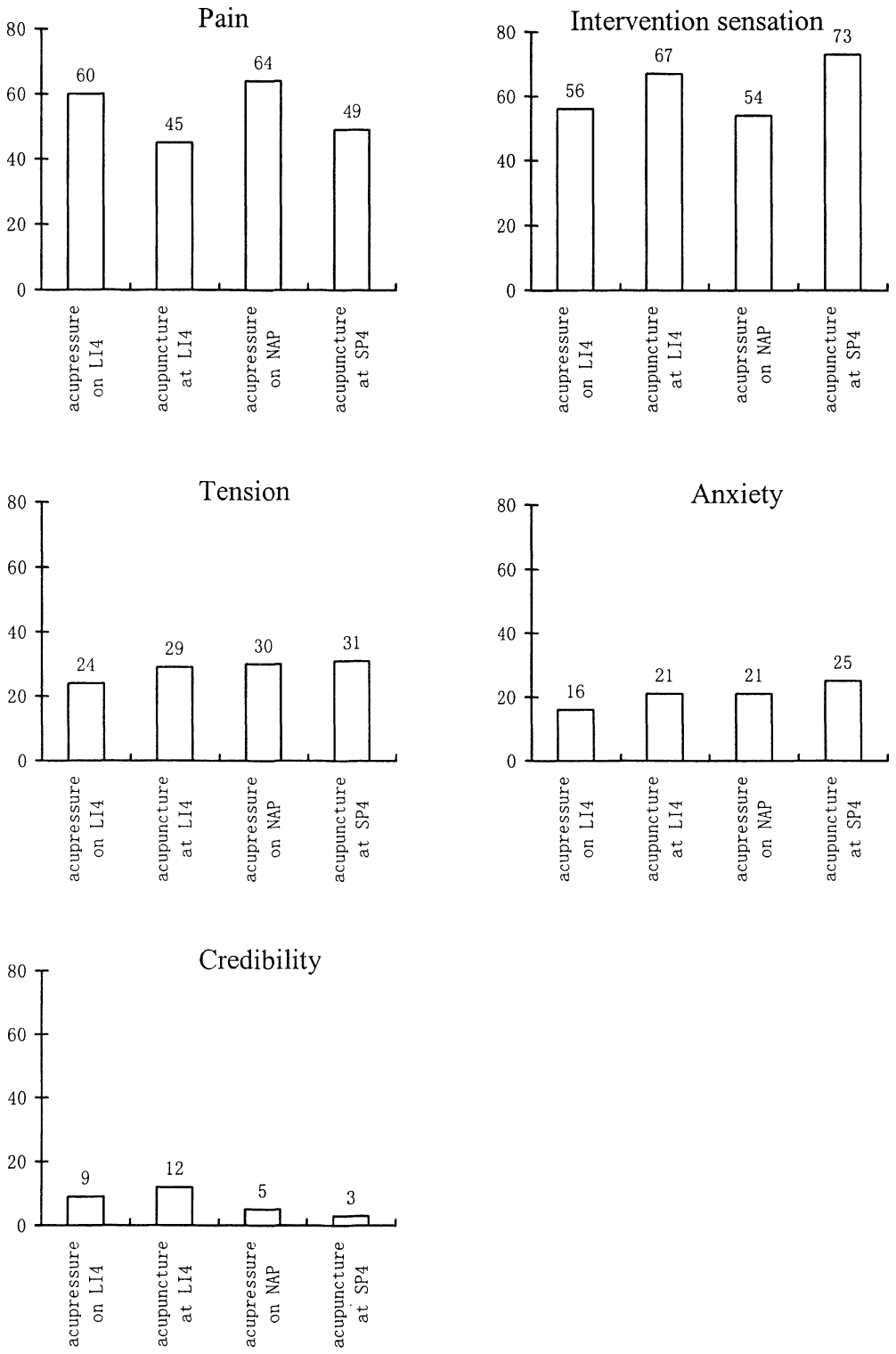

Figure 4.6: Comparison of the pain experienced, intervention sensation, feeling of tension, anxiety and acupuncturist's behaviour change between interventions (the vertical axis indicates the mean percentage VAS score and the horizontal axis indicates four interventions), with no any statistically significant difference among interventions for any of these subjective variables.

There was no statistically significant difference in mean percentage VAS scores reported among the interventions for any of the five subject variables (pain experienced, intervention sensation experienced, tension, anxiety or acupuncturist's behaviour change). The quality of the sensations were described as cold, dull, electricity, heaviness, numbness, pain, prickle, vibration or warmth; and the four interventions showed generously similar features among interventions. The only difference of possible interest was that two acupuncture interventions were described as producing more "electricity" like sensation (four cases reported in acupuncture to LI4, five cases in acupuncture to SP4) compared with acupressure interventions (only one case reported in acupressure on LI4, none in acupressure on NAP). Sharp was a description used by 11 subjects as sensation to acupuncture interventions (six cases in acupuncture to LI4, five cases in acupuncture to SP4) compared with three cases reported in acupressure on LI4 and three in acupressure on NAP. Mean pain scores for the four interventions ranged from 45% to 64% of the scale, and the acupuncturist's behaviour change scores were also low (3.2% to 11.7% of VAS scores), suggesting this was not a source of bias.

4.9.2 Comparison of relationship between pairs of subject variables

Relationships between pairs of these subject variables are shown in Tables 4.14 (statistically significant relationships are shown in bold using Pearson product moment r).

There were nine significant relationships between levels of pain, intervention sensation, tension, anxiety and acupuncturist's behaviour change. Tension and anxiety were significantly related in all four interventions; pain and tension were significantly related in three interventions (not for acupressure on NAP); pain and anxiety were significantly related only in acupuncture at LI4; intervention sensation and anxiety were significantly related in acupuncture at SP4 only. There was no relationship between pain and intervention sensation, or intervention sensation and tension. Therefore, these subject variables did not appear to have contributed to the relative differences in effects elicited by different interventions.

Intervention		Pain		Sensation		Tension	
		r	p	r	p	r	p
Acupressure on LI4	Sensation	-0.28	0.20				
	Tension	**0.59**	**0.00**	0.04	0.86		
	Anxiety	0.34	0.10	-0.08	0.73	**0.76**	**0.00**
Acupuncture at LI4	Sensation	0.09	0.70				
	Tension	**0.49**	**0.02**	-0.11	0.64		
	Anxiety	**0.55**	**0.01**	-0.05	0.84	**0.65**	**0.00**
Acupressure on NAP	Sensation	-0.17	0.43				
	Tension	0.27	0.21	-0.41	0.05		
	Anxiety	0.18	0.40	- 0.19	0.40	**0.54**	**0.01**
Acupuncture at SP4	Sensation	0.39	0.07				
	Tension	**0.59**	**0.00**	0.42	0.05		
	Anxiety	0.21	0.32	**0.43**	**0.05**	**0.63**	**0.00**

Table 4.14 Correlation matrix of Pearson product moment r for VAS scores for pain, intervention sensation, tension, anxiety and acupuncturist's behaviour change, recorded for the 21 minutes procedure in four interventions.

4.10 Summary of results

The study findings are summarised in relation to the study aims as follows.

4.10.1 To examine effects upon PPT among four interventions independent of measurement sites (en bloc)

All four interventions increased mean percentage PPT values. Acupuncture at LI4 achieved a lesser increase in mean percentage PPT (4.7%) than the other three interventions, when the four interventions were compared.

4.10.2 To examine effects of four interventions upon PPT by measurement site, within and between interventions

Acupressure on LI4 elicited some elevations of mean PPT at all regional measurement sites and all the increases were statistically significant, being in the range of 9.4% to 15.6% approximately. These increases, with average value of 12.0%, were spread across the body from face to foot, and across the midline to the contra lateral side of the body to the intervention.

The mean percentage increases in PPT recorded following acupuncture at LI4 were

typically much less than following acupressure on LI4 intervention. At seven sites, the PPT remained virtually unchanged from preintervention levels ranging from 3.0% to 7.2%; significant increases in PPT were evident at only three sites. No significant elevations were recorded for three of the four contra lateral measurement sites.

The intervention of acupressure to NAP produced statistically significant increases in mean percentage PPT at all ten regional measurement sites, which were generalised across the body and involved both acupoints and nonacupoints. Mean PPT increases ranged from 9.0% to 14.8% and the average PPT elevation across these ten sites was 12.6%.

Unlike acupuncture at LI4, acupuncture at SP4 elicited statistically significant elevations in mean percentage PPT at all ten regional sites (like acupressure on LI4 and NAP), with the mean increases ranging from 8.2% to15.3%. Therefore, in terms of actual mean increase in PPT, acupressure to NAP achieved the best result, following intervention by acupuncture to SP4, acupressure to LI4, and finally acupuncture to LI4.

4.10.3 To compare the distribution of regional PPT effects of the four interventions

The distribution of significant PPT effects among the ten regional sites clearly did not support that predicted by either neural segment theory or TCM channel theory. The observed effects following acupressure on LI4 and NAP and acupuncture at SP4 supported the explanation of generalisation of acupressure/acupuncture effect all over the body, because these three interventions achieved statistically significant increase in PPT at all ten sites. Even the restricted effects produced by acupuncture at LI4 were not those predicted by either theory.

4.10.4 To compare subject perceptions among interventions

The four interventions did not differ significantly in relation to the perceptions of subjects in pain, intervention sensation, tension, anxiety, or change in the acupuncturist's behavior. But the two acupuncture interventions were described as producing more "electricity" like sensation compared with acupressure interventions and sharp was a description used more in acupuncture interventions compared with the acupressure interventions. There were several significant relationships between levels of pain,

intervention sensation, tension and anxiety: tension and anxiety were significantly related in all four interventions; pain and tension were significantly related in three interventions; pain and anxiety, intervention sensation and anxiety were significantly related in one only. There was no relationship between pain and intervention sensation, or intervention sensation and tension.

Chapter IV: Discussion and conclusion

5.1 The present research into regional PPT represented the third and the fifth in a series that have been completed by the acupuncture research group at the College of TCM at UTS. All studies have been linked as follows:

1. they used the same experimental model, procedure, measuring technique and instrument (as described in Chapter III of this thesis), for example, random allocation of subjects, blinding of subject to intervention, blinding of researchers to the intervention or algometer reading, use of identical algometer, the same practitioner to apply intervention in all studies, recording of algometer readings by the same researcher, same location for all treatments, same needle, same duration for interventions;
1. all included the same reference intervention to facilitate comparison: this was deep needling of LI4 with standardised manual manipulations (as described on page 25 in Chapter III of this thesis);
2. same statistical analyses were included (GLM and Pearson product moment r);
3. subjects were drawn from similar populations of volunteers (ie recruited from noticeboards at UTS and by word of mouth);
4. same VAS questionnaires (subjects' beliefs in the effectiveness of acupuncture, their willingness to receive acupuncture as a therapy, subject perceptions of pain, intervention sensation, anxiety, tension, changes in acupuncturist's behaviour relating to the 21 minutes intervention period).

5.2 The main differences were related to changes in regional measurement sites and/or changes in interventions applied.

5.2.1 Changes in some regional measurement sites. Table 5.1 compares the regional measurement sites used in all five studies and these were incorporated to permit:

1. bilateral measurement of effects on PPT (ie the same sites were included on both body sides);
2. measurement of effects on different neural segments or TCM channels (eg the initial

research by Zaslawski and Cobbin (2001) included only three measurement sites located in distal segments and different TCM channels; the second research program by Yuan (2003) included four measurement sites located in distal segments and different TCM channels of the body; both the present studies (2005) added two new measurement sites located on distal neural segments and different TCM channels; the fourth research by Szabo (2005) also applied two new measurement sites located on distal neural segments and different TCM channels);

3. measurement at more distant sites (eg close to ankle).

Measurement site	Research studies in UTS				
	① Zaslawski Cobbin (2001/2003)	② Yuan (2003)	③ Present Study I (2005)	④ Szabo (2005)	⑤ Present Study II (2005)
Acupoint					
LI5R	**22.3**	**18.3**	**10.9**	**7.5**	5.3
LI10R	**18.3**				
LI20R	**15.7**	**14.2**	**8.3**	**10.3**	3.0
SI3R	**13.3**				
PC6R	**15.2**			**8.8**	
CV12	**19.3**	**16.3**			
ST36R	**13.6**	**11.2**	**6.5**		3.3
LI5L		9.6	**7.9**		**7.3**
ST36L		**12.4**	**7.2**		5.2
KD3L			**12.2**		7.2
KD3R			**10.4**	**10.5**	4.3
GB20R			**14.3**		**7.2**
LI10L				5.8	
SP6R				**8.4**	
GB12R				**8.8**	
Nonacupoint					
1R	**18.5**	**10.1**	**9.0**	**7.4**	6.4
2R	**15.7**	**14.7**			
3R	**12.7**	9.2			
2L		**10.8**			
1L			6.1		**8.2**
NAP-Ulna				**9.1**	
NAP-Foot				**5.5**	
Proportion of sites achieving a statistically significant increases	10/10	8/10	9/10	9/10	3/10

Table 5.1: Comparison of measurement sites used in the five UTS research studies (showing the mean percentage increases in PPT reported and statistically significant increases are shown in bold).

5.2.2 Changes in interventions. Obviously each study was designed to answer different research questions and therefore different interventions were required.

1. The first study (Zaslawski and Cobbin 2001) evaluated the relative effects on regional PPT of different acupuncture techniques applied to LI4 or a NAP. From this, deep needling with standerdized manipulation was showed to be the most effective intervention, and application to the acupoint LI4 was more effective than to the NAP located within the same dermatome as LI4, on the dorsal aspect of the hand.
2. The second study (Yuan 2003) examined the bilateral spread of PPT effects following deep needling to LI4, to LR3, to the combination of LI4 with LR3, and to the same NAP that was described by Zaslawski and Cobbin. Therefore, Yuan's study replicated two interventions from Zaslawski and Cobbin, and in addition reported that needling to LI4 or NAP was far more effective in raising regional PPT than either needling LR3 alone or in combination with LI4.
3. The present Study I was the third one in this series. It was designed to compare bilateral with unilateral needling of LI4. It also explored another TCM prescription for pain: the combination needling of LI4 with LI11. In addition, the effects on PPT of needling LI11 alone were evaluated. As with the prescription of LI4 with LR3 evaluated in Yuan's study, the effects on PPT of LI4 with LI11 were also less than those obtained following LI4 alone. That is a second TCM prescription for pain which failed to promote any additional analgesic effects. It should perhaps be noted that in all of these studies at UTS, the model is of experimental pain threshold, and not chronic (or even acute) clinical pain, which are the experiences for which, the prescriptions are presumably intended.
4. The fourth study (Szabo 2005) was completed while the second stage of the current research (Study II) was being undertaken. Although the mean focus was on the relative effectiveness of electro acupuncture and TENS compared with manual acupuncture, it did include the same reference intervention (deep needling of LI4). LI4 significantly increased PPT at nine of the ten regional measurement sites although manual acupuncture was less effective than electro acupuncture.
5. The final study (Study II of the current research) introduced the technique of acupressure by comparing acupuncture and acupressure to LI4, acupressure to NAP (same as used by Zaslawski with Cobbin and Yuan) and acupuncture to SP4. Acupressure to either LI4 or NAP significantly increased regional PPT at all ten measurement sites, as did acupuncture to SP4. The surprising outcome was the relatively weaker effects on PPT elicited by manual acupuncture to LI4. While in all

previous studies, manual acupuncture to LI4 using the same techniques had reliably produced statistically significant increases in regional PPT at virtually all measurement sites in the first research (Zaslawski and Cobbin 2001), at nine sites in the present Study I and the fourth one (Szabo 2005), and at eight sites in the second research (Yuan 2003). While in the present Study II, effects only reached statistically significant increases at three regional sites. Table 5.1 shows all of the regional measurement sites used in these five studies and the effects on PPT produced following the reference intervention to LI4. Most of the sites where significance was not achieved in Study II had been reported to show highly significant increases in PPT in all of the previous studies that had involved the same measurement sites. For example, site LI5R, LI20R and 1R were included in all five studies and achieved significant effects in first four studies; site ST36R was included in four studies and achieved significant effects in first three studies; site ST36L and KD3R achieved significant effects in two of the previous studies (included in two previous studies only).

5.3 The minor effect on PPT elicited by LI4 in the present Study II cannot be easily explained. The order of application of the intervention in this study had been random (manual acupuncture was applied in the first visit for seven subjects; in second visit for five subjects; third for six subjects and fourth for six subjects), therefore effects related to time tied factors can be eliminated. Further comparison of the mean percentage increases in PPT for needling LI4 of different visit orders and relative mean percentage VAS scores for pain, needle sensation, anxiety, tension and changes in acupuncturist's behaviour was performed and the results are shown in Table 5.2. It indicates that needling LI4 produced similarly poor effects on PPT independent of which intervention week it was applied. Interestingly for week three, the mean percentage increase was only 0.6% and this was significantly lower than the mean increase of 3.4%, 2.9% and 3.6% achieved in week one, two and four respectively. This was the only statistically significant difference among the variables in this study by week comparisons. In addition, there was no pattern across the weeks relating to mean pain score or needle sensation. Not unexpectedly, mean scores for both tension and anxiety decreased across the four weeks, as subjects became accustomed to the type of experimental interventions

and they were likely to receive. Indeed, it is because of this time/experience effect that randomisation of the four interventions was deliberately designed for the study.

Variables	Visit No (No of subjects involved)				F	p
	V1 (7)	V2 (5)	V3 (6)	V4 (6)		
Mean percentage increase in PPT	3.4	2.9	0.6	3.6	**$F_{3,2156} = 4.30$**	**0.005**
Pain	46	54	31	49	$F_{3,20} = 0.77$	0.526
Needle sensation	58	84	64	60	$F_{3,19} = 1.02$	0.407
Tension	40	33	26	12	$F_{3,20} = 1.67$	0.205
Anxiety	31	2	16	7	$F_{3,19} = 1.21$	0.335
Practitioner's Behaviour change	N/A	3	6	8	$F_{2,14} = 0.57$	0.577

Table 5.2: Comparison of the mean percentage increases in PPT for needling LI4 of four visit subgroups and relative mean percentage VAS scores for pain, needle sensation, anxiety, tension and changes in acupuncturist's behaviour (statistically significant increases are shown in bold).

The finding in the same study that acupuncture applied to the acupoint SP4 was highly effective in increasing mean percentage PPT rules out some unexpected modification in needling technique by the acupuncturist as a contributing factor. This was unlikely, given that the same acupuncturist had been involved in administration of all interventions reported not only in this study but in all interventions in the entire UTS research program. At present, the simplest explanation may be that the variation in results, in Study II may reflect the fact that data were collected from a relatively small sample and not from an entire population. There is always the chance that random selection of a sample, no matter how thorough, will on occasion generate a group that is relatively atypical of the population from which it was drawn. If this line of reasoning is followed, it raises the question: were the effects on PPT obtained by the other three interventions also relatively different from what would be expected (ie the level of effect that may have been achieved in a different more "typical" sample). The obvious solution is replication of this study. Note that at present, a further investigation that again uses the reference intervention (needling LI4) is being completed by colleagues at UTS (Szabo 2005). They have kindly supplied a preliminary analysis of this intervention for use in this discussion. The findings are: manual acupuncture to LI4 achieved similarly

statistically significant effects in increasing regional PPT (8.3%) to those reported in all the previous studies in UTS apart from the present study II.

A final observation concerning the anomalous LI4 acupuncture effect on PPT in this study is that it lends more support for the lack of placebo effects on PPT outcomes. That is, most subjects were acupuncture students who are very familiar with needling LI4 and its clinical effects on pain. Therefore, if subject expectations were influcencing post intervention PPT, it would be expected that the LI4 intervention would result in significant elevation in PPT.

5.4 Study I involved three main comparisons of effects on regional PPT: (1) bilateral and unilateral needling of LI4; (2) needling two different acupoints (LI4 and LI11) on the same TCM channel; (3) needling LI4 and LI11 individually and in combination (ie the TCM prescription). While needling LI4 unilaterally or bilaterally both increased regional PPT at nine of the ten measurement sites (unilaterally: all except site 1L; bilaterally: all except site LI5L), the effects on mean percentage PPT of the bilateral intervention were statistically significantly greater than unilateral at eight of these sites (exceptions: LI5R and LI5L). This suggests some advantage in using bilateral needling over unilateral in achieving increase in PPT. Needling LI11 was less effective than LI4 in increasing PPT with statistically significant increases achieved at six sites (GB20R, ST36L, KD3L, KD3R, 1L and 1R). The surprising finding was the relative ineffectiveness of the combined needling LI4 and LI11 intervention, where statistically significant increases were attained at only five sites. In addition, when significant effects were seen, they were relatively weaker than following the bilateral needling of LI4 at all sites except for LI20R; or following the unilateral needling of LI4 at seven sites (LI5R, GB20R, KD3L, LI5L, ST36R, KD3R and 1L).

These results are in keeping with those reported in Yuan's study (2003) where LI4 was needled in combination with LR3. In his study, needling LR3 alone only statistically significantly increased mean percentage PPT at sites ST36R, CV12 and 3R, while needling LI4 increased PPT at nine of the ten measurement sites. The combined needling of LI4 and LR3 produced significant increases at only two sites (LI5L and CV12). Thus, both Yuan's and the present Study I do not provide support for the claims made for these

simple TCM prescriptions for pain. According to TCM practice, it is common to use a chain of acupoints to strengthen the effect on the same acupuncture channel; the use of LI4 and LI11 in combination is such an example. Obviously in the present experimental (not clinical) situation not only did this fail to occur, but in fact the opposite effect was obtained: these was a diminished effect on mean percentage PPT following the combined interventions compared with LI4 (or LI11) alone. The combined use of LR3 with LI4 in acupuncture theory is clinically used to enhance effects of LI4 on pain, again this was not translated to the experimental pain threshold situation studied by Yuan. More interestingly, both of these combined interventions do suggest some form of interaction when the additional points (ie LR3 or LI11) were applied in combination with LI4. In both cases, they dramatically decreased the effects on regional PPT that had been elicited by the reference intervention (LI4). However, this cannot simply be due to the insertion of a second needle, since the bilateral needling of LI4 statistically significantly increased the effects of unilateral needling of LI4 in the present Study I.

5.5 In the introduction (page 21), the lack of effect of PPT measurement by the algometer in our experimental procedure was discussed. Therefore, any explanation calling on such an effect can be ruled out.

5.6 Summary for both studies

5.6.1 Study I

1. Bilateral needling was more effective than unilateral needling of LI4 although both have reliably increased regional PPT (the mean percentage increase in PPT for unilateral LI4 was 10.0% and for bilateral LI4 was 13.4%).
2. Bilateral needling of LI11 produced statistically significant increases in PPT at six measurement sites but was not as effective as unilateral needling of LI4 for which statistically significant increases obtained at nine sites.
3. The combined needling of LI4 and LI11 was the least effective intervention in increasing regional PPT (statistically significant increases obtained at five sites).
4. The distribution of effects on PPT best support a generalised effect rather than patterns predicted by either neural segment or TCM channel theory.
5. TCM theory was only supported in relatione to the claimed superior effect of bilateral needling of the same point (LI4) over unilateral needling. The diminished effect on

PPT following the combined needling merits further study particularly since it is in keeping with the similar report by Yuan of the combined intervention of LI4 with LR3.

5.6.2 Study II

For Study II, the results are reviewed with some caution in view of the atypical effects elicited by needling LI4, discussed earlier in this chapter. The main aim of this study was to: (1) compare the effects of acupuncture with acupressure (to LI4) given that acupressure is often more readily accepted by some patients and also is potentially of great value for self management by the patient and/or carer, and children particularly; (2) compare the effects of acupressure to LI4 and the same NAP that had been used in two previous studies (Zaslawski and Cobbin 2001/2003, Yuan 2003); (3) compare the effects of acupuncture to LI4 and the new acupoint SP4. Acupressure applied to LI4 and NAP was found to be effective in increasing regional PPT: statistically significant effects were reported at all ten sites for both interventions (the mean percentage increase in PPT are 11.0% and 11.6% respectively). Acupuncture to the point SP4 also achieved statistically significant increases in PPT (11.0%) at ten measurement sites. Surprisingly, acupuncture to LI4 (the mean percentage increase in PPT is 4.7%), which was used in previous UTS studies and obtained good effects in increasing regional PPT, elicited statistically significant increases at only three sites (GB20R, LI5L and 1L). In addition, the distribution of effects on PPT best supports a generalised effect rather than patterns predicted by either neural segment or TCM channel theory. Again, replication of Study II is recommended.

5.7 Future directions

The findings from study II strongly suggest two avenues for future related research. First is replication of the study, as previously discussed, to demonstrate the reliability or otherwise of the findings. The unusually weak effects of acupuncture to LI4 on PPT were so out of keeping with related research involving many subjects that this is an essential first step. A second interesting direction is further examination of the effects of combination needling reported for LI4 with LI11 in study I. As discussed, the study by Yuan (2002) also found an interactive effect when two different acupoints were needled simultaneously: an interactive effect

that appeared to partially block or antagonise the effects of the unilateral needling of LI4. In that case, the second point needled (LR3) was from a different channel; in the present study I both points were from the same channel. While summative effects following combined needling seem to be regarded as likely and would possibly be also accepted in Western pain theory in terms of an increased effect due to nonspecific diffuse noxious inhibitory controls (DNIC) (Murase et al 2000; Flossos 2004; Le Bars 1979; De Broucker et al 1990); the occurrence of a partial blocking of the effects that increase PPT are not similarly explicable.

References

Acupuncture Anesthesia Theory Research Group, Department of Basic Theory, Beijing Medical University. Scientia Sinica 1973; 3: 151- 157.

Aird M, Coyle M, Cobbin D, Zaslawski C. A Study of the Comparative Accuracy of Two Methods of Locating Acupuncture Points. Acupuncture in Medicine 2000; 18 (1): 1-7.

Antonaci F, Bovim G, Fasano ML, Bonamico L, Shen JM. Pain Threshold in Humans: A Study with the Pressure Algometer. Functional Neurology 1992; 7(4): 283-288.

Arendt-Nielsen L, Bjerring P. Reaction Times to Painless and Painful CO_2 and Argon Laser Stimulation. European Journal of Applied Physiology and Occupational Physiology 1988; 58: 266-273.

Arendt-Nielsen L, Sumikura H. From Pain Research to Pain Treatment: Role of Human Pain Models. Journal of Nippon Medical School 2002; 69 (6): 514- 522.

Arima T, Arendt-Nielsen L, Svensson P. Effect of Jaw Muscle Pain and Soreness Evoked by Capsaicin before Sleep on Orofacial Motor Activity during Sleep. Journal of Orofacial Pain 2001; 15: 245-256.

Ashton H, Ebenezer I, Golding JF, Thompson JW. Effects of Acupuncture and Transcutaneous Electrical Nerve Stimulation on Cold Induced Pain in Normal Subjects. Journal of Psychosomatic Research 1984; 28(4): 301-308.

Autheroche B, Gervais G, Auteroche M, Navailh P, Toui-Kan E. Acupuncture and Moxibustion: A Guide to Clinical Practice. UK: Churchill Livingstone 1992.

Bai X, Baron RB. Acupuncture: Visible Holism. Butterworth Heinemann 2001.

Bahr F. The Acupressure Health Book. London: Unwin Paperbacks 1983.

Beggs, DM. Acupressure as a Preventive Measure, as a Diagnostic Aid and a Treatment Modality. American Journal of Acupuncture 1980; 8 (4): 341-347.

Bell-Krotoski J, Tomancik E. The Repeatability of Testing with Semmes-Weinstein Monofil. Journal of Hand Surgery 1987; 12: 155-161.

Brennum J, Kjeldsen M, Jensen K, Jensen TS. Measurements of Human Pressure-Pain Threshold on Fingers and Toes. Pain 1989; 38: 211-217.

Brockhaus A, Elger CE. Hyperalgesic Efficacy of Acupuncture on Experimental Pain in Man: Comparison of Laser Acupuncture and Needle Acupuncture. Pain 1990; 43: 181-185.

Bromm AC, Treede RD. Withdrawal Reflex, Skin Resistance Reaction and Pain Ratings Due to Electrical Stimuli in Man. Pain 1980; 9: 339-354.

Broucker TD, Cesaro P, Willer JC, Le Bars D. Diffuse Noxious Inhibitory Controls in Man. Involvement of the Spinoreticular Tract. Brain 1990; 113 (4): 1223-1234.

Carlin S, Ward WD, Gershon A, Ingraham R. Sound Stimulation and Its Effect on Dental Sensation Threshold. Science 1962; 138: 1258-1259.

Cheng XN. Chinese Acupuncture and Moxibustion. Beijing: Foreign Language Press 1987.

Chiang CY, Chang CT, Chu HL, Yang LF. Peripheral Afferent Pathway for Acupuncture Analgesia. Scientia Sinica 1973; 16: 210-217.

Chudler EH, Dong WK, Kawakami Y. Cortical Nociceptive Responses and Behavioral Correates in Monkey. Brain Research 1986; 397: 47-60.

Coyle M, Aird M, Cobbin D, Zaslawski C. The Cun Measurement System: An Investigation into Its Suitability in Current Practice. Acupuncture in Medicine 2000; 18 (1): 1-5.

Croze S, Antonietti C, Duclaux R. Changes in Burning Pain Threshold Induced by Acupuncture in Man. Brain Research 1976; 104: 335-340.

De Broucker, Cesaro P, Willer JC, Le Bars D. Diffuse Noxious Inhibitory Controls in Man. Brain 1990; 113: 1223- 1234.

Drewes AM, Schipper KP, Dimcevski G, Petersen P, Anderson OK, Gregersen H, Arendt-Nielsen L. Multimodal Assessment of Pain in the Oesophagus: A New Experimental Model. American Journal of Physiological Gastrointest Liver Physiology 2002;283: G95- G103.

Dworkin SF, Chen CNA. Pain in Clinical and Laboratory Contexts. Journal of Dental Research 1982; 61: 772-774.

Ernst E, White A. Acupuncture: A Scientific Appraisal. USA: Butterworth-Heinemann 1999.

Felhendler D, Bjorn L. Pressure on Acupoints Decrease Postoperative Pain. The Clinical Journal of Pain 1996; 12: 326-329.

Fernandes de Lima VM, Chatrian GE, Lettich E, Canfield RC, Miller RC, Soso MJ. Electrical Stimulation of Tooth Pulp in Human: Relationships among Physical Stimulus Intensities, Psychological Magnitude Estimates and Cerebral Evoked Potentials. Pain 1982; 14: 207-232.

Filshie J, White A. Medical Acupuncture: A Western Scientific Approach. UK: Churchill Livingstone 1998.

Fischer AA. Pressure Tolerance over Muscles and Bones in Normal Subjects. Archives of Physical and Medical Rehabilitation 1986; 67: 406-409.

Fischer AA. Algometry in Diagnosis of Musculoskeletal Pain and Evaluation of Treatment Outcome: an Update. Journal of Musculoskeletal Pain 1998; 6(1): 5-32.

Fischer AA. Pressure Algometry over Normal Muscles. Standard Values, Validity and Reproducibility of Pressure Threshold. Pain 1987; 30: 115-126.

Flossos A. An Introduction to the Neurobiology of Pain. The Greek E-Journal of Perioperative Medicine 2004; 2(2): 10.

Gach, MR. Acupressure's Potent Points. USA: Bantam Books 1990.

Gracely EH. Studies of Pain in Normal Man. Textbook of Pain, 4th ed, Wall PD End Melzack R EDT. UK: Churchill Livingstone 1999.

Graven-Nielsen T, Mense S. The Peripheral Apparatus of Muscle Pain: Evidence from Animal and Human Studies. Clinical Journal of Pain 2001; 17: 2-10.

Ha H, Tan EC. Effect of Acupuncture on Pain Threshold Measurement of Tooth Pulp in the Monkey. American Journal of Chinese Medicine 1982; X (1-4): 92-100.

Ha H, Wu RS, Contreras RA, Tan EC. Measurement of Pain Threshold by Electrical Stimulation of Tooth Pulp Afferents in the Monkey. Experimental Neurology 1978; 61: 260-269.

Han JS. Some Developments of Pain Feeling Physiology. The Collection of Papers on the Soft Tissue Pain Academic Meeting of Integrated Traditional Chinese and Western Medicine. Shanghai 1984: 1-3.

Han JS. Physiology of Acupuncture: Review of Thirty Years of Research. The Journal of Alternative and Complementary Medicine 1997; 3(1): 101- 108.

Han SH, Terenius L. Neurochemical Basis of Acupuncture Analgesia. Annual Review of Pharmacology and Toxicology 1982; 22: 193- 220.

Harper DJ. Early Chinese Medical Literature: The Mawangdui Medical Manuscripts. London and New York: Kegan Paul International 1998.

Jensen K, Norup M. Experimental Pain in Human Temporal Muscle Induced by Hypertonic Saline, Potassium and Acidity. Cephalalgia 1992; 12: 101-106.

Johnson MH, Breakwell G, Douglas W. The Effect of Imagery and Sensory Detection Distractors on Different Measures of Pain: How Does Distraction Work? British Journal of Clinical Psychology 1998; 37: 141-154.

Johnson MI, Kundu S, Ashton CH, Marsh VR, Thomson JW. The Analgesic Effects of Acupuncture on Experimental Pain Threshold and Somatosensory Evoked Potentials in Healthy Volunteers. Complementary Therapies in Medicine 1996; 4: 219-225.

Kim, M. Traditional Chinese Medicine Tongue Inspection: An Examination of the Inter and Intra Practitioner Reliability for Specific Tongue Characteristics. MSc Thesis, University of Technology, Sydney 2003.

Kosek E, Ekholm J, Nordemar R. A Comparison of Pressure Pain Thresholds in Different Tissues and Body Regions. Scandinavian Journal of Rehabilitation Medicine 1993; 25: 117-124.

Lautenbacher S, Roscher S, Strian F. Inhibitory Effects Do not Depend on the Subjective Experience of Pain during Heterotopic Noxious Conditioning Stimulation (HNCS): a Contribution to the Psychophysics of Pain Inhibition. European Journal of Pain 2002; 6 (5): 365-374.

Leavitt AH, King GJ, Ramsay DS, Jackson DL. A Longitudinal Evaluation of Pulpal Pain during Orthodontic Tooth Movement. Orthodontics and Craniofacial Research 2002; 5: 29-37.

Le Bars D, Dickenson AH, Besson JM. Diffuse Noxious Inhibitory Controls (DNIC). II. Lack of Effect on Non-convergent Neurones, Supraspinal Involvement and theoretical Implications. Pain 1979; 6(3): 305-327.

Leng TT, Tan MYC, Veith I. Acupuncture Therapy - Current Chinese Practice. Philadelphia: Temple University 1973.

Li CL, Ahlberg D, Lansdell H, Gravitz MA, Chen TC, Ting CY. Acupuncture and Hypnosis: Effects on Induced Pain. Experimental Neurology 1975; 49: 272-280.

Lin MT, Chandra A, Chen YSM. Effects of Needle Stimulation of Acupuncture Loci Nei Kuan (PC6), Tsu-San-Li (ST36), San-Yin-Chiao (SP6) and Chu-Chih (LI11) on Cutaneous Temperature and Pain Threshold in Normal Adults. American Journal of Chinese Medicine 1982; 9(4): 305-314.

Li SH. (trans: Broffman MD) Points: 2001: A Comprehensive Textbook/Manual of 20th Century. Taipei: Hundreds Talents Press 1976.

Lundeberg T, Eriksson S, Lundeberg S, Thomas M. Acupuncture and Sensory Thresholds. American Journal of Chinese Medicine 1989; XVII(3-4): 99-110.

Matthews B. Functions of Tooth-Pulp Afferents. In: Bonical JJ, ed. Advances in Pain Research and Therapy. New York: Raven Press 1979; 3: 261-263.

Mayer DJ, Price DD, Rafu A. Antagonism of Acupuncture Analgesia in Man by the Narcotic Antagonist Naloxone. Brain Research 1977; 121: 368-372.

Mok YP. Acupuncture-Assisted Anesthesia. Medical Acupuncture Online Journal 2000; 12(1).

Morosko TE, Simmons FF. The Effect of Audio-Analgesia on Pain Threshold and Pain Tolerance. Journal of Dental Research 1966; 45: 1608-1617.

Murase K, Kawakita K. Diffuse Noxious Inhibitory Controls in Anti-Nociception Produced by Acupuncture and Moxibustion on Trigeminal Caudalis Neurons in Rats. Japanese Journal of Physiology 2000; 50: 133- 140.

Nussbaum EL, Downes L. Reliability of Clinical Pressure Pain Algometric Measurements Obtained on Consecutive Days. Physical Therapy 1998; 78 (2): 160-169.

O'Connor J, Bensky D, eds. Acupuncture: a Comprehensive Text. Chicago: Eastland Press 1981.

Ohrbach R, Gale EN. Pressure Pain Thresholds in Normal Muscles: Reliability, Measurement Effects and Topographic Difference. Pain 1989; 37: 257- 263.

Olausson B, Sagvik J. Pain Threshold Changes Following Acupuncture Measured with Cutaneous Argon Laser and Electrical Tooth Pulp Stimulation, a Comparative Study. Progress in Neuro-Psychopharmacology and Biological Psychiatry 2000; 24: 385-395.

Pomeranz B. Brain's Opiates at Work in Acupuncture. New Scientist 1977; 6: 12-13.

Reeves JL, Jaeger B, Graff-Radford SB. Reliability of the Pressure Algometer as a Measure of Myofascial Triggerpoint Sensitivity. Pain 1986; 24: 313- 321.

Research Group of Acupuncture Anesthesia, Peking Medical College. The Effect of Acupuncture on the Human Skin Pain Threshold. Chinese Medical Journal 1973; 3: 151-157.

Roth LU, Maret-Maric A, Adler RH, Neuenschwander BE. Acupuncture Points Have Subjective (Needling Sensation) and Objective (Serum Cortisol Increase) Specificity. Acupuncture in Medicine 1997; 15(1): 2-5.

Saletu B, Saletu M, Brown M, Stern J, Sletten I, Ulett G. Hypno-Analgesia and Acupuncture Analgesia: A Neurophysiological Reality? Neuropsychobiology 1975; 1: 218-242.

Sessle, BJ. Is the Tooth Pulp a "Pure" Source of Noxious Input? In: Bonical JJ, ed. Advances in Pain Research and Therapy. New York: Raven Press 1979; 3: 245-259.

Simone DA, Baumann TK, LaMotte RH. Dose-Dependant Pain and Mechanical Hyperalgesia in Humans after Intradermal Injection of Capsaicin. Pain 1989; 38: 99-107.

Soper WY, Melzack R. Stimulation-Produced Analgesia: Evidence for Somatotopic Organization in the Midbrain. Brain Research 1982; 251: 301-311.

Stacher G, Wancura I, Bauer P, Lahoda R, Schulze D. Effect of Acupuncture on Pain Threshold and Pain Tolerance Determined by Electrical Stimulation of the Skin: A Controlled Study. American Journal of Chinese Medicine 1975; 3 (2): 143-149.

Svensson P, Arendt-Nielsen L, Houe L. Muscle Pain Modulates Mastication: an Experimental Study in Humans. Journal of Orofacial Pain 1998; 12: 7-16.

Szabo S, 2005 (personal communication).

Takeshige C, Oka K, Mizuno T, Hisamitsu T. The Acupuncture Point and Its Connecting Central Pathway for Producing Acupuncture Analgesia. Brain Research Bulletin 1993; 30: 53- 67.

Tariq M, Zahir J, Saleem SA. Case Report: Role of Acupuncture in Thoracic Outlet Syndrome. Acupuncture in Medicine 2000; 18(2).

Tekeoglu I, Adak B, Ercan M. Suppression of Experimental Pain by Auriculopressure. Acupuncture in Medicine 1996; 14(1).

Ulett GA, Han JS, Han SP. Traditional and Evidence-Based Acupuncture: History, Mechanisms, and Present Status. Southern Medical Journal 1998; 91(12): 1115-1120.

Unschuld PU. Huang Di Nei Jing Su Wen: Nature, Knowledge, Imagery in an Ancient Chinese Medical Text. USA: Berkeley, University of California Press 2003.

Veith I. (trans) The Yellow Emperor's Classic of Internal Medicine. USA: University of California Press 1949.

Voerman VF, Egmond VJ, Crul BJ. Normal Values for Sensory Threshold in Cervical Dermatomes: A Critical Note on the Use of Semmes-Weinstein Monofilaments. American Journal of Physiology and Medical Rehabilitation 1999; 78: 24-29.

Walsh NE, Schoenfeld L, Ramamurthy S, Hoffmann J. Normative Model for Cold Pressor Test. American Journal of Physiology and Medical Rehabilitation 1989; 68: 6-11.

Webster-Harrison P, White A, Rae J. Acupuncture for Tennis Elbow: An E-mail Consensus Study to Define a Standardised Treatment in a GPs' Surgery. Acupuncture in Medicine 2002; 20(4): 181-185.

Weisenberg M. Pain and Pain Control. Psychological Bulletin 1977; 84: 1008-1044.

Widerstrom-Noga E, Dyrehag LE, Borglum-Jensen L, Aslund PG, Wenneberg B, Andersson SA. Pain Threshold Responses to Two Different Modes of Sensory Stimulation in Patients with Orofacial Muscular Pain: Psychologic Considerations. Journal of Orofacial Pain 1998; 12 (1): 27-34.

Yen HL, Chan W. An East-West Approach to the Management of Central Post-Stroke Pain. Cerebrovascular Disease 2003; 16: 27-30.

Yuan XY. A Study into the Effects of Deep Manual Acupuncture on Pressure Pain Threshold. MSc Thesis, University of Technology, Sydney 2002.

Zaslawski C, Cobbin D. A Comparison of Regional PPT Effects Produced by Deep and Shallow Needling of LI4. Proceedings of the Sixth Australian Acupuncture and Chinese Herbal Medicine Conference, UTS, Sydney 2001: September.

Zaslawski C, Cobbin D, Lidums E, Petocz P. The Impact of Site Specificity and Needle Manipulation on Changes to Pain Pressure Threshold Following Manual Acupuncture: A Controlled Study. Complementary Therapies in Medicine 2003; 11(1): 11-21.

Appendix I: Information sheet and consent form for participants

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CONSENT FORM - STUDENT RESEARCH

I _____ *(participant's name)* agree to participate in the research project *"The Effect of Acupuncture on Pain Pressure Threshold Part II"* being conducted by masters student, Mr Xiao Yong Yuan (Andrew), Room 1313 Building 1 Broadway Campus phone: 9514-2177 of the University of Technology, Sydney.

I understand that the purpose of this study is to evaluate whether acupuncture can relieve pain or discomfort arising from pressure in certain regions of the body.

I understand that my participation in this research will involve approximately four hours of my time for which I will receive a pecuniary of $40. I have read the subject/participant information sheet and understand that there may be some risks associated with the procedure such as a bruise or slight discomfort/pain. If at any time during the procedure should you wish to discontinue the procedure the process will be stopped immediately and acupuncture needles withdrawn.

I am aware that I can contact Mr Xiao Yong Yuan (Andrew) or his supervisor Dr Deirdre Cobbin (ph:9514-2231), if I have any concerns about the research. I also understand that I am free to withdraw my participation from this research project at any time I wish and without giving a reason. I understand that if I am currently a UTS student the withdrawal from the research will not prejudice my academic progress.

I have read the subject/participant information sheet and I agree that Xiao Yong Yuan (Andrew) has answered all my questions fully and clearly.

I agree that the research data gathered from this project may be published in a form that does not identify me in any way.

_____ ____/____/____
Signed by

_____ ____/____/____
Witnessed by

NOTE:
This study has been approved by the University of Technology, Sydney Human Research Ethics Committee. If you have any complaints or reservations about any aspect of your participation in this research which you cannot resolve with the researcher, you may contact the Ethics Committee through the Research Ethics Officer, Ms Susanna Davis (ph: 9514 1279). Any complaint you make will be treated in confidence and investigated fully and you will be informed of the outcome.

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UNIVERSITY OF TECHNOLOGY, SYDNEY
SUBJECT/PARTICIPANT INFORMATION SHEET- STUDENT RESEARCH

The aim of thesis project is to evaluate the effect of acupuncture on pain pressure threshold. You will be required to attend for four sessions each taking approximately one hour each. Each session will involve two acupuncture needles that will puncture the skin in the area on your hand and will remain in place for approximately 40 minutes. A practitioner of 21 years experience will provide the acupuncture. Twenty minutes after the initial puncture an algometer, described below, will be applied to a number of regions on your body (see figure below) to measure pain pressure threshold. Pain pressure threshold refers to discomfort produced by pressing on your skin or muscles. An instrument called an algometer produces this pressure. An algometer is a spring loaded pressure (force) gauge that is attached to a rubber plunger with a 0.5 cm diameter (see photograph below). It does not puncture the skin.

If at any stage you feel discomfort or pain and wish to withdraw from the experiment, please inform the researchers immediately and the procedure will be terminated. You will be asked whether you want to continue the experiment or withdraw completely from the project.

You will be asked to expose some areas of the body during algometric measurement. A hospital gown will be available and an adjacent changing room has been allocated. There are some risks associated with acupuncture, for example a bruise. All measures will be taken to minimise such risks.

You will also be asked to fill out a questionnaire at the completion of each session. Your identity will be confidential. To thank you for your participation a fee of $10 per session has been allocated to cover travel cost.

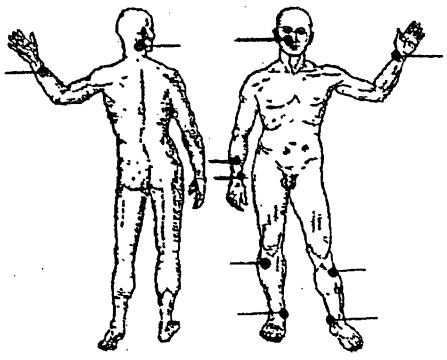
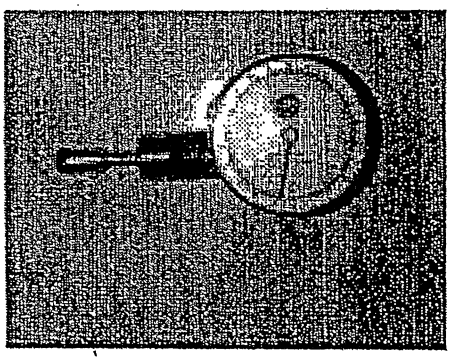


Figure 1-Points on your body at which the algometer is to be applied



Photograph 1- Algometer used to measure pressure

Appendix II: Statistical analysis tables

Study I

1. Examination of the effect of needling of LI4 alone upon PPT, measured at the ten regional sites (Table 4.2)

Pre and post intervention comparisons

```
Factor          Type Levels Values
Subject         fixed     22  1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17
                             18 19 20 21 22
Site            fixed     10  1  2  3  4  5  6  7  8  9 10
2 Times(Site)   fixed     20 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2
```

Analysis of Variance for % of bas, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Subject	21	33220.5	33047.3	1573.7	6.81	0.000
Site	9	3513.8	2022.8	224.8	0.97	0.461
2 Times(Site)	10	43422.9	43422.9	4342.3	18.79	0.000
Error	1934	446968.6	446968.6	231.1		
Total	1974	527125.7				

2. Examination of the effect of needling of LI4 and LI11 in combination upon PPT, measured at the ten regional sites (Table 4.2)

Pre and post intervention comparisons

```
Factor          Type Levels Values
Subject         fixed     22  1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17
                             18 19 20 21 22
Site            fixed     10  1  2  3  4  5  6  7  8  9 10
2 Times(Site)   fixed     20 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2
```

Analysis of Variance for % of bas, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Subject	21	85881.4	81595.6	3885.5	16.47	0.000
Site	9	4785.2	2841.7	315.7	1.34	0.212
2 Times(Site)	10	34942.1	34942.1	3494.2	14.81	0.000
Error	1933	456009.5	456009.5	235.9		
Total	1973	581618.3				

3. Examination of the effect of needling of LI11 alone upon PPT, measured at the ten regional sites (Table 4.2)

Pre and post intervention comparisons

```
Factor          Type Levels Values
Subject         fixed     22  1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17
                             18 19 20 21 22
Site            fixed     10  1  2  3  4  5  6  7  8  9 10
2 Times(Site)   fixed     20 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2
```

Analysis of Variance for % of bas, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Subject	21	72186.1	72598.3	3457.1	14.40	0.000
Site	9	5665.9	3609.7	401.1	1.67	0.091
2 Times(Site)	10	44048.4	44048.4	4404.8	18.34	0.000
Error	1913	459343.1	459343.1	240.1		
Total	1953	581243.4				

4. Examination of the effect of needling of LI4 bilaterally upon PPT, measured at the ten regional sites (Table 4.2)

Pre and post intervention comparisons

Factor	Type	Levels	Values
Subject	fixed	22	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22
Site	fixed	10	1 2 3 4 5 6 7 8 9 10
2 Times(Site)	fixed	20	1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2

Analysis of Variance for % of bas, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Subject	21	73138.2	68749.7	3273.8	11.00	0.000
Site	9	10643.5	6216.4	690.7	2.32	0.014
2 Times(Site)	10	85424.8	85424.8	8542.5	28.70	0.000
Error	1941	577754.3	577754.3	297.7		
Total	1981	746960.7				

5. Examination of the relative effects on PPT of the four interventions by site

There are ten pre/post comparisons, each concerning a single regional site and each involving all four interventions (summarised in Table 4.4)

LI5R

Factor	Type	Levels	Values
Subject	fixed	22	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22
Treatmen	fixed	4	1 2 3 4
2 Times(Treatmen)	fixed	8	1 2 1 2 1 2 1 2

Analysis of Variance for % of bas, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Subject	21	28235.8	27174.2	1294.0	5.45	0.000
Treatmen	3	1778.1	1047.9	349.3	1.47	0.221
2 Times(Treatmen)	4	13163.8	13163.8	3291.0	13.85	0.000
Error	759	180357.8	180357.8	237.6		
Total	787	223535.5				

LI20R

Factor	Type	Levels	Values
subject	fixed	22	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22
Treatmen	fixed	4	1 2 3 4
2 Times(Treatmen)	fixed	8	1 2 1 2 1 2 1 2

Analysis of Variance for % of bas, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
subject	21	23058.4	22133.8	1054.0	6.49	0.000
Treatmen	3	1399.8	802.4	267.5	1.65	0.177
2 Times(Treatmen)	4	13093.1	13093.1	3273.3	20.15	0.000
Error	759	123291.3	123291.3	162.4		
Total	787	160842.6				

GB20R

Factor	Type	Levels	Values
subject	fixed	22	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22
Treatmen	fixed	4	1 2 3 4
2 Times(Treatmen)	fixed	8	1 2 1 2 1 2 1 2

Analysis of Variance for % of bas, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
subject	21	34974.4	33489.3	1594.7	5.07	0.000
Treatmen	3	1428.1	838.4	279.5	0.89	0.447
2 Times(Treatmen)	4	39620.8	39620.8	9905.2	31.46	0.000
Error	760	239257.1	239257.1	314.8		
Total	788	315280.5				

ST36L

Factor	Type	Levels	Values
subject	fixed	22	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22
Treatmen	fixed	4	1 2 3 4
2 Times(Treatmen)	fixed	8	1 2 1 2 1 2 1 2

Analysis of Variance for % of bas, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
subject	21	19817.3	19388.8	923.3	3.31	0.000
Treatmen	3	218.8	104.8	34.9	0.13	0.945
2 Times(Treatmen)	4	21487.6	21487.6	5371.9	19.23	0.000
Error	758	211745.8	211745.8	279.3		
Total	786	253269.5				

KD3L

Factor	Type	Levels	Values
subject	fixed	22	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22
Treatmen	fixed	4	1 2 3 4
2 Times(Treatmen)	fixed	8	1 2 1 2 1 2 1 2

Analysis of Variance for % of bas, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
subject	21	21861.0	20411.0	972.0	4.02	0.000
Treatmen	3	455.2	298.5	99.5	0.41	0.745
2 Times(Treatmen)	4	15957.8	15957.8	3989.4	16.48	0.000
Error	761	184188.3	184188.3	242.0		
Total	789	222462.3				

LI5L

Factor	Type	Levels	Values
subject	fixed	22	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22
Treatmen	fixed	4	1 2 3 4
2 Times(Treatmen)	fixed	8	1 2 1 2 1 2 1 2

Analysis of Variance for % of bas, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
subject	21	20235.5	18420.7	877.2	3.07	0.000
Treatmen	3	3915.0	2291.3	763.8	2.68	0.046
2 Times(Treatmen)	4	31457.4	31457.4	7864.3	27.55	0.000
Error	759	216622.8	216622.8	285.4		
Total	787	272230.7				

ST36R

Factor	Type	Levels	Values
subject	fixed	22	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22
Treatmen	fixed	4	1 2 3 4
2 Times(Treatmen)	fixed	8	1 2 1 2 1 2 1 2

Analysis of Variance for % of bas, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
subject	21	32222.8	31068.5	1479.5	5.81	0.000
Treatmen	3	1323.6	982.0	327.3	1.28	0.278
2 Times(Treatmen)	4	9711.3	9711.3	2427.8	9.53	0.000
Error	766	195171.4	195171.4	254.8		
Total	794	238429.2				

KD3R

Factor	Type	Levels	Values
subject	fixed	22	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22
Treatmen	fixed	4	1 2 3 4
2 Times(Treatmen)	fixed	8	1 2 1 2 1 2 1 2

Analysis of Variance for % of bas, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
subject	21	21059.3	20397.7	971.3	3.81	0.000
Treatmen	3	6065.0	3482.5	1160.8	4.56	0.004
2 Times(Treatmen)	4	23361.4	23361.4	5840.4	22.93	0.000
Error	754	192040.8	192040.8	254.7		
Total	782	242526.5				

1R

Factor	Type	Levels	Values
subject	fixed	22	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22
Treatmen	fixed	4	1 2 3 4
2 Times(Treatmen)	fixed	8	1 2 1 2 1 2 1 2

Analysis of Variance for % of bas, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
subject	21	17872.8	16714.7	795.9	4.03	0.000
Treatmen	3	2371.2	1428.0	476.0	2.41	0.066
2 Times(Treatmen)	4	16658.1	16658.1	4164.5	21.07	0.000
Error	762	150590.1	150590.1	197.6		
Total	790	187492.2				

1L

Factor	Type	Levels	Values
Subject	fixed	22	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22
Treatmen	fixed	4	1 2 3 4
2 Times(Treatmen)	fixed	8	1 2 1 2 1 2 1 2

Analysis of Variance for % of bas, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Subject	21	33290.7	32664.2	1555.4	4.51	0.000
Treatmen	3	2024.1	1180.0	393.3	1.14	0.332
2 Times(Treatmen)	4	21230.7	21230.7	5307.7	15.40	0.000
Error	757	260938.1	260938.1	344.7		
Total	785	317483.7				

6. Comparison of subjects perceptions of the acupuncture experience among interventions (Table 4.6)

Pain by intervention

```
Factor      Type   Levels  Values
Subject     fixed      22  1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15,
                           16, 17, 18, 19, 20, 21, 22
Treatment   fixed       4  1, 2, 3, 4


Analysis of Variance for %Pain VAS, using Adjusted SS for Tests

Source      DF   Seq SS   Adj SS  Adj MS     F      P
Subject     21  23004.1  23004.1  1095.4  2.63  0.002
Treatment    3   2492.1   2492.1   830.7  1.99  0.124
Error       63  26264.9  26264.9   416.9
Total       87  51761.1
```

Needle sensation by intervention

```
Factor      Type   Levels  Values
Subject     fixed      22  1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15,
                           16, 17, 18, 19, 20, 21, 22
Treatment   fixed       4  1, 2, 3, 4


Analysis of Variance for %Sensation VAS, using Adjusted SS for Tests

Source      DF   Seq SS   Adj SS  Adj MS     F      P
Subject     21  47030.8  47030.8  2239.6  5.17  0.000
Treatment    3   2968.2   2968.2   989.4  2.28  0.088
Error       63  27299.3  27299.3   433.3
Total       87  77298.3
```

Tension by intervention

```
Factor      Type   Levels  Values
Subject     fixed      22  1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15,
                           16, 17, 18, 19, 20, 21, 22
Treatment   fixed       4  1, 2, 3, 4


Analysis of Variance for %Tension VAS, using Adjusted SS for Tests

Source      DF   Seq SS   Adj SS  Adj MS     F      P
Subject     21  27464.3  27464.3  1307.8  6.25  0.000
Treatment    3   1536.3   1536.3   512.1  2.45  0.072
Error       63  13192.7  13192.7   209.4
Total       87  42193.3
```

Anxiety by intervention

```
Factor      Type   Levels  Values
Subject     fixed      22  1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15,
                           16, 17, 18, 19, 20, 21, 22
Treatment   fixed       4  1, 2, 3, 4


Analysis of Variance for %Anxiety VAS, using Adjusted SS for Tests

Source      DF   Seq SS   Adj SS  Adj MS     F      P
Subject     21  35695.3  35695.3  1699.8  7.32  0.000
Treatment    3   2739.9   2739.9   913.3  3.93  0.012
Error       63  14624.1  14624.1   232.1
Total       87  53059.3
```

Acupuncturist's behaviour by intervention

```
Factor      Type    Levels  Values
Subject     fixed       22  1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15,
                            16, 17, 18, 19, 20, 21, 22
Treatment   fixed        4  1, 2, 3, 4


Analysis of Variance for %Credibility VAS, using Adjusted SS for Tests

Source      DF   Seq SS   Adj SS  Adj MS     F      P
Subject     21  1102.61  1086.97   51.76  1.10  0.387
Treatment    3     5.71     5.71    1.90  0.04  0.989
Error       41  1931.62  1931.62   47.11
Total       65  3039.94
```

Study II

1. Examination of the effect of acupressure to LI4 alone upon PPT, measured at the ten regional sites (Table 4.9)

Pre and post intervention comparisons

```
Factor           Type Levels Values
Subject          fixed     24  1  2  3  4  5  6  7  8  9 10 11 12 13 14
15 16 17
                            18 19 20 21 22 23 24
Site             fixed     10  1  2  3  4  5  6  7  8  9 10
2 times(Site)    fixed     20 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2

Analysis of Variance for % of bas, using Adjusted SS for Tests

Source           DF     Seq SS     Adj SS     Adj MS       F      P
Subject          23   133944.3   133944.3     5823.7   21.17  0.000
Site              9     1737.0     1389.6      154.4    0.56  0.830
2 times(Site)    10    78734.2    78734.2     7873.4   28.62  0.000
Error          2117   582436.8   582436.8      275.1
Total          2159   796852.3
```

2. Examination of the effect of needling of LI4 upon PPT, measured at the ten regional sites (Table 4.9)

Pre and post intervention comparisons

```
Factor           Type Levels Values
Subject          fixed     24  1  2  3  4  5  6  7  8  9 10 11 12 13 14
15 16 17
                            18 19 20 21 22 23 24
Site             fixed     10  1  2  3  4  5  6  7  8  9 10
2 times(Site)    fixed     20 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2

Analysis of Variance for % of bas, using Adjusted SS for Tests

Source           DF     Seq SS     Adj SS     Adj MS       F      P
Subject          23    89198.2    89198.2     3878.2   19.44  0.000
Site              9     1872.9     1476.3      164.0    0.82  0.595
2 times(Site)    10    13160.9    13160.9     1316.1    6.60  0.000
Error          2117   422231.6   422231.6      199.4
Total          2159   526463.7
```

3. Examination of the effect of acupressure to NAP alone upon PPT, measured at the ten regional sites (Table 4.9)

Pre and post intervention comparisons

```
Factor          Type Levels Values
Subject         fixed     24  1  2  3  4  5  6  7  8  9 10 11 12 13 14
15 16 17
                           18 19 20 21 22 23 24
Site            fixed     10  1  2  3  4  5  6  7  8  9 10
2 times(Site)   fixed     20 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2

Analysis of Variance for % of bas, using Adjusted SS for Tests

Source           DF     Seq SS     Adj SS     Adj MS       F      P
Subject          23    89459.2    89459.2     3889.5   16.33  0.000
Site              9     2236.4     1789.1      198.8    0.83  0.584
2 times(Site)    10    73373.0    73373.0     7337.3   30.81  0.000
Error          2117   504157.6   504157.6      238.1
Total          2159   669226.2
```

4. Examination of the effect of needling of SP4 alone upon PPT, measured at the ten regional sites (Table 4.9)

Pre and post intervention comparisons

```
Factor          Type Levels Values
Subject         fixed     24  1  2  3  4  5  6  7  8  9 10 11 12 13 14
15 16 17
                           18 19 20 21 22 23 24
Site            fixed     10  1  2  3  4  5  6  7  8  9 10
2 times(Site)   fixed     20 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2

Analysis of Variance for % of bas, using Adjusted SS for Tests
Source           DF     Seq SS     Adj SS     Adj MS       F      P
Subject          23   139766.6   139766.6     6076.8   20.21  0.000
Site              9     2312.6     1850.1      205.6    0.68  0.724
2 times(Site)    10    66890.3    66890.3     6689.0   22.25  0.000
Error          2117   636526.0   636526.0      300.7
Total          2159   845495.5
```

5. Examination of the relative effects on PPT of the four interventions by site

There are ten pre/post comparisons, each concerning a single regional site and each involving all four interventions (summarised in Table 4.11)

LI5R

```
Factor             Type Levels Values
Subject            fixed     24  1  2  3  4  5  6  7  8  9 10 11 12 13
14 15 16
                             17 18 19 20 21 22 23 24
Treatmen           fixed      4 1 2 3 4
2 times(Treatmen)  fixed      8 1 2 1 2 1 2 1 2

Analysis of Variance for % of bas, using Adjusted SS for Tests

Source              DF     Seq SS     Adj SS     Adj MS       F      P
Subject             23    12913.9    12913.9      561.5    2.04  0.003
Treatmen             3     3870.0     3020.8     1006.9    3.66  0.012
2 times(Treatmen)    4    28647.0    28647.0     7161.7   26.06  0.000
Error              833   228962.2   228962.2      274.9
Total              863   274393.2
```

LI20R

Factor	Type	Levels	Values
Subject	fixed	24	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Treatmen	fixed	4	1 2 3 4
2 times(Treatmen)	fixed	8	1 2 1 2 1 2 1 2

Analysis of Variance for % of bas, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Subject	23	14077.3	14077.3	612.1	3.48	0.000
Treatmen	3	3272.8	2518.5	839.5	4.77	0.003
2 times(Treatmen)	4	16189.3	16189.3	4047.3	23.01	0.000
Error	833	146547.2	146547.2	175.9		
Total	863	180086.7				

GB20R

Factor	Type	Levels	Values
Subject	fixed	24	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Treatmen	fixed	4	1 2 3 4
2 times(Treatmen)	fixed	8	1 2 1 2 1 2 1 2

Analysis of Variance for % of bas, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Subject	23	17656.3	17656.3	767.7	2.73	0.000
Treatmen	3	1972.7	1590.7	530.2	1.89	0.130
2 times(Treatmen)	4	25702.0	25702.0	6425.5	22.86	0.000
Error	833	234114.4	234114.4	281.0		
Total	863	279445.5				

ST36L

Factor	Type	Levels	Values
Subject	fixed	24	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Treatmen	fixed	4	1 2 3 4
2 times(Treatmen)	fixed	8	1 2 1 2 1 2 1 2

Analysis of Variance for % of bas, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Subject	23	16497.5	16497.5	717.3	2.62	0.000
Treatmen	3	2024.3	1619.1	539.7	1.97	0.117
2 times(Treatmen)	4	24622.4	24622.4	6155.6	22.46	0.000
Error	833	228338.1	228338.1	274.1		
Total	863	271482.3				

KD3L

Factor	Type	Levels	Values
Subject	fixed	24	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Treatmen	fixed	4	1 2 3 4
2 times(Treatmen)	fixed	8	1 2 1 2 1 2 1 2

Analysis of Variance for % of bas, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Subject	23	21017.0	21017.0	913.8	2.99	0.000
Treatmen	3	1956.5	1543.2	514.4	1.68	0.170
2 times(Treatmen)	4	19743.3	19743.3	4935.8	16.13	0.000
Error	833	254865.1	254865.1	306.0		
Total	863	297582.0				

LI5L

Factor	Type	Levels	Values
Subject	fixed	24	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Treatmen	fixed	4	1 2 3 4
2 times(Treatmen)	fixed	8	1 2 1 2 1 2 1 2

Analysis of Variance for % of bas, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Subject	23	24780.4	24780.4	1077.4	2.82	0.000
Treatmen	3	1975.1	1570.3	523.4	1.37	0.251
2 times(Treatmen)	4	28569.3	28569.3	7142.3	18.68	0.000
Error	833	318472.1	318472.1	382.3		
Total	863	373796.9				

ST36R

Factor	Type	Levels	Values
Subject	fixed	24	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Treatmen	fixed	4	1 2 3 4
2 times(Treatmen)	fixed	8	1 2 1 2 1 2 1 2

Analysis of Variance for % of bas, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Subject	23	14244.4	14244.4	619.3	2.57	0.000
Treatmen	3	1007.2	834.5	278.2	1.15	0.327
2 times(Treatmen)	4	18885.8	18885.8	4721.4	19.58	0.000
Error	833	200897.6	200897.6	241.2		
Total	863	235035.0				

KD3R

Factor	Type	Levels	Values
Subject	fixed	24	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Treatmen	fixed	4	1 2 3 4
2 times(Treatmen)	fixed	8	1 2 1 2 1 2 1 2

Analysis of Variance for % of bas, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Subject	23	15043.5	15043.5	654.1	2.54	0.000
Treatmen	3	2015.3	1644.0	548.0	2.13	0.095
2 times(Treatmen)	4	29086.3	29086.3	7271.6	28.22	0.000
Error	833	214644.3	214644.3	257.7		
Total	863	260789.4				

1R

Factor	Type	Levels	Values
Subject	fixed	24	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Treatmen	fixed	4	1 2 3 4
2 times(Treatmen)	fixed	8	1 2 1 2 1 2 1 2

Analysis of Variance for % of bas, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Subject	23	28296.2	28296.2	1230.3	3.63	0.000
Treatmen	3	2783.9	2167.9	722.6	2.13	0.094
2 times(Treatmen)	4	17781.3	17781.3	4445.3	13.13	0.000
Error	833	282119.2	282119.2	338.7		
Total	863	330980.6				

1L

Factor	Type	Levels	Values
Subject	fixed	24	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Treatmen	fixed	4	1 2 3 4
2 times(Treatmen)	fixed	8	1 2 1 2 1 2 1 2

Analysis of Variance for % of bas, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Subject	23	16390.6	16390.6	712.6	1.93	0.006
Treatmen	3	3554.3	2808.2	936.1	2.53	0.056
2 times(Treatmen)	4	22931.8	22931.8	5733.0	15.51	0.000
Error	833	307842.8	307842.8	369.6		
Total	863	350719.6				

6. Comparison of subjects perceptions of the acupuncture/acupressure experience among interventions (Table 4.13)

Pain by intervention

```
Factor      Type    Levels  Values
Subject     fixed       24  1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15,
                            16, 17, 18, 19, 20, 21, 22, 23, 24
Treatment   fixed        4  1, 2, 3, 4


Analysis of Variance for %Pain VAS, using Adjusted SS for Tests

Source      DF   Seq SS   Adj SS  Adj MS     F      P
Subject     23  30516.0  30516.0  1326.8  2.50  0.002
Treatment    3   5740.4   5740.4  1913.5  3.61  0.018
Error       69  36618.6  36618.6   530.7
Total       95  72875.0
```

Needle/acupressure sensation by intervention

```
Factor      Type    Levels  Values
Subject     fixed       24  1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15,
                            16, 17, 18, 19, 20, 21, 22, 23, 24
Treatment   fixed        4  1, 2, 3, 4


Analysis of Variance for %Sensation VAS, using Adjusted SS for Tests

Source      DF   Seq SS   Adj SS  Adj MS     F      P
Subject     23  49768.7  48976.8  2129.4  5.61  0.000
Treatment    3   4924.2   4924.2  1641.4  4.32  0.008
Error       64  24304.1  24304.1   379.8
Total       90  78997.0
```

Tension by intervention

```
Factor      Type    Levels  Values
Subject     fixed       24  1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15,
                            16, 17, 18, 19, 20, 21, 22, 23, 24
Treatment   fixed        4  1, 2, 3, 4


Analysis of Variance for %Tension VAS, using Adjusted SS for Tests

Source      DF   Seq SS   Adj SS  Adj MS     F      P
Subject     23  25393.6  25393.6  1104.1  3.06  0.000
Treatment    3    707.4    707.4   235.8  0.65  0.584
Error       69  24911.8  24911.8   361.0
Total       95  51012.8
```

Anxiety by intervention

```
Factor      Type    Levels  Values
Subject     fixed       24  1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15,
                            16, 17, 18, 19, 20, 21, 22, 23, 24
Treatment   fixed        4  1, 2, 3, 4


Analysis of Variance for %Anxiety VAS, using Adjusted SS for Tests

Source      DF   Seq SS   Adj SS  Adj MS     F      P
Subject     23  31722.3  31722.0  1379.2  4.52  0.000
Treatment    3    955.5    955.5   318.5  1.04  0.379
Error       68  20766.7  20766.7   305.4
Total       94  53444.5
```

Acupuncturist's behaviour by intervention

Factor	Type	Levels	Values
Subject	fixed	24	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24
Treatment	fixed	4	1, 2, 3, 4

Analysis of Variance for % Credibility VAS, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Subject	23	13320.8	12753.2	554.5	2.95	0.001
Treatment	3	135.1	135.1	45.0	0.24	0.868
Error	45	8444.1	8444.1	187.6		
Total	71	21900.0				