An Assessment of Pain Responses During Stages of Pregnancy

Ann H. Dunbar

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Date: 9 November 1987

Approved:

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AN ASSESSMENT OF PAIN RESPONSES DURING STAGES OF PREGNANCY

by

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Submitted in partial fulfillment of the requirements for the Degree of Masters of Science in the School of Allied Health Professions

Medical College of Virginia

Virginia Commonwealth University

Richmond, Virginia

December, 1987
ACKNOWLEDGEMENTS

I would like to acknowledge the contributions of the faculty of the School of Physical Therapy during my graduate studies, with special recognition to my committee members: Bob Lamb, whose guidance encouraged me to pursue further study in physical therapy; Don Price, whose creativity, extensive experience and encouragement have contributed to the completion of this research and further study of pain; and especially Roberta Newton, whose guidance, expertise, and nurturing have encouraged me with perseverance and continued growth.

For her assistance in the chart review process, I would like to thank Joan M. Christie, M.D.

I would also like to recognize Freida Centor, R.N. and her staff for assisting me in recruiting women to participate in this study. In addition, I want to recognize the Labor and Delivery Staff at the Medical College of Virginia for their assistance during data collection procedures.

For her patience and assistance in the typing of this manuscript, I would like to recognize Linda Marks.

Lastly, I want to thank my husband Frank, and my sons Mike and Jerry whose never ending love and understanding sustain me always.
Tables of Contents

page

ACKNOWLEDGEMENTS .................................................. ii
LIST OF TABLES ....................................................... vi
LIST OF FIGURES ..................................................... vii
ABSTRACT ............................................................... viii

CHAPTER I

Introduction ......................................................... 1
Problems ............................................................... 3
Research Questions ..................................................... 3
Research Hypotheses .................................................... 3
Operational Definitions .................................................. 4
Assumptions ............................................................. 6
Limitations .............................................................. 7
Organization of the Remaining Chapters ................................ 7

CHAPTER II

Review of the Literature ............................................. 9
Pain Measurement ....................................................... 9
Pain Assessment During Stages of Pregnancy ....................... 13
Endogenous Opiates .................................................... 20
Physical Therapy in Obstetrics ....................................... 24
Conclusions ............................................................ 24
Summary ............................................................... 25
CHAPTER III
Methods ..................................................... 26
Subjects ...................................................... 26
Research Design ............................................ 27
Materials and Instrumentation ......................... 27
Procedures .................................................. 28
Data Collection ............................................. 31
Data Reduction ............................................. 32
Data Analysis .............................................. 32
Summary .................................................... 33

CHAPTER IV
Sample Characteristics ................................... 34
Testing ....................................................... 34
Results Related to Hypothesis ......................... 39
Related Findings .......................................... 39
Analgesia Index ........................................... 41
Summary ................................................... 45

CHAPTER V
Discussion and Summary ................................ 47
Discussion .................................................. 47
Comparison With Previous Research ................. 47
Analysis of Current Methods ......................... 51
Endorphins ............................................... 52
Limitations of the study ................................. 57
Summary and Conclusions of the Study ............. 57
APPENDICES

A. Letter to Subjects .......................... 71
B. Physician Consent Form ...................... 72
C. Letter to Physicians ........................ 73
D. Random Order Form ........................ 75
E. Consent Form ................................ 76
F. Prenatal Data Sheet .......................... 79
G. Intensity Visual Analogue Scale .......... 80
H. Unpleasantness Visual Analogue Scale .... 81
I. Standardized Instructions ................. 82
J. Intensity Visual Analogue Scale For Labor 83
K. Labor Data Sheet ............................ 84
L. Data Collection Sheet ......................... 85
M. Comparison of Experimental Pain and Labor Pain 86
N. Article ........................................ 87

VITAE .............................................. 117
List of Tables

Table 1: Responses to Thermal Stimuli. ........... 36
Table 2: Results of ANOVA for Fixed Temperature and Dimension Across Stages of Pregnancy. . 41
Table 3: Pain Scores for Combined Stages of Pregnancy . ......................... 42
Table 4: Mean Pain Scores of Pregnant and "Normal" Subjects . ................. 43
List of Figures

Figures 1 & 2: Comparing Stages of Pregnancy . . . . 38
Figures 3 & 4: Study Patients Versus Normals . . . . 44
ABSTRACT

AN ASSESSMENT OF PAIN RESPONSES DURING STAGES OF PREGNANCY

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As physical therapists are becoming more involved with the pregnant population both in traditional patient care as well as in childbirth education, a better understanding of the influence of pregnancy on the pain system is needed. The purpose of this study was to determine if an endogenous analgesia system is present in pregnant humans as has been shown to be present in animals (Ginzler, 1980). Women's affective and intensity responses were measured during late pregnancy, labor and post-partum. Using a repeated measures design, fifteen women responded to thermal stimuli (43-52 degrees C) by marking a visual analogue scale. No significant difference was found to exist demonstrating that stages of pregnancy have no effect on subjects' responses to thermal stimuli.
Additional research has shown that levels of endorphins in the cerebrospinal fluid also do not change with stages of pregnancy (Steinbrook et al, 1982). This study provides a behavioral measurement of pain perception that supports the clinical finding that no endogenous analgesia is present in humans during stages of pregnancy. Lastly, by reviewing research examining levels of endorphins present in the plasma and cerebrospinal fluid during stages of pregnancy, this study also supports the growing body of knowledge which suggests that pain mediation by endorphins occurs centrally and not in the periphery.
To understand and control pain has been the quest of scholars since the ancient civilizations of Egypt, Babylonia, and Greece (Bonica, 1980). Not until recently, however, have researchers developed more interest in the mechanisms and pathophysiology of the pain system (Bonica, 1980). The research interest in this century has led to the discovery and investigation of the endogenous opiate system and its influence on pain. To better understand this pain modulator, researchers have examined a wide variety of pain experiences. The focus of this study will be to examine more closely, the changes in pain responses that occur with one life experience, pregnancy and labor.

Childbirth pain has been a topic of study for numerous researchers (Bonica, 1967; Javert & Hardy, 1950; Melzack, Taenzer, et al., 1981; Melzack, Kinch et al., 1984; Price, Harkins, & Baker, 1987). Using various measurement tools, researchers have found that labor pain ranks among the most intense types of pain that have been examined. Animal studies have shown that there is an increase in pain threshold during late pregnancy that is
mediated by the endorphin system (Gintzler, 1980). Similar investigations have been done with pregnant human subjects using signal detection procedures (Goolkasian & Rimer, 1984) and pressure-induced pain thresholds (Cogan & Spinnato, 1986). The studies show somewhat divergent results though the measurement tools are difficult to compare and their methods are not without problems (Rollman, 1977; Price, in Press).

In a study examining chronic pain, Price et al (1983) developed a method for measuring chronic pain that has been shown to be reliable and valid. Using thermal stimuli and a visual analogue scale (VAS), this measurement tool was shown to be sensitive to two distinct dimensions of pain, was administered with ease, and yielded data that allow predictive statements to be made. These characteristics make it uniquely different from other pain measurement tools.

As physical therapists are becoming more involved with the pregnant population both in traditional patient care as well as in childbirth education, a better understanding of the influence of pregnancy on the pain system is needed. The purpose of this study, therefore, is to examine variations in women's pain response systems comparing late pregnancy, labor and the puerperium by using thermal stimuli and the VAS. It is hoped the
results of this study will provide more insight into the influences of pregnancy on pain, will contribute to the existing body of knowledge on pain mediation, and will thus enable physical therapists and other health care workers to better deliver high standards of health care practice.

Problems

This research compares women's affective and intensity responses to thermal stimuli at three stages of pregnancy. The following research questions and hypotheses were thus formulated.

Research Questions

1-For each of five nociceptive temperatures used, how do women's affective responses change across stages of pregnancy: late pregnancy, labor and the puerperium?

2-For each of five nociceptive temperatures used, how do women's intensity responses change across stages of pregnancy: late pregnancy, labor and the puerperium?

Research Hypotheses

1-Null-No statistically significant difference in women's affective pain responses to thermal stimuli will be found when comparing responses during late pregnancy, early/active labor and the puerperium.
2-Null-No statistically significant difference in women's intensity pain responses to thermal stimuli will be found when comparing responses during late pregnancy, early/active labor and the puerperium.

Operational Definitions

For the purpose of this study, the following terms have been defined:

1. **Thermal stimuli**—noxious heat stimuli of 5 seconds duration at 43, 45, 47, 49, and 51 degrees C delivered to the ventral forearm by a hand-held contact thermode. Noxious heat stimuli are defined as being in the range of 45 degrees to 51 degrees C (Hardy, 1953; Perl, 1980; Price, 1983; Price & Dubner, 1977).

2. **Visual analogue scale**—a straight line 15 cm in length whose endpoints define the parameters being measured. For intensity, the endpoints are: on the left, no sensation, and on the right, the most intense sensation imaginable. For unpleasantness, the endpoints are: on the left, not bad at all, and on the right, the most intense bad feeling possible for me.

3. **Individual responses**—an indication made on separate VASs of the degree of intensity and unpleasantness experienced with each of the thermal
stimuli. The dimensions are defined as follows: (1) Intensity response: a dimension of the pain experience describing the magnitude of the pain (adapted from Mayer & Price, 1982). The response is made by marking the VAS for intensity; and, (2) Affective response: a dimension of the pain experience describing the degrees of unpleasantness of the pain (adapted from Mayer & Price, 1982). The response is made by marking the VAS for affect.

4. Stages of pregnancy:

(1) Late pregnancy: defined in terms of weeks gestation as determined by counting from the first day of a woman's last menstrual period, 280 days to arrive at the approximate due date (due date also termed Estimated Day of Confinement or EDC). The duration of the pregnancy in weeks is about 40 weeks (Reeder, Mastroianni, & Martin, 1983). For the purposes of this study, late pregnancy will be 35–37 weeks gestation.

(2) Labor: the process by which the uterus expels the fetus. There are 3 stages of labor: Stage I is dilatation or opening and effacement or thinning of the lower part of the uterus, the cervix; Stage II is the expulsion of the baby; and Stage III is the expulsion of the placenta. This study will be concerned only with Stage I, the process of which is measured in centimeters of dilatation of the cervix. The dilatation of the
cervix is determined by the nurse or physician who completes an internal vaginal exam measuring the opening of the cervix by digital estimation. The cervix can range from 0 cm dilatation to 10 cm, full dilatation. For the purposes of this study, the thermal stimuli will be administered at 3 cm (range 2–4 cm).

(3) Puerperium: the period from the end of labor to the involution of the uterus, or when the uterus returns to its normal size and condition (Reeder, Mastroianni, & Martin, 1983). The measurement period for this stage of pregnancy will be at 48–72 hours after delivery (Newnham, Dennett et al, 1984; Kimball, Chang et al, 1984).

**Assumptions**

The following assumptions have been made:

1. The participants in this study are representative of the population of women with uncomplicated pregnancies and normal vaginal deliveries who have completed Lamaze preparation.

2. The participant's responses are an honest representation of the intensity and unpleasantness of the sensations they experience.

3. The participant's due date or Estimated Day of Confinement is sufficiently accurate for the purposes of this study.
4. The measurements assessing the dilation of the cervix taken by the nurse or physician during labor are sufficiently accurate for the purposes of this study.

Limitations

This study is designed to be representative of the population of women with uncomplicated pregnancies and deliveries who have completed Lamaze preparation. The results can be extrapolated to include all women who elect Lamaze preparation. This population has been found to have a higher family income (Leonard, 1973; Whitley, 1979) and to be better educated (Chertock, 1969; Whitley, 1979).

Organization of the Remaining Chapters

This study intends to examine women's pain response systems by comparing responses to thermal stimuli at three stages of pregnancy. The terminology relevant to the study have been defined. Also discussed in this chapter are the assumptions and limitations. The introduction leading to this investigation has been discussed and the problem has been formally stated.

The remaining chapters have been organized to present first, a review of the literature. Next, the methodology used to collect the data is described. This
is followed by the reduction and results of the data, the
discussion and conclusions of the results, the
implications and recommendations, and lastly, the
summary of the study.
Chapter II

REVIEW OF THE LITERATURE

A review of the literature on women's pain responses during various stages of pregnancy would need to begin with a review of the tools used for the measurement of pain. Presented first is an overview of pain measurement followed by a more specific description of those tools used for pain measurement during pregnancy and labor. To further support this research problem, summary of the pertinent literature on endorphins and their function on pain modulation is included. The conclusions discuss the expanding role of physical therapy in obstetrics and the application of this research.

Pain Measurement

The assessment of an internal and private experience like pain has proven to be a challenge for clinicians and scientists alike. The measurement of human pain probably began in the late 1890's with VonFrey's psychophysical studies using tactile and pressure stimulation (Wolff, 1980). Psychophysics is that part of psychology dealing with the measurement of sensory perception. Though classical psychophysics began
by using what are now called "indirect scaling" methods, it has only been more recently that direct measurement of sensory magnitudes has been done (Wolff, 1980). Direct scaling techniques present a broad range of stimulus intensities delivered several times in a random sequence. Using verbal descriptors, category scales, visual analogue scales and cross modality matching, subjects respond with a subjective estimate of each evoked stimulus or sensation (Gracely, 1984). In the early work of Stevens (1957, 1961), he demonstrated that with the direct scaling technique, response magnitudes are power functions of stimulus intensity (Wolff, 1980).

Another approach toward the psychophysical study of pain, the signal detection theory (SDT), is primarily concerned with the detection of a signal of stimulus above any background "noise". This method suggests that the sensory dimension of the pain experience could be differentiated from the attitudinal dimension of pain. Thus, it represents an attempt toward being able to single out the sensory dimension of pain from other influences to provide more accurate pain measurement.

More recently however, this theory has been criticized for over simplifying the pain experience (Rollman, 1977, 1979; McCreery, 1978). Wolff (1980) feels it is a measure of one's ability to discriminate
pain, and is not able to account for the multidimensional aspects of the pain experience. As such, Wolff and others now feel this method is inappropriate to use for pain measurement.

In the field of human pain measurement, Wolff (1980) identifies five response parameters. These parameters include: (1) pain threshold: which is that point at which pain is perceived 50% of the time; (2) difference limen or just-noticeable-difference (JND): applies the Weber Law (Hardy, Wolff & Goodell, 1947) which states that the ability to discriminate differences in intensity of stimuli decreases proportionally as the intensity of the stimulus increases. Using this law, Hardy developed the Dol scale of pain measurement and determined pain could be divided into 21 JND (or steps) progressing from no pain to the most excruciating pain; (3) pain tolerance: that point at which a person will terminate or withdraw from a noxious stimulation. Wolff cautions that though this measurement is artificial, it is a useful parameter for studying pain in the laboratory, (4) drug request point: that point between pain threshold and pain tolerance at which a subject reports sufficient pain as to request medication; and, (5) pain sensitivity range: the arithmetical difference between pain tolerance and pain threshold. Wolff further states that current pain research uses all but the difference limen parameter.
Used in a laboratory setting these response parameters measure experimental pain which can be induced in several ways. Wolff divides pain induction into five broad categories. First, thermal methods include both the cold pressor method (Hines & Brown, 1932) and the radiant heat technique (Hardy et al, 1947). Second, mechanical methods include the pressure algometer (Keele, 1954) and then automatic inflation of an electro-sphygmomanometer (Cogan et al, 1986) to pain threshold or 300 mmHg. Third, chemical methods include the cantharidin blister technic developed by Keele and Armstrong (1964) and hypertonic saline stimulation. Fourth, electrical stimulation provides a high degree of control for the experimenter and is probably the most frequently used technique (Wolff, 1980). The stimulation itself, however, does yield a sensation quite different from pain. Most frequently it is described as "discomfort" (Wolff, 1980). Lastly, miscellaneous methods are those which did not fit the preceding categories such as ultrasonic stimulation.

In summary, the measurement of human pain, experimentally and clinically is best done with methods that are precisely defined and carry out controlled induction, that are sensitive to the dimensions of the pain experience, and that yield data allowing for statistical analysis. A review of the pertinent research
addressing pain assessment during stages of pregnancy is described below.

Pain assessment during stages of pregnancy

The assessment of pain during labor has been widely studied (Cogan, 1976; Chertock, 1969; Melzack, Taenzer, Feldman, & Kinch, 1981; Davenport-Slack & Boylan, 1974; Nettlebladt, Fagerstrom, & Uddenberg, 1976) though not without difficulties (Charles, Norr, Block, Meyering & Meyers, 1978). The focus of this section will be on major studies using objective measurement tools during labor. This section will also discuss several studies assessing pain responses during pregnancy.

Hardy, Wolff, & Goodell (1947) were the first to study pain using radiant heat stimulation and the JND parameter previously described. In 1950, Javert and Hardy expanded the pain assessment to also include pregnancy and labor. Using a dolorimeter, they found that skin pain thresholds did not vary during pregnancy, labor or the puerperium. Where zero Dols is no pain and ten Dols is the amount of heat necessary to reproduce the pain of a third degree burn, they found pain intensity could be determined by calculating the number of milli-calories of heat applied to each test area. Javert and Hardy (1950) used this scale with 26 women in labor and found contraction pain intensities in Dols
approximately equal to the dilatation of the cervix in centimeters. This study quantified pain intensities on a constant scale making statistical comparisons possible. Subsequently other investigators had difficulty duplicating the 21 levels of pain discrimination so that Hardy's Dol scale has fallen into disuse (Wolff, 1980).

The development of the McGill Pain Questionnaire has enabled researchers to study the various dimensions of the pain experience. Melzack and Torgerson (1971) first had subjects classify 102 words for the purpose of developing a new method to describe and measure pain in human subjects. Among the word selection, they found that a high degree of agreement was present and that the words fell into classes and subclasses representing specific dimensions. They also found these associations would remain true for people with varied backgrounds. These word lists have provided the basis for a questionnaire to use as a measuring instrument in experimental studies of clinical pain. The McGill Pain Questionnaire has been shown to be reliable for multiple major diagnostic pain categories (Melzack, 1975) and to be sensitive enough to discriminate between different sources of pain including labor pain (Dubiusson & Melzack, 1976).
Melzack et al first used the Questionnaire with women in labor in 1981 and then again in 1984. These researchers found that labor pain ranked among the most intense pains recorded by the McGill Pain Questionnaire. In both studies, the pain rating index and the present pain intensity score were calculated from questionnaire results and were also correlated with other medical and social variables. Being sensitive to individual pain experiences, the Questionnaire quantifies pain to allow for statistical comparison. It has been used extensively with a wide variety of pain problems. However, the Questionnaire requires 20 minutes for a trained person to administer and also requires a person to fit her experience into the list of word choices, narrowing the response possibilities.

One additional tool used to study pain during labor is the visual analogue scale (VAS). This scale is a 150 mm line with the ends marked to indicate the 2 extremes of pain. In a study done with women in labor, Price, Harkins, and Baker (1987) used the VAS to measure two different dimensions of pain: affective or unpleasantness and sensory or intensity. As outlined below, these two dimensions affective and sensory, have been recognized and examined as two primary dimensions of the pain experience. In their gate control theory, Melzack and Wall (1965) identified three dimensions of
pain: sensory-discriminative, affective-motivational, and cognitive-evaluative. Mayer and Price (1982) subsequently stated that the affective dimension is based on the cognitive-evaluative aspects of the pain experience; that is, the meaning given to the pain is based on past experience and the present situation. Price (Price, Barrell & Gracely, 1980) analyzed experiential factors which selectively influence the dimensions of pain experience including sensory intensity and unpleasantness. Using such experiential factors as expectation, uncertainty and judgements controlled by thought focusing, the dimensions of affect and sensation could be selectively influenced demonstrating the uniqueness of these dimensions and their need to be studied selectively. Likewise, Price (1987) also found a clear distinction between sensation and affect as women progressed from Stage I, the dilatation stage to Stage II, the expulsion stage. This study demonstrated that the VAS is sensitive to these two distinct dimensions of pain and can be administered with ease. Price et al has further shown the VAS to be a ratio measure (1983).

In a subsequent study investigating the use of the VAS, Price et al (1983) studied 30 chronic pain patients and 20 healthy subjects using nociceptive thermal stimuli ranging from 45 degrees to 51 degrees C (Perl,
1980; Price, 1983; Price et al 1980; Price & Dubner, 1977). In this temperature range, verbal reports of pain and impulse frequencies of nociceptive neurons increase consistently (Beitel & Dubner, 1976; Dubner, Beitel & Brown, 1976; Melzack & Casey, 1968). Price related the stimulus intensities in degrees centigrade to the two dimensions of perceived pain previously described, stimulus intensity and stimulus unpleasantness. The response to the thermal stimuli were recorded on separate VASs and plotted on separate graphs as a function of the stimulation intensities in degrees centigrade, deriving a stimulus response curve. Next, using a temperature matching technique, the subjects matched the thermal stimulus to their lowest, usual and highest pain intensities experienced in the previous week and rated the same on a VAS for pain intensity. Each match point when placed on the graph fell on or near the stimulus response curve. This procedure has shown that the VAS sensory-intensity responses to levels of experimental pain, VAS sensory-intensity responses to levels of chronic pain and direct temperature matches to the three levels are internally consistent. This technique also provided a ratio level measure of pain; one where real numbers were assigned to the observations and where these numbers can be used to reflect actual ratios of magnitude (Price, Rafii, Watkins, & Buckingham, 1984).
In a recent investigation testing women in late pregnancy, Goolkasian and Rimer (1984) assessed women's reactions to radiant heat. The impetus for this investigation came from a study by Gintzler (1980) where significant increases were found in pain thresholds in pregnant rats, within a few weeks prior to parturition. Because the increase in pain threshold could be reversed by administering naltrexone (a narcotic antagonist), it was hypothesized that these changes were mediated by the endorphin system. Goolkasian and Rimer questioned whether the same changes in pain reactions occurred in humans as was demonstrated to occur in rats. Using the signal detection theory (SDT) as their measurement tool, the researchers hypothesized that pregnant women would be more reluctant to report pain during the last two weeks of pregnancy as compared with early pregnancy. To do this study, they used a dolorimeter to randomly deliver three stimulus intensities to the subjects' forearm. The subjects were instructed to assign each stimulus to one of the following response categories: (1) nothing, (2) warm, (3) hot, (4) faintly painful, (5) moderately painful, and (6) strongly painful. From these responses, the differences in stimulus "discriminability" and differences in willingness to report pain were calculated and an analysis was completed. Their results showed that pregnant women were significantly more willing to
label radiant heat as painful during the last two weeks of pregnancy than at any other stage. These findings suggest that the changes in pain reactions during pregnancy i.e., the subject's willingness to label stimuli as painful are influenced by non-sensory factors.

It has long been recognized that non-sensory factors contribute to an individual's response to noxious stimuli, such as anxiety level and other personality traits (Sternbach, 1974). Thus the development and use of the SDT was felt to offer significant information differentiating the physiological and the emotional components of pain (Chapman, 1974). As Rollman (1977) has discussed, however, the SDT used for pain assessment demonstrates inadequacies in its theoretical framework, experimental methods, data analysis and interpretation. The primary research question asked when using the SDT for pain assessment is: does one stimulus change in "discriminability" from another? Price (in press) states that this assessment of "discriminability" reflects one's ability to pay attention and to notice differences in intensities of stimulation. It is also a reflection of one's desire to perform well. Rollman's conclusions (1977) caution therefore that the SDT measures discrimination and that pain intensity and discrimination cannot be equated.
Concerned about extending the findings of Gintzler to humans and clarifying the findings of Goolkasian and Rimer, Cogan and Spinnato (1986) conducted an investigation studying the responses of pregnant women to pressure induced pain. The first portion of their study assessed pain thresholds of six pregnant women for the last 16 days before parturition. The second portion examined the same parameters using 10 pregnant and 10 non-pregnant women through the same time period. For both groups, an electro-sphygmomanometer was inflated on the non-dominant arm of each subject. The pressure was increased at a rate of 12.5 mmHg/sec until the woman reported feeling pain or until 300 mmHg was reached. The cuff was then deflated. One preliminary trial and 3 test trials were completed with 30 seconds between each trial. Testing was done daily for each pregnant subject and for a complete three week time span for the non-pregnant group. Consistent with the findings of Gitzler the results of this study clearly indicated that pain and discomfort thresholds of women significantly decrease during late pregnancy as compared to non-pregnant women.

Endogenous opiates
Since the first report on the presence of endogenous opiates (Reynolds, 1969), researchers have investigated
the many interactions of this system. During stages of pregnancy in humans, investigators have focused primarily on endorphin levels in the plasma (Goland, Wardlaw, Stark, & Franty, 1981; Genazzani, Facchinetti, Porini, 1981; Newnham et al, 1984) and to a lesser degree, endorphin levels in the cerebrospinal fluid (Steinbrook, Carr, Datta, Nautly, Lee, Fisher, 1982; Budiamal, Muetterties, Seltzer, Jacoby, Vogel, 1981; Christie, in prep). With continued investigation, researchers are hypothesizing that the plasma Beta endorphin and the cerebrospinal fluid measure of endorphins are produced at two different locations and serve different physiological functions (Budiamal et al, 1981; Steinbrook et al, 1982; Rossier, French, Rivier, Ling, Guillemin, Bloom, 1977). Beta endorphins present in the plasma have been associated with increases in stress (Rossier et al, 1977; Goland et al, 1981; Thomas, Fletcher, Hill, 1982). In rats, Beta endorphin and adrenocorticotropic (ACTH) have been shown to be produced and secreted simultaneously into the blood stream by the pituitary gland (Guillemin et al, 1977). Jeffcoate et al (1978) found that Beta endorphin was found in the cerebrospinal fluid of patients who had hypopituitarism with no noticeable trace of plasma Beta endorphin. This finding suggests that Beta endorphin in the cerebrospinal fluid is synthesized
in the brain, within a system separate from the plasma endorphins.

Beta endorphins in the cerebrospinal fluid on the other hand, have been associated with analgesia (Mayer & Price, 1976). A known morphine-inhibitor, naloxone has been used to reverse the effects of the analgesic in question, in order to verify the specific substance(s) involved. This procedure has been used experimentally to alter the effects of pregnancy induced analgesia in rats (Ginzler, 1980) and to alter the effects of acupuncture analgesia (Mayer, Price, Rafii, 1977). In a parallel study (Von Knorring, Almay, Johanson, Terenius, 1978) involving 45 chronic pain patients, the pain threshold and tolerance levels from electrical stimulation induced pain were found to be significantly higher in those patients with above median levels of cerebrospinal fluid endorphins. These results suggest that endorphins in the cerebrospinal fluid are a significant physiologic factor that contributes to pain threshold and tolerance levels.

Addressing the literature on endorphin levels during pregnancy shows varied results. Plasma endorphin levels have been shown to be higher in the pregnant population than in the non-pregnant population (Akil, Watson, Barchas, Li, 1979; Genazzani et al, 1981; Moss, Conner, Yee, Iorio, Scapelli, 1982). Further, the plasma endorphin levels have been shown to increase with the
onset of labor, continuing to increase with the strength and intensity of contractions (Csontos, Rust, Holt, 1979; Facchinetti, Certini, Parrini, 1982; Gennazzani et al 1981; Goland et al, 1981; Kimball, Chang, Chapman, 1984; Moss et al, 1982, Newnham et al, 1984; Thomas, et al, 1982) peaking about one hour before delivery (Facchinette et al, 1982). Thomas et al (1982), also demonstrated that levels of circulating Beta endorphins increased with longer labors and induced or augmented labors. Fluctuations in levels were also found to be associated with different analgesic drugs. Post-partum endorphin levels were found to return to near normal levels 24 (Newnham et al, 1984) to 48 (Kimball et al, 1984) hours after delivery.

Unlike the plasma endorphins, Beta endorphin levels in the cerebrospinal fluid did not change over the course of pregnancy (Christie, in prep) or during labor (Steinbrook et al, 1982). In the latter study, plasma levels were significantly higher than cerebrospinal fluid levels in women in active labor. These findings suggest that the occurrence of an elevated level of plasma Beta endorphins during labor may be a nonspecific response to the stress of the event rather than a specific physiologic change accompanying parturition.

In summary, the research suggests that Beta endorphins found in the plasma and in the cerebrospinal
fluid come from different sources and serve different functions. Plasma endorphins accompany the release of ACTH and thus are a part of a stress response. The literature suggests that cerebrospinal fluid endorphins are a part of an endogenous analgesia system.

**Physical therapy in obstetrics**

The role of physical therapy in obstetrics is documented in the literature as early as the 1930's (Frost, 1932; Morris, 1932). The majority of the literature deals with prenatal and post-partum exercise. However, more recently reports discussing involvement in childbirth education and the management of labor pain have become more prevalent (Bing, 1969; Grim & Morey, 1985; Noble, 1983). A physical therapist's education in physiology of exercise, posture awareness, body mechanics, breathing patterns and relaxation can benefit the obstetric population. In addition, physical therapy developments in the area of pain and pain management create opportunities to expand the traditional roles of the physical therapist. Most recently this includes the use of TENS during labor for pain management (Grim et al, 1985). Such growth and expansion requires an in depth understanding of the anatomy and physiology of the targeted patient population.
Conclusions

The conclusions drawn from the review of literature suggest that an assessment of pain responses during stages of pregnancy should be sensitive to the dimensions of a woman's pain experience, should accurately assess pain responses, and should yield data that allow statistical analysis.

The literature also suggests that cerebrospinal fluid endorphins are associated with pain mediation and analgesia. Based on the findings in this review, little change in pain responses to thermal stimuli would be expected, comparing late pregnancy, labor, and the puerperium.

Summary

This chapter began with a review of the tools used for studying and measuring clinical and experimental pain. This was followed by a review of those studies assessing pain responses during pregnancy as well as pain responses and actual labor pain measurement during labor. Next, a review of the literature on endorphins was presented. In addition, this topic was further supported by a brief discussion on physical therapy in obstetrics. Conclusions were drawn relevant to the study question.
Chapter III

METHODS

The following chapter describes the methods, tools and techniques used for conducting this research. The sub-sections include: subjects, research design, materials and instrumentation, procedures, and data reduction.

Subjects

Fifteen subjects were admitted to the study based on the following criteria: (1) the subject was between 17 and 37 years of age; (2) the subject had an uncomplicated pregnancy having taken no medication that would influence the results of the study; (3) the subject was planning Lamaze preparations; (4) the subject would be delivering at the Medical College of Virginia; (5) the subject's labor remained uncomplicated, unmedicated for pain, and when possible, unaugmented prior to the measurement taken; and, (6) the subject's puerperium remained uncomplicated and when possible, without pain medication for eight hours before final measurement.
Research Design

A repeated measures design was used for this study. The same measures were taken on the same women at three different stages of pregnancy: twice in late pregnancy (however, the first measurement was established as a practice session), once in labor and once in the post-partum phase.

For this study, the independent variable was the temperature stimulus, the controlled variable was the stage of pregnancy, and the dependent variable was the pain score.

Materials and Instrumentation

Utilized for this study was a thermal stimulator\(^1\) designed to produce a five second stimulus of a preset temperature. The stimulus was delivered by a hand held contact thermode with a surface diameter of 1 cm. As preset, the thermode temperature rose rapidly from a baseline of 35 degrees C to a peak of either 43, 45, 47,

\(^1\)Thermal Stimulator: designed by Alexander Clark, Biomedical Instrumentation Dept., MCV, Richmond, VA 23298
49, or 51 degrees C. The stimulus lasted 5 seconds; the temperature returned to baseline in another 5 seconds by an active cooling mechanism. This procedure has been shown to be safe as well as valid and reliable (Price et al, 1983).

Responses to the stimuli were marked on a 15 cm visual analogue scale (VAS) whose ends were marked "no sensation" and "the most intense sensation imaginable" for intensity and "not bad at all" and "the most intense bad feeling possible for me" for unpleasantness.

Procedures

Subjects were recruited through the Lamaze classes at MCV. Every three weeks a new list of class participants was obtained and each prospective participant was sent a letter of introduction (Appendix A). At either the first or second Lamaze class session, the examiner would meet the class, answer questions and leave a roster which interested women would sign. Contacts were then made by phone to clarify admission criteria, secure information about the subject's doctor and to set up a meeting time for the first session. The physician's permission form (Appendix B) was sent accompanied by a cover letter introducing the study format (Appendix C).
In advance of each instrument session, the 10 temperatures (43, 45, 47, 49, and 51 degrees C each delivered twice) were placed in a random order for unpleasantness and for intensity (Appendix D). At the beginning of the first meeting, subjects read and signed the consent form (Appendix E) and completed the Prenatal Data information sheet (Appendix F). Procedures for the study and the stimulator were described to the subject. Each subject was positioned beside the thermal stimulator and was given a clip board holding the VASs for intensity and unpleasantness (Appendix G and H respectively) and a cover sheet. A prepared set of instructions (Appendix I) were then read by the examiner to standardize all instructions given and to clarify the distinction between the intensity and unpleasantness or affective dimensions of pain (Price et al, 1983). During the prenatal visits, subjects were seated in a chair with their arms supported by the arms of the chair. The controls of the stimulator were out of the subject's sight.

The stimuli were delivered to alternate forearms beginning proximally and moving distally. After each stimulation, the subject marked on the appropriate VAS indicating her response to the stimulus. She covered her response with the cover sheet which indicated her
readiness for the next stimulus. This procedure was followed until 10 trials for unpleasantness and 10 trials for intensity were completed. The order for delivering the sets of stimuli for unpleasantness and intensity were alternated with each subsequent measurement session.

For the measurement taken during labor, subjects were positioned supine with the head of the labor bed elevated between 45 and 75 degrees which in all cases, was the position of choice. Usually with the head of the bed was elevated 50 to 70 degrees.

The first session was designated as a practice session. At its completion, a follow-up date was set for the first testing session. At the completion of this session subjects were given the information needed to contact the examiner at the onset of labor. For the post-partum measurement session, the date and time were set for convenience between 48 to 72 hours after delivery.

One additional measurement was taken during the labor and post-partum sessions that was used for discussion and a priori investigations. After a subject completed the 20 stimuli (10 intensity and 10 unpleasantness) she was asked to indicate on a VAS (Appendix J), the intensity of her present labor contractions. This procedure was done twice.
During the early post-partum phase, each subject was contacted to set up a time for the final measurement. Prior to the measurement session, the post-partum nurse was consulted about any post-partum complications and about medications given for pain. Also at this time, data describing the subject's labor was recorded for descriptive purposes (Appendix K).

Data Collection

Data was collected by measuring on each VAS, the distance from the zero end point to the point where the subject's mark intersected the line. The measurement, in centimeters, were recorded on Appendix L. The data reduction is described below.

After the data collection was completed, it was determined additional medication information was needed. The hospital record of each subject was secured and reviewed. All post-partum pain medications were recorded noting the amount and time given.

Data Reduction

To reduce the collected data, the mean of the two measurements at each temperature and stage was found and
recorded. This was defined as the pain score (Appendix M). The mean was also found for each of the following categories: (1) weeks of pregnancy at entry into the study, at trial measurement, and at first measurement, (2) age of subjects, (3) length of labor in hours, and (4) hours after delivery for post-partum measurement.

Data Analysis

Data analysis was considered for the following research questions. For each of five temperatures used, how do women's affective responses change across stages of pregnancy and for each of five temperatures used, how do women's intensity responses change across stages of pregnancy: late pregnancy, labor and the puerperium?

To further analyze the data, an analysis of variance was used to compare responses to each of the temperatures across stages of pregnancy. The combined scores at each temperature were then compared with a normal population by plotting them on a graph together.

Summary

This chapter has described the methods used to complete this study. The subject's admission criteria and the research design were described. The materials,
instrumentation and procedures were outlined; the method of data reduction was reviewed.

Chapter four, Data Analysis, will describe the statistical analysis of the collected data.
CHAPTER IV

RESULTS

Presented in the following chapter are the results of this study. The sample characteristics are described. The responses to thermal stimuli at late pregnancy, labor and post partum are presented for both the affective and intensity dimensions of pain. Statistical analysis was used to compare the pain score for a given temperature and dimension with stages of pregnancy. The analysis was also used to compare responses to combined stages of pregnancy with control data.

Sample Characteristics

The sample consisted of 15 women who were at least 30 weeks pregnant (x=34.9 weeks) and who had uncomplicated pregnancies. They ranged in age from 18 to 43 (x=28.4 years); 14 were primiparas and 1 a multipara. Of the 15 subjects, 10 delivered vaginally, 4 were delivered by Caesarean and 1 subject died during delivery. Labor ranged in length from 7 hours to 72 hours (x=24 hours).
Testing

Four measurement sessions were conducted. The first session between 33 and 37 weeks (x=34.9 weeks) was designated as a practice. The second session was named Late Pregnancy (n=15) and took place at 36-39 weeks (x=37 weeks). The session named Labor (n=15) took place in early labor for 11 subjects (at 2-3 cm dilatation) and in early/active for 4 subjects (at 4-5 cm dilatation). The final session, named Post Partum (n=8), took place 48-84 hours after delivery except for one at 28 hours due to scheduling problems (x=55.5 hours). Six of the subjects were eliminated from the post partum measurement. It was determined after reviewing the medication records that the subjects' responses to the stimuli may have been influenced by medications received prior to testing. The seventh subject was not included due to death.

In each measurement session, subjects were asked to rate five levels of thermal stimuli delivered twice and in random order. The pain score was defined to be the mean of the two observations for a given temperature and dimension. The pain scores were used to calculate group means and the standard error of the means for each temperature, stage, and dimension (Table 1). The mean pain score for each temperature, stage and dimension was then plotted for further illustration (Figures 1 & 2).
### TABLE 1
RESPONSES TO THERMAL STIMULI

#### AFFECTIVE

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* Temperatures in degrees Centigrade

** Visual analogue scale responses in centimeters
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RESPONSES TO THERMAL STIMULI

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INTERIENCY
LATERN PREGNANCY

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</table>

* Temperatures in degrees Centigrade

** Visual analogue scale responses in centimeters
COMPARING STAGES OF PREGNANCY

Pain Score - Mean Two Observations

Intensity

Skin Temperature

1-Late Pregnancy  3-Labor  4-Post Delivery

Figure 1.

Figure 1 and 2. Subjects' responses to experimental pain (degrees C) using a visual analogue scale (VAS in cm) rating the intensity (Figure 1) and affective or unpleasant dimensions (Figure 2). Three stages of pregnancy are compared.
Results Related to Hypothesis

To determine if there was a difference in response to thermal stimuli due to stage of pregnancy, an ANOVA was performed for each fixed temperature (43, 45, 47, 49, and 51 degrees C) and dimension (affective and intensity). The results of the ANOVA are shown in Table 2.

As shown by the analysis, none of the five temperatures are significant comparing a fixed temperature and dimension with stages of pregnancy. Therefore, the null hypotheses are accepted. Descriptively, there is no difference in intensity responses to thermal stimuli comparing late pregnancy, labor and post partum. These results are illustrated on Figure 1. Secondly, there is no difference in affective responses to thermal stimuli comparing late pregnancy, labor, and post partum. These results are illustrated on Figure 2.

Related Findings

To further investigate any changes occurring in response to the stimuli due to pregnancy, the responses made during this investigation by the 15 pregnant subjects were compared to the responses of 21 volunteer
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controls (19 women, 2 men; 19-50 & mean = 30 years) 
(Price & Harkins, 1987). To do this, all stages were 
combined to calculate the means and standard errors of 
the means for each temperature and dimension (Table 3). 
These means are then compared with means obtained from 
the volunteer controls (Table 4). Because the raw data 
was unavailable, no statistical comparison was made. 
However, plotting the data on a graph illustrates 
that the curves are very similar (Figures 3 and 4).

**Analgesia Index**

After the main investigations were completed, the 
investigator decided to examine the relationship between 
the VAS responses to experimental pain during late 
pregnancy and labor and the clinical VAS measurements of 
labor pain.

To test this question, the mean pain score for each 
patient was calculated for the five temperatures combined 
for late pregnancy and for labor. The index of pain 
reduction was calculated both by finding the difference 
of the two means (late pregnancy - labor) and by 
calculating the percent change from late pregnancy to 
labor (Appendix M). The difference and percent change
## TABLE 3

PAIN SCORES FOR COMBINED STAGES OF PREGNANCY

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# Table 4

Mean Pain Scores of Pregnant and "Normal" Subjects

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\(^1\text{Price et al, 1987}\)
Figure 3 & 4. Subjects' responses to experimental pain (degree C) using a visual analogue scale (in cm) were combined across three stages of pregnancy and plotted for intensity (Fig. 3) and affect or unpleasantness (Fig. 4). Scores from "normals" (Price & Harkins, 1987) were plotted for comparison.
were termed the index of reduction. To determine if any correlation existed between the index of reduction and the magnitude of clinical pain during labor, a Spearman correlation co-efficient was calculated. They were found to be -.025 for the difference index and .089 for the percent index. Thus, in either case, there was no evidence that a correlation existed between the index of pain reduction and the magnitude of labor pain. These results suggested that no relationship existed between the possible change in responses to experimental pain for late pregnancy and labor and the responses to clinical labor pain. Further, the results supported the hypothesis that there is no endogenous analgesia present at the time of labor.

**Summary**

Presented in this chapter are the results of this study investigating intensity and affective responses to thermal stimuli during stages of pregnancy. The mean pain score is derived for each fixed temperature and dimension of pain. An ANOVA was done to determine the influence, if any, that stage of pregnancy could have on responses to the stimuli. The results support the null hypotheses: (1) there is no difference in intensity responses to thermal stimuli comparing late pregnancy,
labor and post partum (2) there is no difference in affective responses to thermal stimuli comparing late pregnancy, labor and post partum.

This chapter further compares the responses collected in this investigation with the responses collected from a volunteer control population. The comparison failed to identify any differences between the populations. Further comparison between experimental VAS responses and VAS ratings of labor pain showed no correlation was present. These results support the hypothesis that there is no endogenous analgesia present at the time of labor.

The interpretation of these results based on the limitations of the study and the review of current literature are discussed in the next chapter.
CHAPTER V

DISCUSSION AND SUMMARY

This study examined the differences in women's affective and intensity responses to thermal stimuli comparing the stages: late pregnancy, labor and postpartum. The following chapter will present the results of the study as they relate to the current literature. Further, the limitations of this study and recommendations for further study will be discussed. A summary discussion incorporating these factors will conclude Chapter Five.

Discussion

Comparison with previous research. The results of this study are consistent with the findings of Javert and Hardy (1950) and yet divergent from the results of Cogan and Spinnato (1966). In the latter study, the authors used an electrosphygmomanometer to test "pain and discomfort thresholds" during the last weeks of pregnancy.

The cuff was applied to the non-dominant arm and the pressure was increased at a rate of 12.5 mmHg/sec until the subject reported feeling pain. The cuff was deflated after reaching this threshold or 300 mmHg, the maximum
allowed. Three tests trials were carried out at each testing session with each of the subjects participating in one of two experiments. In Experiment one, eight pregnant women were tested daily from 14 days prior to the due date to their delivery. Experiment two included ten pregnant women who were measured daily from 14 days before their due date until their delivery, and ten nonpregnant women who were measured daily for three weeks. The results demonstrated that the pain threshold levels of pregnant women increased as the delivery date approached. An ANOVA (p < 0.001) showed a statistically significant difference in pain tolerance between the pregnant and nonpregnant groups.

The pain threshold measurement procedures used in Cogan and Spinnato's study have been used by others primarily after the Second World War (Hardy et al, 1954; Beecher, 1959). The early studies used radiant heat and pain threshold measurements; these studies were some of the first to use a precise methodology for studying pain and pain thresholds. Price (in press) identified several critical factors inherent in the reliability of these early studies. Blitz and Dinnerstein (1968) demonstrated that thresholds can vary considerably as to function of the instructions given to subjects. Price also states that threshold measures can be influenced by placebo effects and response bias. It
would seem that women in late pregnancy might be biased toward higher thresholds of pain as they prepare themselves for tolerating labor pain. This characteristic would not be relevant for non-pregnant women. Clearly, the detail of the instructions given and the number of trials are important to minimizing the Hawthorne effect.

A second study assessing pain responses in pregnant women found, using the signal detection theory (SDT), that pregnant women were significantly more willing to label radiant heat stimuli as painful during the last two weeks of pregnancy than at any other time during pregnancy (Goolkasian & Rimer, 1984). These findings are however, difficult to interpret because of problems inherent to the basic concepts in the signal detection theory. Applied to pain research, the theory assesses a subject's ability to discriminate between levels of pain stimuli. Rollman (1977) states that the SDT studies cannot produce a true estimate of the painfulness of a stimulus and reiterates that the detection theory only provides an estimate of a subject's ability to discriminate between painful stimuli. Price (in press) states the results from SDT studies may be altered by factors such as fatigue, significance of the situation and alertness which can hamper one's true ability to discriminate. These factors can further obscure the
interpretation of the results. For example, applying these criticisms to Goolkasian and Rimer's study, we could ask whether the results, i.e. women are more willing to report pain in late pregnancy, could be influenced by subjects' ability to concentrate, pay attention, and by their desire to perform well. Such problems found with this pain measurement methodology weaken the results of the study.

Hardy, Wolff, and Goodell (1947) were the first to study pain using radiant heat stimulation. In 1950, Javert and Hardy examined pain responses in pregnant women in labor (Javert & Hardy, 1950). Though the majority of the study focuses on labor pain, they also found women's skin pain thresholds to painful stimuli did not change across pregnancy, labor and the puerperium. They utilized precise methods of measurement including detailed instructions to each subject. Despite the precision employed, however, their research contains problems inherent with pain threshold methods. In addition to the need for detailed instructions, Beecher (1956) demonstrated that known narcotic drugs do not alter responses to pain threshold measurements. Thus, one criticism of the negative findings from Javert and Hardy's study is that the method is insensitive to reductions in pain elicited by therapeutic doses of standard narcotic analgesics.
**Analysis of current methods.** In a variety of different settings, the combined use of the thermal stimulator and the VAS has been shown to be a reliable, sensitive, and versatile measurement tool for studying pain (Priet et al, 1983; Price et al, 1985; Price et al, 1986; Price et al, 1987, Price et al, 1987). Unlike the threshold measure of Hardy et al (1947), the tool uses the full range of noxious stimulus intensities (Beitel and Dubner, 1976; Dubner, Beitel, & Brown, 1976; Price et al, 1980). In 1980, Price et al demonstrated using the VAS and thermal stimulator, that the affective dimension but not the sensory-discriminative dimension, could be selectively influenced by experiential factors such as expectation, uncertainty, and judgements controlled by thought focusing. This sensitivity was demonstrated again in a study with women in labor. Price et al (1987) found a clear distinction between sensation and affect as a woman in labor progressed from Stage I, the dilation stage to Stage II, the expulsion stage. They also found the affective measures could be altered by a change in thought focus. Affective responses were decreased by focusing on the birth of the baby rather than the labor pain.

Using low to moderate doses of morphine (Price et al, 1985) and fentanyl (Price et al, 1986), Price and colleagues studied subjects' VAS sensory and affective
responses both before and after administration of these drugs. Graphing the responses showed the narcotic drugs produced a parallel downward shift in the stimulus response curve. Moreover, the distance the curve was displaced downward was dependent on the dose given. The same parallel downward shift in the stimulus response curve was also produced by testing subjects before and after electroacupuncture (Price et al, 1984), a presumed endogenous opiate pain mediating system.

Giving that both exogenous and endogenous opiate analgesic effects can be clearly demonstrated using this experimental approach, the lack of positive signs of analgesia in the present study are not likely due to insensitivity in the methods.

**Endorphins.** The role of endorphins in the pain mediation system continues to be a topic of study. In a study done with rats, Gintzler (1980) has shown cerebrospinal fluid (CSF) levels of Beta endorphins to be elevated during late pregnancy. The pregnant rats were shown to have an increase in pain threshold two weeks prior to parturition, consistent with the rise in Beta endorphin levels. Gintzler also found this increase could be abolished by administering naloxone, therefore suggesting that endorphins in the CSF are a significant physiologic factor contributing to pain threshold and tolerance levels.
Human studies examining endorphin levels in pregnancy include measurement in the plasma as well as in the CSF. Researchers have shown that endorphins are present at a higher concentration in the plasma of the pregnant population than in the nonpregnant population (Akil et al., 1979; Genazzani et al., 1981; Moss et al., 1982). Further, plasma endorphin levels have also been shown to increase at the onset of labor, continue to increase as labor progresses (Csontos, Rust, Holt, Mahr, Kromer, Teschemacher, 1979; Facchinetti et al., 1982; Gennazzani et al., 1981; Goland et al., 1981; Thomas et al., 1982), and drop to a pre-pregnancy level within 24 to 48 hours (Newnham et al., 1984; Kimball et al., 1984). Beta endorphin levels in the CSF on the other hand, do not change through pregnancy or labor (Christie, in prep; Steinbrook et al., 1982).

Additional research has also led investigators to hypothesize that plasma Beta endorphins and Beta endorphins in the CSF are produced at two different locations and serve two different functions. Endorphins in the plasma have been associated with increases in stress (Rossier et al., 1977; Goland et al., 1981; Thomas et al., 1982), whereas endorphins in the CSF have been found to be associated with analgesia (Mayer & Price, 1976). Researchers have further shown that this analgesic state can be reversed by naloxone, a known

In the current study, the presence of an endogenous system of analgesia was further investigated by examining the relationship between the difference of VAS responses to experimental pain between late pregnancy and labor (termed the index of pain reduction) and the clinical VAS responses to actual labor pain. The difference in the combined VAS responses between late pregnancy and labor was correlated for each woman with her VAS rating of labor pain intensity. Using the Spearman correlation co-efficient, no correlation was found to exist (−.025). The results suggested that no relationship existed between an index of pain reduction and the magnitude of labor pain. These findings further supported the hypothesis that there is no endogenous analgesia system present at the time of labor.

In summary, the sensitivity of the pain measurement tool used in the current investigation has been discussed. It is concluded that the variation from previous studies and the lack of positive signs of analgesia in this study are not due to insensitivity in the methodology. Although elevated endorphin levels in the CSF and an increase in analgesia have been shown to be present in pregnant rats, human studies have shown endorphins in the CSF do not change with stages of pregnancy. Unlike endorphins in the plasma, researchers
have hypothesized that an endogenous analgesia system is in part provided by endorphins in the central nervous system. Therefore, the results of this study provide a behavioral measure to support the clinical findings that no endogenous system of analgesia is active during stages of pregnancy including, late pregnancy, labor, and the puerperium.

**Limitations of the Study**

The primary limitations of this study arise out of the difficulties in working within the wide variations of the labor process. Though none of the subjects had received any medication known to alter pain responses prior to the labor measurement, the labor of five subjects had been augmented by either artificial rupture of membranes, pitocin, or stripping the membranes, prior to testing. Such facilitation was not felt however, to influence the subject's responses to the thermal stimuli.

The greatest difficulties with the problem of subject variability arose during the post-partum period. Though screening for pain medications had been attempted prior to the post partum measurement, an effective collection of these medications was difficult. Therefore, at the completion of the data collection, each subject's chart was retrieved and reviewed by a physician in the Department of Anesthesiology with record made of
pain medications used: type, amount given, and time administered. Further, based on the timing of the post-partum measurement, a determination was made as to whether the subject's responses were influenced by narcotic medication still in the bloodstream. Based on this review, six subjects were removed from the post-partum measurement data.

In my opinion, further variation arose from an environmental change and the difficulties of scheduling around the needs of a newborn infant. During the measurement sessions for ten of the subjects, the infants were in the room with their mothers. Interruptions and attentiveness to their newborns may have affected the concentration ability of the subjects during this post-partum measurement.

One final limitation to address in this discussion is the fact that all subjects were Lamaze prepared. This researcher felt uniform preparation would offer a control for the experience of labor pain, because childbirth preparation has been shown to have a positive influence on the reduction of labor pain (Charles et al, 1978; Chertok, 1969; Cogan, Henneborn, Kloper, 1976; Melzack et al, 1981; Norr et al, 1977). Though this population has been shown to have a higher family income (Leonard, 1973; Whitley, 1979) and to be better educated (Chertok, 1969; Whitley, 1979) the magnitude of these findings may not be
strong enough to limit the extrapolation of the study results to the population of all women, regardless of preparation.

Recommendations of Future Study

The present investigation was designed to examine the effects of different stages of pregnancy on responses to experimental pain. To more accurately compare this study with previous works, the methodology should be altered to include 10 to 12 measurements taken during the last month of pregnancy.

A limited body of research can be found rating the intensity of labor pain (Wolff et al, 1949; Melzack et al, 1984). The measurement tool used in this study could be used to further study labor pain comparing responses to thermal stimuli as well as having subjects match the intensity of their labor pain to the intensity of the experimental pain. Such measurement would produce objective information on the intensity of labor pain.

Summary and Conclusions of the Study

This study was designed to answer the question: for each of five temperatures used, how do women's affective and intensity responses change across stages of pregnancy for late pregnancy, labor and post partum? A repeated measures design was employed. Using a thermal
stimulator, subjects responded for both intensity and sensation (unpleasantness) to the thermal stimuli (43 to 51 degrees C) by marking a VAS. This procedure was used at three stages of pregnancy: late pregnancy, labor and postpartum. An ANOVA was used to compare the means of the pain responses across stages of pregnancy. No significant difference in responses to thermal stimuli was found to exist demonstrating that stages of pregnancy have no effect on responses to experimental pain. The results further suggest that there is no central pain mediating system present in pregnant women in late pregnancy or labor. These findings are contrasted with previous works done during late pregnancy using different pain measurement tools. They are however, consistent with work done by Javert and Hardy (1950). Lastly, by reviewing research examining levels of endorphins present in the plasma and CSF during stages of pregnancy, this study also supports the growing body of knowledge which suggests that pain mediation by endorphins occurs centrally and not in the periphery.
BI BLOGRAPHY


Beitel, R. E. & Dubner, R. (1976). Response of unmyelinated (c) polymodal nociceptors to thermal stimuli applied to monkey's face. *Journal of Neurophysiology*, 39, 1160-1175.


APPENDIX A

The study of labor pain is essential for developing methods of pain management. It is not known, for instance, the exact intensity of labor pain and how our bodies' responses to pain change with pregnancy and labor.

As a physical therapist, graduate student, and candidate to become an ASPO/Lamaze certified instructor, I have become interested in studying labor pain. Through this letter I would like to introduce myself and the study in which I am asking for your participation.

It is my plan to carry out a study here at MCV that will help to answer several questions (1) How do the responses to pain change between late pregnancy, labor and post-partum? (2) How intense is labor pain? My study has been approved by your physicians and by the hospital. The methods I will follow have been used extensively here at MCV for studying and learning more about pain.

Your participation would involve five 15 minute sessions (2 in late pregnancy, 2 in labor and 1 post-partum) and will require that you mark on a scale provided, your responses to 5 brief (5 seconds) heat stimuli given 4 times each. The procedures are safe, very simple and easy to do. Lastly, you can withdraw, should you desire, at any point during the study.

I will be present at your first or second Lamaze class to meet you, answer your questions and to enlist your help. Please feel free to call me as well (if you call my home, please leave message on machine). Each participant will receive $25.00 at the completion of the study ($5.00 per session).

I will look forward to meeting you. Thank you for your consideration.

Most sincerely,

Ann H. Dunbar, RPT
APPENDIX B

Physician Consent Form

Your patient __________________________________________
is interested in being a participant in a study examining
the influence of pregnancy and labor on responses to
thermal stimuli. She understands the procedures and that
she is free to withdraw from the study at any time. If
you agree with her participation, please sign the
appropriate line below.

__________________________
AGREE

__________________________
DO NOT AGREE

Thank you for your assistance.

Ann H. Dunbar, P.T.
Dear Physician,

As a physical therapist and candidate to become an ASPO certified childbirth instructor, I have become interested in the possible factors affecting the perception of pain during labor. One such factor is the presence of endorphins shown to increase through labor and more specifically, shown to increase according to the length and strength of uterine contractions. It is not known, however, what affect these endorphins have on the perception of pain during labor.

In partial fulfillment of requirements for the Masters program in Physical Therapy, it is my hope to study changes in responses to thermal stimuli comparing late pregnancy, labor and the puerperium. This I will do using the pain measurement technique validated by Dr. Donald Price (MCV Department of Anesthesiology). This technique uses responses made on a visual analogue scale (VAS) to thermal stimuli. The stimuli are delivered to the ventral forearm by a hand-held contact thermode (1 cm surface diameter). The temperature rises rapidly from a baseline of 35 degrees C to a peak of either 43, 45, 47, 49, or 51 degrees C and then returns to a baseline 5 seconds later by an active cooling mechanism. There is minimal chance of tissue injury; indeed this technique has been used extensively for studying pain at MCV. Participants will respond to each of 5 temperatures by indicating the intensity of discomfort and its unpleasantness of two different VASs. The procedure takes 15 minutes and for the purposes of this study will be done at 33-34 weeks of pregnancy, 35-36 weeks of pregnancy, during labor at about 3 cm and about 6 cm dilatation, and at 48-72 hours postpartum. By comparing the responses at these stages I hope to outline the changes in responses to pain in relation to pregnancy, labor and nonpregnancy, applying this information to the rationale for pain management skills for labor. Once this baseline data is gathered, the pain measurement technique could also be used to test the effectiveness of other interventions for labor pain.
The criteria for admission to the study include: (1) 17-37 years of age (2) uncomplicated pregnancy (3) 30-32 weeks of pregnancy, (4) no prescription medication prior to onset of study or prior to labor (5) planning Lamaze preparation (6) labor must be spontaneous, unaugmented, and unmedicated up to the final measurement taken (7) uncomplicated postpartum recovery.

Once a woman indicates she is interested in participating in the study, I will send a form to her physician for her medical approval to enter the study. Each subject will sign a consent form herself, demonstrating her knowledge of the study procedures and of her understanding she is free to withdraw at any time. It is understood measurements taken during labor will be taken when convenient with mother, coach, and birthing attendants.

Please feel free to contact me at any time with your questions or concerns: I will look forward to working with you.

Sincerely,

Ann H. Dunbar, RPT
APPENDIX D

Subject: 

Date: 

RANDOM ORDER

<table>
<thead>
<tr>
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<th>Unpleasantness</th>
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<tbody>
<tr>
<td>1.</td>
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Date: 

RANDOM ORDER

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<th>Unpleasantness</th>
<th>Intensity</th>
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APPENDIX E

Consent Form

Ann Dunbar, RPT, under the guidance of the Department of Anesthesiology and the School of Physical Therapy at MCV, is conducting a research program on the changes in pain responses comparing late pregnancy, early and active labor, and the post-partum phase. Twenty women will participate in five 15-20 minutes testing sessions set up at the following times: 33-34 weeks of pregnancy, 35-36 weeks of pregnancy, during labor at about 3 cm and 6 cm dilatation, and 48-72 hours postpartum. The first session will be used for practice and orientation to the procedure and equipment. The last 4 sessions will be testing sessions with measurements recorded.

Each measurement session will consist of the application of brief (5 seconds) heat stimuli applied to your forearms. Immediately following each of the 20 stimuli (4 trials at each of 5 different temperatures) you will indicate on a scale provided, the level of intensity or unpleasantness you experienced. At the 2 sessions during labor you will also be asked to indicate your labor pain intensity by (1) matching it to the intensity of a heat stimulus that will be applied to your forearm and (2) indicating the intensity of your
labor pain on the scale provided.

Although these stimuli will produce varying levels of pain, they will be brief in duration so as not to cause any prolonged discomfort or tissue damage. You may remove at any time, any stimulus you find very uncomfortable.

**Participation and Termination**

Your participation in this study is voluntary. You may refuse to participate or even withdraw at any stage for any reason. Also if you choose to participate, your physician must indicate agreement by signing the consent form provided.

**Benefits and Risks**

Using the 5 second heat stimulus which will cool actively in 5 seconds, there is minimal chance of tissue injury. For the testing procedure you will be lying down on your back positioned with pillows for comfort. During labor, the procedure will be carried out at a time deemed appropriate by both you and your birth attendants and as close to 3 and 6 cm as possible.

The possible benefits of this study are to develop a better understanding of pain responses in pregnancy and labor using the information in several ways. First, to develop a method of pain measurement that will accurately
assess pain responses and the pain a woman experiences during labor. Second, to gain a baseline measure of the influence of pregnancy and labor on pain responses. Lastly, to support current methods or aid in developing and testing new methods of pain management for labor.

Confidentiality

Your identity in this study will be treated as confidential. All information gathered for this study will also remain confidential.

Consent

I ______________________________ understand all of the information in this document and have had all my questions answered to my satisfaction. I voluntarily consent to participate in the study designed to examine the influences of pregnancy and labor on responses to experimental pain.

Signature of Subject _______________________________ Date _________________

Signature of Witness _______________________________ Date _________________

Ann Dunbar, RPT

Home: ______________________________

Work: 232-5620
APPENDIX F

Prenatal Data Sheet

Name ___________________________ Date ______

Address __________________________ Age ______

_________________________________ Phone ________

Doctor ___________________________ Work Phone ________

Work outside Home ____Yes ____ No

If yes, how many hours per week ______

Occupation _____________ Yrs. of education ________

Clinical Information

Due Date _________

Present number of weeks pregnant ______

Number of previous pregnancies _____________

Number of children _____ Their Ages __________________

Length of previous labors in hours: 1st __2nd__3rd__

Exercise during pregnancy (hours/week) __________

Exercise before pregnancy (hours/week) __________

Prepregnant Weight ___________ Height ___________

Any menstrual difficulties prior to pregnancy? If yes, please explain: ________________________________

________________________________________

________________________________________

________________________________________

________________________________________

________________________________________

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________________________________________
APPENDIX G

NAME: ____________________________

DATE: ____________________________

INTENSITY

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<th>The Most Intense Sensation Imaginable</th>
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<tbody>
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<tr>
<td>10.</td>
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No Sensation
APPENDIX H

NAME: _______________________

DATE: _______________________

UNPLEASANTNESS

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<th>The Most Intense Bad feeling Possible For Me</th>
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<tr>
<td>8.</td>
<td></td>
</tr>
<tr>
<td>9.</td>
<td></td>
</tr>
<tr>
<td>10. Not Bad At All</td>
<td>The Most Intense Bad Feeling Possible For Me</td>
</tr>
</tbody>
</table>
There are two aspects of pain which I am interested in measuring: the intensity, how strong the pain feels, and the unpleasantness, how unpleasant or disturbing the pain is for you. The distinction between these two aspects of pain might be made clearer if you think of listening to a sound, such as a radio. As the volume of the sound increases, I can ask you how loud it sounds or how unpleasant it is to hear it. The intensity of pain is like loudness; the unpleasantness of pain depends not only on intensity but also on other factors which may affect you. There are scales for measuring each of these two aspects of pain. Although some pain sensations may be equally intense and unpleasant, I would like you to judge the two aspects independently. Please mark the dotted line to indicate the relative intensity of your pain sensation; the further to the right, the greater the intensity. Similarly, mark the second dotted line to indicate the relative unpleasantness of your pain sensation."
APPENDIX J

NAME: ____________________________
DATE: ____________________________

INTENSITY

<table>
<thead>
<tr>
<th>No Sensation</th>
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<th>10. No Sensation</th>
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<tbody>
<tr>
<td>10. No Sensation</td>
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APPENDIX K

NAME: ______________________

Labor Data Sheet

1. Length of Labor

Stage I: Early 2.5-4 cm __________________________
        Active 4-7 cm __________________________
        Transition 7-10 cm ______________________

Stage II: 10 cm to delivery ______________________

2. Significant medical factors influencing labor

________________________________________________________________________

3. Rupture of membranes: When _______ How _______

4. Medication: Name _____________________________

    Dose _____________________________

    Time Given ______________________

5. Fetal monitor: When attach/unattach ____________

6. Positions for labor (observation) _______________

7. Location of labor pain (subjective report) ________

8. Episiotomy: If done, type ______________________

Newborn Information

1. Weight ___________________________ 2. Length ___________________________
3. Time Born _______________________ 4. Date Born _______________________
5. Presentation ____________________ 6. Position _______________________

Apgar: 1 min. ___________ 5 min. ___________
APPENDIX L

NAME: ________________________

INTENSITY

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AFFECTIVE

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### APPENDIX M

**COMPARISON OF EXPERIMENTAL PAIN AND LABOR PAIN**

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<th>MEAN*</th>
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<th>MAGNITUDE* LABOR</th>
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</table>

*in cm
APPENDIX N

An Assessment of Pain Responses to Thermal Stimuli During Stages of Pregnancy

by

A.H. Dunbar¹, R. A. Newton ², and D. D. Price³,

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Send correspondence to:
Summary

A psychophysical analysis was carried out to determine whether women demonstrate a change in pain responses across stages of pregnancy. This study utilized a thermode system and visual analogue scale (VAS), a combination tool which has been shown to be reliable and sensitive to different dimensions of pain (24-30). Using a repeated measures design, fifteen women were tested in late pregnancy, labor and post partum receiving 20 thermal stimuli (5 second exposure of preset temperatures 43, 45, 47, 49, and 51 degrees C delivered twice) to which they made a VAS response, 10 for unpleasantness and 10 for intensity. An ANOVA was used to compare the means of the pain responses across stages of pregnancy. No significant difference in responses to thermal stimuli was found to exist demonstrating that stages of pregnancy have no effect on responses to experimental pain. The results further suggest that there is no central pain mediating system present in pregnant women in late pregnancy or labor. These findings are contrasted with previous works done during late pregnancy using different pain measurement tools (6, 14). They are however, consistent with work done by Javert and Hardy (16). Lastly, by reviewing research examining levels of endorphins present in the plasma and
cerebrospinal fluid during stages of pregnancy, this study supports the growing body of knowledge which suggests that pain mediation by endorphins occurs centrally and not in the periphery.

INTRODUCTION

Childbirth pain has been a topic of study for numerous researchers (16, 19, 20, 26). Using various measurement tools, researchers have found that labor pain ranks among the most intense types of pain that have been examined. Animal studies have shown that there is an increase in pain threshold during late pregnancy that is mediated by the endorphin system (12). Similar investigations have been done with pregnant human subjects using signal detection procedures (14) and pressure-induced pain thresholds (16). The studies show somewhat divergent results though the measurement tools are difficult to compare and their methods are not without problems (31).

In a study examining chronic pain, Price (27) developed a method for measuring chronic pain that has been shown to be reliable and valid. Using thermal stimuli and a visual analogue scale (VAS), this measurement tool was shown to be sensitive to two distinct dimensions of pain, was administered with ease,
and yielded data that allow predictive statements to be made. More recently, Price has demonstrated the sensitivity of this psychophysical technique for studying mechanisms of analgesia active with acupuncture (29) morphine (30) and fentanyl (28). These studies demonstrate distinct differences in the stimulus response functions comparing central and non-central mechanisms of analgesia.

Because of the sensitivity shown to be present in this psychophysical tool, the combined use of the VAS and thermal stimuli were selected to further study pain responses during stages of pregnancy. The purpose of this study was to examine variations in women's pain response systems during pregnancy by comparing intensity and affective (unpleasantness) responses to thermal stimuli during late pregnancy, labor, and the puerperium.

METHODS

Characteristics of Subjects

Fifteen women (18-43 years; \( x = 28.4 \)) at least 30 weeks pregnant (\( x = 34.9 \) weeks including 14 primiparas and 1 multipara) were admitted into this study based on the following criteria: (1) the subject had an uncomplicated pregnancy having taken no medication that would influence the results of the study, (2) the subject
was planning to deliver at the Medical College of Virginia; (3) the subject's labor remained uncomplicated, unmedicated for pain, and when possible, unaugmented prior to the measurement taken; and (4) the subject's puerperium remained uncomplicated and when possible without pain medication for eight hours before final measurement.

Following a presentation and discussion of the study and thermode procedures, each subject signed a consent form. Signing this form demonstrated each women's understanding that the testing procedures had been adequately explained, that the chance of tissue damage from the heat stimuli would be minimal, and that they were free to withdraw from the study at any time.

**Study Procedures**

Subjects were recruited through the Lamaze classes taught at the Medical College of Virginia. Once a woman indicated her interest in the study, the approval of her physician was obtained and the admission criteria were verified. Prior to the start of each measurement session, the ten temperatures (43, 45, 47, 49, and 51 degrees C each delivered twice) were placed in random order for both unpleasantness and for intensity. The initial meeting (33-37 weeks; $x = 34.9$) weeks was designated as a practice session. The first testing
session then followed two weeks later (36-39 weeks; $x = 37$ weeks). Subjects were given instructions to page the examiner at the onset of labor so that the labor testing session could be done in early or early/active labor. The post partum session was set up to take place 48-72 hours after delivery. Prior to the labor and post partum sessions, medical staff were consulted as to the subject's progress and appropriateness of the session timing.

Psychophysical Procedures

At the initial meeting, procedures for the study and the stimulator were described. After the consent form was signed, a prepared set of instructions were read by the examiner. The set of instructions which follow, standardized all the instructions given and clarified the distinction between the intensity and unpleasantness or affective dimension of pain (27).

"There are two aspects of pain which I am interested in measuring: the intensity, how strong the pain feels, and the unpleasantness, how unpleasant or disturbing the pain is for you. The distinction between these two aspects of pain might be made clearer if you think of listening to a sound, such as a radio. As the volume of the sound increases, I can ask you how loud it sounds or how unpleasant it is to hear it. The intensity of pain is like loudness; the unpleasantness of pain depends not only on intensity but also on other factors which may affect you. There are scales for measuring each of these two aspects of pain. Although some pain sensations may be equally intense and unpleasant, I would like
you to judge the two aspects independently. Please mark the dotted line to indicate the relative intensity of your pain sensation; the further to the right, the greater the intensity. Similarly, mark the second dotted line to indicate the relative unpleasantness of your pain sensation."

Subjects were seated with their arms supported by the arms of the chair during the practice session and the late pregnancy session. During the labor and post-partum measurements subjects were positioned for comfort, usually reclined about 25-45 degrees in bed.

The stimulus temperatures were placed in random order and the stimuli were delivered to alternate forearms beginning proximally and moving distally. After each stimulation, the subject would mark the appropriate VAS indicating her response to the stimulus. She then covered her VAS response with a cover sheet indicating her readiness for the next stimulus. This procedure was followed until all 20 stimuli (ten for unpleasantness and ten for intensity) were delivered.

The visual analogue scale consisted of a set of lines, fifteen centimeters in length whose endpoints were designated as "no sensation" and "the most intense sensation imaginable" for the measurement of intensity and "not bad at all" and "the most intense bad feeling possible for me" for the measurement of the affective dimension. The response for each stimulus was done by making a slash mark on the fifteen centimeter line
between the designated endpoints.

One additional measurement was taken during the labor that was used for discussion purposes. After a subject completed the 20 stimuli, she was asked to indicate on a VAS, the intensity of her present labor contractions. This step was repeated again and the mean of the two responses was calculated and recorded. These VAS measurements of clinical pain were used for discussion purposes.

RESULTS

Testing Characteristics

Of the fifteen subjects that participated in this investigation, ten delivered vaginally, four were delivered by Cesarean and one subject died during delivery. Labor ranged in length from seven to seventy-two (x = 24 hours). The labor measurement session took place in early labor for eleven subjects (at two to three centimeters dilation) and in the early-active phase for four subjects (four to five centimeters dilation). The final session took place 48-84 hours after delivery (x = 55.5 hours) except for one at 28 hours due to scheduling problems. The data from six of the subjects was eliminated from the post partum measurement. After reviewing the medication
records, we felt that the subjects' responses to the stimuli may have been influenced by medications received prior to testing.

**Testing Results**

In each measurement session, subjects were asked to rate five levels of thermal stimuli delivered twice and in random order. The pain score was defined to be the mean of the two observations for a given temperature and dimension. The pain scores were used to calculate means and the standard error of the means for each temperature, stage and dimension (Table 1). The mean pain score for each temperature, stage and dimension was then plotted for further illustration (Figures 1 and 2).

To determine if there is a difference in responses to thermal stimuli due to stage of pregnancy, an ANOVA was performed for each fixed temperature (43, 45, 47, 49, and 51 degrees C) and dimension (affective and intensity). The results are shown in Table 2.

As shown by analysis, there is no difference in intensity responses to thermal stimuli comparing late pregnancy, labor and post-partum (illustrated in Figure 1). In addition, there is no difference in affective responses to thermal stimuli comparing the same stages of pregnancy (illustrated in Figure 2).

To further investigate any changes occurring in
## Table 1
RESPONSES TO THERMAL STIMULI

### Affective

#### Late Pregnancy

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<th>StdErr</th>
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<td>0.27</td>
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#### Labor

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#### Post Delivery

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* Temperatures in degrees Centigrade

** Visual analogue scale responses in centimeters
### TABLE 1 (Continued)
RESPONSES TO THERMAL STIMULI

#### INTENSITY

**LATE PREGNANCY**

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**POST DELIVERY**

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* Temperatures in degrees Centigrade

** Visual analogue scale responses in centimeters
Comparing Stages of Pregnancy

Pain Score - Mean Two Observations

Intensity

Figure 1.

Comparing Stages of Pregnancy

Pain Score - Mean Two Observations

Affective

Skin Temperature

1 - Late Pregnancy 3 - Labor 4 - Post Delivery

Figure 2.

Figure 1 and 2. Subjects' responses to experimental pain (degrees C) using a visual analogue scale (VAS in cm) rating the intensity (Figure 1) and affective or unpleasant dimensions (Figure 2). Three stages of pregnancy are compared.
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response to the stimuli due to pregnancy, the responses made in this investigation were compared to 21 volunteer controls matched in age range (19 women, 2 men; 19-50 yrs; x = 30 yrs.). To do this, all stages were combined to calculate the means and standard errors for each temperature and dimension (Table 3). These means were then compared with means obtained from the volunteer controls (Table 4). Because the raw data was unavailable, no statistical comparison was made. However, plotting the means on a graph illustrates that the curves are very similar (Fig. 3 & 4).

After the main investigations were completed, the investigators decided to examine the relationship between the VAS responses to experimental pain during late pregnancy and labor and the clinical VAS measurements of labor pain.

To test this question, the mean pain score for each patient was calculated for the five temperatures (combined) for late pregnancy and for labor. The index of pain reduction was calculated both by finding the difference of the two means (late pregnancy - labor) and by calculating the percent change from late pregnancy to labor (Table 5). The difference and percent change were termed the index of reduction. To determine if any correlation existed between the index of reduction and the magnitude of pain during labor, a Spearman
### TABLE 3
PAIN SCORES FOR COMBINED STAGES OF PREGNANCY

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TABLE 4
MEAN PAIN SCORES OF PREGNANT AND "NORMAL" SUBJECTS

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</table>

1Price et al, 1987
Figure 3 & 4. Subjects' responses to experimental pain (degree C) using a visual analogue scale (in cm) were combined across three stages of pregnancy and plotted for intensity (Fig. 3) and affect or unpleasantness (Fig. 4). Scores from "normals" (Price and Harkins, 1987) were plotted for comparison.
correlation co-efficient was calculated. They were found to be \(-0.025\) for the difference index and \(0.089\) for the percent index. Thus, in either case, there was no evidence that a correlation existed between the index of pain reduction and the magnitude of labor pain. These results suggested that no relationship existed between the change in responses to experimental pain for late pregnancy and labor and the responses to clinical labor pain. Further, the results supported the hypothesis that there is no endogenous analgesia present at the time of labor.

**DISCUSSION**

The results of this study indicate the women's responses to painful stimuli do not change across stages of pregnancy. They further indicate that there is no endogenous system of analgesia present in late pregnancy, labor and the post-partum period.

**Comparison With Previous Studies**

Previous studies examining the influence of pregnancy on responses to experimental pain have used the signal detection theory (SDT) (14) and pain threshold measurements (6, 16) for assessment procedures. Hardy,
Wolff, and Goodell (15) were the first to study pain thresholds by using radiant heat stimulation. A follow-up done in 1950 by Javert and Hardy examined pain responses in pregnant women in labor (16). Though the majority of the study focuses on labor pain, Javert and Hardy also found women's skin pain thresholds to painful stimuli did not change across pregnancy, labor and the puerperium. They utilized precise methods of measurement including detailed instructions to each subject.

In a more recent study, Cogan and Spinnato examined pain thresholds in late pregnancy using an electrosphygmanometer (6). They compared findings between non-pregnant women and women in the last two weeks before delivery. The results demonstrated that the pain threshold levels of pregnant women increased significantly \((p < .001)\) as the delivery date approached.

Despite the precision employed, other researchers have identified several critical factors inherent in the reliability of threshold testing. In 1956, Beecher demonstrated that known narcotic drugs do not alter responses to pain threshold measurements (2). Blitz and Dinnerstein (4) demonstrated that thresholds can vary considerably according to the instructions given to subjects. Price (23) stated that threshold measures can be influenced by placebo effects and response bias. It would seem that women in late pregnancy might be biased
toward higher thresholds of pain as they prepare themselves for tolerating labor pain. This characteristic would not be relevant for non-pregnant women. Clearly, the detail of instructions given are important for minimizing the Hawthorne effect.

Another study assessing pain response in pregnant women used the signal detection theory (14). The researchers found that pregnant women were significantly more willing to label radiant heat stimuli as painful during the last two weeks of pregnancy than at any other time during pregnancy. These findings are however, difficult to interpret because of problems inherent to the basic concepts in the signal detection theory. Applied to pain research, the theory assesses a subject's ability to discriminate between levels of pain stimuli. Rollman (31) stated that the SDT studies cannot produce a true estimate of the painfulness of a stimuli and reiterated that the detection theory only provides an estimate of a subject's ability to discriminate between painful stimuli. Gracely (10) stated the results from SDT studies may be altered by factors such as fatigue, significance of the situation and alertness which can hamper one's true ability to discriminate. These factors can further obscure the interpretation of the results. For example, applying these criticisms to Goolkasian and Rimer's study, we could ask whether the results
(i.e. women are more willing to report pain in late pregnancy) could be influenced by subjects' ability to concentrate, pay attention, and by their desire to perform well. Such problems found with this pain measurement methodology weaken the results of the study.

In summary, previous studies examining the influence of pregnancy on responses to painful stimuli, have produced varying results. As discussed, the methods of pain measurement employed have been shown to be influenced by a variety of factors. Therefore, both the positive as well as the negative findings of the previous studies are difficult to interpret.

Current Psychophysical Measurement

In a variety of different settings, the combined use of experimental pain and the VAS has been shown to be a reliable, sensitive, and versatile measurement tool for studying pain (24-30). Unlike the threshold measures of Hardy et al, (15), this tool uses the full range of noxious stimuli (3, 8). In 1980, Price et al (24) demonstrated using the VAS and thermal stimulator, that the dimensions of affect and sensation could be selectively influenced by experiential factors such as expectation, uncertainty and judgements controlled by thought focusing. This sensitivity was demonstrated again in a study with women in labor. Price (26) found a
clear distinction between sensation and affect as a woman in labor progressed from Stage I, the dilation stage to Stage II, the expulsion stage.

Using low to moderate doses of morphine (32) and fentanyl (28), Price and colleagues studied subjects' VAS sensory and affective responses both before and after administration of the drugs. Graphing the responses showed the narcotic drugs produced a parallel downward shift in the stimulus response curve. Moreover, the distance the curve was displaced downward was dependent on the dose given. The same parallel downward shift in the stimulus response curve was also produced by testing subjects before and after electro-acupuncture (29), a presumed endogenous opiate pain mediating system.

In conclusion, the lack of positive signs of analgesia in the present study are not likely due to insensitivity in the methodology for measuring endogenous and exogenous analgesia. In addition, though the lack of positive signs of analgesia in the present study may have been related to the level of clinical pain which is lower in early labor, one would then have expected a correlation between clinical pain and a reduction in experimental pain. When this correlation was done, no relationship was found to exist. This is further evidence against the hypothesis that labor triggers an endogenous analgesia system.
Endorphins

The role of endorphins in the pain mediation system continues to be a topic of study. In a study done with rats, Ginzler (12) has shown cerebrospinal fluid (CSF) levels of Beta endorphins to be elevated during late pregnancy. The pregnant rats were shown to have an increase in pain threshold two weeks prior to parturition, consistent with the rise in Beta endorphin levels. Ginzler also found this increase could be abolished by administering naloxone suggesting that endorphins in the CSF are a significant physiologic factor contributing to pain threshold and tolerance levels.

Human studies examining endorphin levels in pregnancy have been varied. Researchers have shown that plasma endorphins are present at higher concentration in pregnancy (1, 19, 21) with significant elevations during labor (7, 9, 11, 13, 34). The endorphin levels measured in the CSF during pregnancy and labor (5, 33) do not change. Further research has shown that endorphins in the plasma have been associated with increases in stress (13, 32) whereas endorphins in the CSF have been found to be associated with analgesia (17). Researchers have also shown that this analgesic state can be reversed by naloxone (18).
In the current study, the presence of an endogenous system of analgesia was further investigated by examining the relationship between the difference of VAS responses to experimental pain between late pregnancy and labor (termed the index of pain reduction) and the clinical VAS responses of actual labor pain. The difference in the combined VAS responses between late pregnancy and labor was correlated for each woman with her VAS rating of labor pain intensity. The percent change was also calculated. Using the Spearman correlation co-efficient, no correlation was found to exist (-.025 for difference index and .089 for percent index). The results suggested that no relationship existed between an index of pain reduction and the magnitude of labor pain. These findings further supported the hypothesis that there is no endogenous analgesia system present at the time of labor.

Thus, neither studies of CSF endorphins in pregnancy and labor nor the present study provide evidence that an endorphin mediated analgesia has a functional role in late pregnancy or labor. The lack of positive findings is likely not due to insensitivity of the pain assessment tool nor low levels of clinical labor pain. These results further suggest that there is no central pain mediating system present in pregnant women in late pregnancy or labor.
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