TOUCH AND MASSAGE *in Early Child Development*

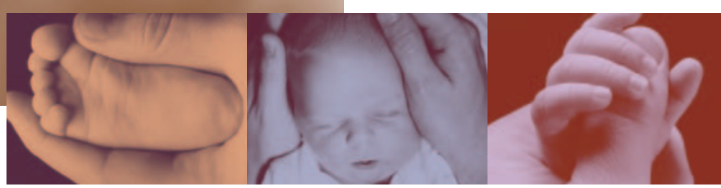

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TABLE OF CONTENTS

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PREFACE

The Johnson & Johnson Pediatric Institute, L.L.C., is proud to sponsor this groundbreaking compilation of studies on the power of touch in childhood growth and development.

Astounding advances in health and medicine have improved the lives of millions of children in the last century. Vaccines prevented childhood diseases; antibiotics cured those who became ill; sophisticated new technologies and gleaming incubators helped physicians keep tinier and younger premature infants alive.

In the midst of this exciting progress, however, the importance of old-fashioned touch—holding, massaging, rocking and soothing children—was often dismissed, forgotten or even negated. Touching was not sterile. It was not scientific. It was not *modern*. However, a handful of parents, clinicians and researchers continued their commitment to this more traditional therapy. Scientific research has validated their commitment as touch has now been shown to have numerous therapeutic benefits.

Today, a growing body of research from around the world shows that human touch is a powerful contributor to infants' ability to thrive and grow. Rigorous scientific studies show that

- Even a few minutes a day of touching measurably increases a newborn's health and vigor, from body weight to bone mass
- During skin-to-skin contact, a mother's chest naturally adjusts to provide exactly the warmth and comfort that her baby needs
- Touch and massage significantly reduce infant crying and distress
- Infant massage under accepted guidelines can increase weight gain in premature infants

and much more.

Each of the studies included in this book establishes a powerful case for touch. In bringing this wide-ranging research together, the Johnson & Johnson Pediatric Institute's goal is to remind us that in this high technology world, there is still room for low technology therapies that can increase the health and happiness of infants and families around the world.

Johnson & Johnson Pediatric Institute, L.L.C.

INTRODUCTION

The Importance of Touch

The act of touch fulfills the basic human need to feel safe, comfortable and loved. Touch is also an intrinsic factor in child development, but despite touch's importance, in recent years "touching" has been tabooed in the American school system because of fears of sexual and physical abuse. Elementary and high school teachers have been mandated not to touch children, and even children as young as preschoolers cannot be touched in many private nursery schools because of potential accusations of sexual abuse following increased publicity about abuse in schools.[1] Although the rates of sexual and physical abuse have climbed steadily despite this mandate, teachers uphold this rule from fear of lawsuits by parents and losing their jobs. In a study we conducted on the amount of teacher touching in preschool classrooms, we observed significant decreases in teachers touching nursery school children as the children became older (from infant to toddler to preschool age) including less holding, hand-holding, stroking and carrying, and resulted in increased aggressive behavior.[2] Being concerned about the extremely low levels of touching, we then provided demonstrations and instructions to the teachers in an attempt to increase the levels of touching. Following this intervention, the teachers increased their level of touching (including holding, hugging, kissing, hand-holding and caregiving touch), although touching was still relatively infrequent following this intervention. Others have tried to increase touching in nursery schools by having the children give each other back rubs.

The implications of limited touch for children involve significant effects on their growth, development and emotional well-being. Extreme cases can be seen in the Romanian orphanages where children have achieved half their expected height due to extreme forms of touch deprivation. Their cognitive and emotional development has also been significantly delayed by the lack of physical stimulation. Other data suggest that touch deprivation in early development may contribute to violence in adults.

In a cross-cultural study, cultures in which there was more physical affection toward infants had lower rates of adult physical violence and vice versa.[3] The amount of touching that occurs in different cultures is highly variable. For example, touching behavior between couples was observed in cafes in several countries.[4] Couples were observed sitting at tables in cafes for 30-minute periods, and the amount of touching between them was recorded. Among the highest touch cultures was France (110 times per 30 minutes) and among the lowest was the United States (2 times per 30 minutes). The high touch cultures had relatively low rates of violence while the low touch cultures, in turn, had extremely high rates of youth and adult violence. In a 1994 report by the Centers for Disease Control and Prevention, the homicide rate per 100,000 population was 1 in France and 22 in the United States.[5]

The cafe data suggest that French families may provide more touch stimulation for their children, and conversely, American families provide less. Studies we conducted on Paris and Miami playgrounds suggested that these cultures differed in the touching of preschoolers by parents, in peer touching among preschoolers and in peer touching in young adolescents.[6,7] For the Paris parents, touching occurred 43% of the time as opposed to 11% of the time for Miami parents. Affectionate touch between the preschool children occurred 23% of the time on the Paris playground and only 3% of the time on the Miami playground. In contrast, aggressive touch occurred 37% of the time on the Miami playgrounds and only 1% of the time on the Paris playgrounds.

Because infants and toddlers are touched so infrequently in nursery school, we have begun instructing teachers on how to massage infants and toddlers. In our studies, we have noted that infants/toddlers who are massaged before naptime at preschool are less irritable, go to sleep faster and sleep more soundly. Thus, teachers are very happy massaging them. Parents have also been noted to help reduce irritability and enhance sleep by massaging their infants before bedtime. These are potential ways to reintroduce touch into our society.

This volume highlights the importance of touch across early development. Diego et al present research data on how the fetus responds to tactile stimulation, while Hernandez-Reif et al discuss the data on newborns' responses to tactile stimulation. In a chapter by Perez and Gewirtz, studies are presented on how young infants respond to different types of touch. Infants' responses to touch during early interactions are addressed by Stack, and data on early interactions in different cultures are presented by Martini.

In other chapters, Field covers therapeutic applications including pregnancy and labor massage, Anderson et al address kangaroo care for neonates, Harrison reviews tactile stimulation for preemies, Moyer-Mileur presents data on moving the limbs of preemies, and Goldstein Ferber examines the effects of massage therapy on full-term infants. These are followed by a chapter on oxytocin as a possible underlying mechanism for massage effects by Uvnäs-Moberg and chapters on massage for preemies and pediatric conditions by Cifra, massage for infant orphans by Jump, and massage for several pediatric problems including attention and behavior problems, pain, neuromuscular conditions, autoimmune disorders, and immune dysfunction by Field et al.

The power of touch as a therapeutic modality is highlighted by the data from these studies. Many of them also suggest the importance of training parents to massage their infants for growth and development and their chronically ill children for helping treat their medical conditions. Methods to provide adequate touch could effectively be introduced in delivery units, children's hospitals and schools. They are easy to learn and have been noted to help not only infants and children but also reduce the stress levels and stress hormones of the parents and teachers providing the stimulation. Touching and being touched are comforting, growth-producing and healing experiences that need to be supported by our medical and educational communities. The data presented in this volume are compelling and will help advance touch in our world.

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SECTION I.

MATERNAL TOUCH AND TOUCH PERCEPTION

CHAPTER 1:

FETAL RESPONSES TO FOOT AND HAND MASSAGE OF PREGNANT WOMEN

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Abstract

The fetus responds to extrauterine stimuli depending on such factors as the nature and intensity of the stimuli and gestational age. The study discussed in this chapter assessed fetal responses to maternal foot and hand massages during ultrasound examinations conducted midgestation (mean, 19.9 weeks). The study involved 80 women, divided equally into a foot-massage substudy and a hand-massage substudy. Control subjects did not receive massages, but rather rested quietly during the observation periods. Results indicated that foot massaging was associated with a 16% increase in fetal activity. In contrast, hand massaging elicited only a 10% rise in fetal activity, which did not significantly differ from the activity of the control group. These results suggest that the hands may be *less* innervated than the feet or that the foot- versus the hand-massage procedure may have triggered distinct reflex arches and physiological responses. Further research is needed to explore the mechanisms involved in the fetal response to maternal tactile stimulation.

Introduction

The fetus is often believed to develop in total isolation from the outside world. Throughout gestation, the mother and fetus share a common environment, which is affected continuously by the external world. Extrauterine light and sound cross the maternal abdomen, uterus and embryonic membranes, thereby reaching the amniotic fluid and the fetus.[1,2] Furthermore, vibration applied to the mother's abdomen is transmitted mechanically across the intrauterine environment.[1] Similarly, external tactile stimulation has been shown to produce changes in the mother's physiology[3,4] and biochemistry[5,6] that may affect the intrauterine environment indirectly, even if such stimulation is not applied directly to the mother's abdomen.

Extrauterine stimulation has been used in the antepartum assessment of fetal well-being.[7,8] Vibratory stimulation has been used to test fetal hearing,[9] and habituation to vibratory stimulation has been used to test fetal function.[7,10] Fetuses who respond to vibratory stimulation have been reported to have better biophysical profiles.[11,12]

Fetal responses to stimulation depend largely on the properties of the stimuli *and* the maturation state of the sensory system being tested. The fetus responds to airborne auditory stimuli as early as 28 weeks gestation,[13] which is only 4 weeks after the development of the fetal auditory structures.[14] Furthermore, the fetal response depends largely on the intensity of the stimulus.[15-17]

Similarly, responses of the fetus to tactile stimulation also depend on the intensity of the stimuli. Even though responses by the fetus to tactile stimuli have been noted very early in gestation,[18,19] fetal responses to vibratory stimulation are only apparent after 26 weeks gestation.[16,18,20] Taken together, these findings suggest that vibratory stimulation applied to the mother's abdomen may not be perceived because those nerve endings have not yet been developed and myelinated.[21] Alternatively, the vibratory stimulation that is perceived by the fetus may be primarily auditory, and not tactile in nature, and would be perceived only after sufficient development of the fetal auditory system.

Other forms of external stimulation that may elicit fetal responses have also been studied. Acupuncture delivered to the mother at acupoints SP-6 (located on the tibia, above the tip of the medial malleolus) and LI-4 (located on the hand, between the 1st and 2nd metacarpal bones) affect umbilical-artery blood flow to the fetus during the third trimester.[22] When delivered to the mother at accupoint BL-67 (located on the fifth toe), acupuncture results in decreased fetal heart rate (FHR)[23] and increased movement (FM) in fetuses during the third trimester.[23,24] The stimulation of specific acupuncture points is believed to activate specific nervous system pathways.[25]

Massaging highly innervated areas, such as the feet and hands, may also stimulate fetal activity. Midwives have reported anecdotally that massaging the Achilles tendon of pregnant women during late gestation may induce contractions. Massaging the feet and hands has been shown to reduce heart rate, respiration rate and systolic and diastolic blood pressure,[4,6] decrease levels of norepinephrine and epinephrine, "and attenuate the response of cortisol to a stressful procedure." These changes in the mother's physiology and biochemistry following massage therapy may contribute to the increase in fetal activity. Data have also shown that massaging other highly innervated areas of the mother's body—nipples[26] and breasts[27]—results in uterine contractions during pregnancy.

Current Studies

In this chapter, we review the studies we have done with several of our colleagues on the effects of massaging the mother's feet and hands on fetal activity.[28] The extremities were selected because the feet and hands are highly innervated and because fetal responses to maternal foot acupuncture have been noted.[23,24] These studies were conducted midgestation, inasmuch as fetal responses to stimuli have been noted as early as 14 weeks gestation,[18,19] yet fetal activity responses to vibratory stimuli occur only after 26 weeks gestation.[16,18,20] Furthermore, the responses of fetuses to acupuncture have been studied only after 33 weeks.[23,24] As such, we and our colleagues were interested in determining if foot and hand massage of the pregnant woman would contribute to fetal activity. Finding increased fetal activity would provide preliminary support for using massage as an assessment of fetal responsivity prior to 26 weeks gestation.

METHODS

From a prenatal clinic at a large, urban, university hospital, 80 pregnant women in midgestation (mean, 19.85 weeks) were recruited for this study.[28] Pregnant women were excluded if they met any of the following criteria: carrying more than one fetus; smoked cigarettes or drank alcohol; carrying a fetus that had demonstrated any abnormalities during an ultrasound; had a complicated pregnancy; or had been prescribed any medications other than vitamins. The first 40 mothers, participants in Study 1, were randomly assigned to a foot-massage or a control group. The remaining 40 mothers, participants in Study 2, were randomly assigned to a hand-massage or a control group.

The fetal activity assessment and stimulation procedures occurred immediately prior to a standard clinical ultrasound examination. The pregnant women completed the State/Trait Anxiety Inventory (STAI) immediately before and immediately following the ultrasound. These women were then monitored by ultrasound for baseline fetal activity while lying on an examination table on their left side for 3 minutes. This was followed by a 3-minute massage or control period and a 3-minute poststimulation observation period. All participants were assessed between 10:00 am and 2:00 pm in the same ultrasound examination office. No significant differences were noted on assessment times or days.

FETAL-ACTIVITY ASSESSMENTS

Fetal activity was assessed using interval recordings on a real-time ultrasound scanner fitted with a single Doppler transducer applied to the mother's abdomen.[28] Every effort was made by the technician to visualize the entire fetus by manipulating the transducer and adjusting the zoom control (Figure 1). At 20 weeks gestation, the majority of fetuses were visualized fully. If the fetus could not be visualized fully, the technician focused on the head, torso and arms, as well as on the upper-leg regions to assess leg movement. Every 3 seconds, the researcher was prompted by a tape-recorded cue (heard through an earphone) to record the type of fetal activity that was occurring. All behaviors occurring between tones were ignored. The 3-second interval was chosen arbitrarily for its ability to generate an easy-to-determine total ([60 seconds/3 seconds = 20 observations] x 3 minutes = 60 observations). The researcher recorded the following: a single limb movement, characterized by any movement of any one extremity; multiple limb movements; exclusive of torso movements (i.e. more than one extremity, including the head, moving at any one time); gross body movements with or without single or multiple limb movements; or no movement at all. The percentage of time the fetus engaged in each movement category was calculated by dividing the total number of movements by the total number of observation units. Total amount of movement was calculated by subtracting "1" from the percentage time that the fetus did not show any movement. Interrater reliability, calculated on 10% of the samples from 2 of the observers, revealed adequate kappa values ranging from 0.82 to 1.00.

Figure 1. Ultrasound image of the fetus.

FOOT-MASSAGE PROCEDURE

The 3-minute foot-massage procedure was performed by the therapist as follows: stretching the feet for 5 seconds by holding the ankles with one hand and pulling the tops of the feet toward the therapist with the other hand; squeezing the feet intermittently for 20 seconds each, starting at the heels and moving toward the toes by holding both feet with the thumbs on the top and the other fingers on the soles of the feet; applying pressure with both thumbs to the arch of each foot (one foot at a time), and then using the thumbs to rub between each toe using an up-and-down motion (toward the web of the toe, and then toward the end of the toe) for 30 seconds on each foot; kneading the bottom of each foot for 20 seconds each, and then the top of each foot for 20 seconds each, one foot at a time; flexing and extending each foot, and then flexing and extending all toes on each foot, one foot at a time for 3 seconds each; squeezing each foot for 5 seconds, moving from the heel to the toes, one foot at a time; and, finger-stroking the entire top and bottom of each foot, using all 5 fingers, one foot at a time, for 7 seconds.[28]

HAND-MASSAGE PROCEDURE

The 3-minute hand massage (Figure 2) was performed by the therapist as follows: holding the wrist with one hand, and with the other hand pushing against the fingers for 5 seconds each; with both hands, stroking the tops of the mother's hands briskly for 10 seconds each; with a thumb on the top of each hand and the other

Figure 2. Hand massage procedure.

fingers on the palms, compressing both hands intermittently, starting at the pinkies and moving toward the thumbs for 10 seconds each; finger-stroking the entire back of each hand, from the fingers to the wrists for 10 seconds each; using the thumbs and forefingers to squeeze each finger on each hand for 20 seconds each; stretching each finger by encircling each finger completely, gently pulling fingers away from the hand, for 20 seconds each; applying pressure intermittently to one hand at a time from the center to the edge of the bottom of the hand for 10 seconds each; and, holding the wrist with the left hand, and with the right hand gently pulling the hand away from the wrist for 5 seconds each.[28]

CONTROL-GROUP PROCEDURE

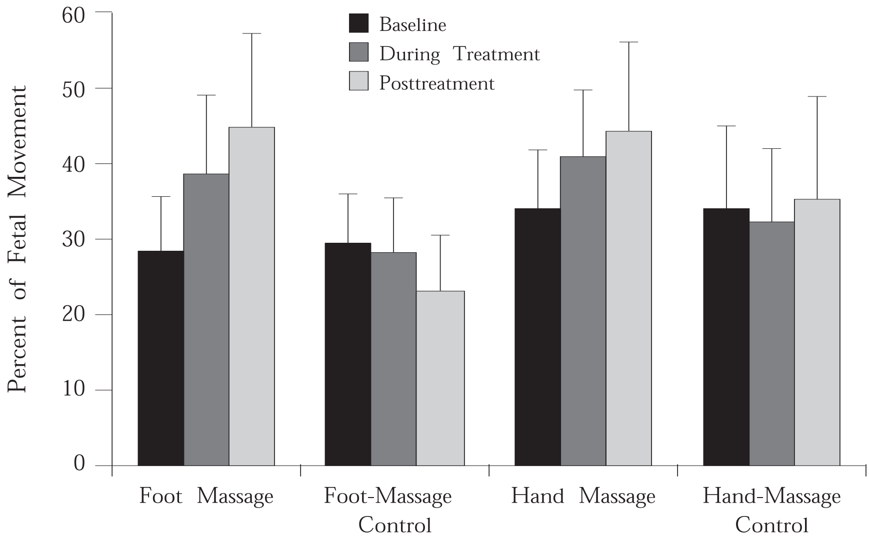
In the control procedure for the foot *and* hand massage the pregnant women were asked to lie on their left side while resting quietly for 3 minutes.[28]

Results and Discussion

The mothers in the massage groups and in the control groups on average reported feeling less anxiety following the massage or rest session.[28] The reduced anxiety was probably a function of the visit for ultrasound. Mothers in this study, each of whom had normal, uncomplicated pregnancies, received immediate feedback from the ultrasonographer on the health of their fetus. In an earlier study we had shown that mothers who received feedback during ultrasound examinations reported less anxiety than mothers who did not receive feedback.[29] In addition, simply resting on the left side for 12 minutes may lower anxiety levels.

Even though vibratory stimulation has failed to elicit fetal movement before 26 weeks gestation,[16,18,20] the foot massage elicited fetal activity as early as 20 weeks gestation.[28] The fetuses of mothers who received a 3-minute foot massage showed increased activity, whereas the fetuses of mothers in the control group did not (Figure 3). The increased fetal activity is consistent with increased fetal movement observed following foot acupuncture in older fetuses.[23,24] Given that the feet are highly innervated, stimulating the feet of a pregnant woman may trigger changes in fetal activity via the activation of reflex arches, changes in maternal physiology and other unknown mechanisms. These findings are consistent with research that show that massaging highly innervated areas produces increased uterine contractions,[26,27] as well as with studies that show that massaging the feet lowers HR, BP and respiration.[4] Changes in HR, HR variability and galvanic skin conductance have been noted to affect fetal movement as early as 20 weeks gestation.[31]

Figure 3. Percent time fetal movement occurred in response to foot and hand massage. Fetuses of mothers receiving a 3-minute foot massage showed a significant increase in fetal movement.[28]



While the hand-massage procedure elicited a 10% increase in fetal movement, compared with a 16% increase for the foot-massage procedure, this change in fetal activity was not significantly different from that shown by a control group (Figure 3). These results are perplexing, as we had expected that fetuses of women who received the hand-massage procedure would show a similar response to fetuses of women who received a foot massage. Research into the effects of exercise by pregnant women indicates that the responses of the fetus are dependent on the intensity of the exercise.[32,33] Although light exercise produces slight or no changes in fetal response, moderate exercise produces increased FHR and fetal breathing, while strenuous exercise produces the opposite effect. Perhaps the hands are less innervated than the feet, which might explain why massaging the hands elicited a less-intense response than massaging the feet. Alternatively, the foot-massage procedure, versus the hand-massage procedure, may have triggered distinct reflex arches and physiological responses. Using longer observation periods for the foot and hand massages may have provided information on the onset *and* the duration of the fetal responses to the foot-massage condition. Thus, the lesser effect of the hand massage versus the foot massage may have been an artifact of the short observation period. Further study may help elucidate the mechanisms whereby massaging the feet of a pregnant woman results in increased fetal activity.

Conclusions

Additional research is needed to determine whether massage therapy given to pregnant women elicits fetal activity at other gestational stages. Additional assessments of fetal state, such as FHR, HR and variability, may enhance the validity of these findings. Furthermore, assessing maternal physiological variables, such as galvanic skin response and uterine contractions, in relation to fetal activity across the different types of stimulation may help suggest possible underlying mechanisms.

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CHAPTER 2:
TOUCH PERCEPTION IN NEONATES

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Abstract

Sucking and grasping behaviors occur *in utero*. This chapter presents data suggesting that such behaviors exhibited by newborns are more than just reflexive responses. Studies involving the handling and mouthing of objects by neonates indicate that newborns clutch or grasp objects presented to them and suck on objects that provide no nutritional value. Newborns, it has been determined, distinguish between objects, perceiving differences in hardness, texture, weight, shape and temperature. Thus, it appears that infants explore objects actively with their hands and mouths, using behaviors similar to those exhibited by adults, attempting to perceive the properties of specific objects. Future studies should explore further the touch and perception abilities of neonates.

Touch Perception in Neonates

The newborn baby invariably responds to touch. Stroking the newborn's face often leads to head turning. Mouth opening and closing (or "rooting") may follow, and if a finger or nipple touches the newborn's lips, typical responding includes opening the mouth, closing the lips around the object and sucking. These behaviors exhibited by the neonate are observed routinely during feedings and in the course of neonatal assessments, such as with the Brazelton Neonatal Behavioral Assessment Scale.[1]

Newborns also respond when their hands are touched. Placing a finger in the palm of the newborn results in the fingers of the neonate closing or grasping. In a study by Nagy and Molnar,[2] decreased heart rate was observed following grasping, which was interpreted as neonatal calming. However, heart-rate decelerations have also been used as measures of "attending" in the very young infant.[3,4] Therefore, perhaps grasping serves multiple functions, as does sucking, the goals of which can be for feeding, for calming (sucking on a pacifier or finger) or for exploring objects.

To date, these responses to touch by the neonate have been defined in the literature as "reflexes," or involuntary responses to stimulation,[5,6] implying little or no intentional behavior on the part of the newborn. Interestingly, examinations by ultrasound have revealed grasping of the umbilical cord by the fetus at 18 weeks gestation,[7] and thumb-sucking at as early as 15 weeks gestation,[8] suggesting that sucking and grasping are not new behaviors for the neonate, or that the neonate comes into the world with sucking and grasping experiences.

In this chapter, we question the traditional view that grasping and sucking responses to touch are merely reflexive responses performed by the newborn. For example, if sucking is reflexive then why does the neonate stop sucking when he or she is full or suck more vigorously when hungry? That the responses are variable may suggest that they are not completely reflexive. Perhaps reflexes exhibited by the neonate are the precursors of voluntary, intentional "touching back." Or, perhaps stimulating the palm or mouth of the neonate elicits the respective reflexive response initially, but the prolonged behaviors that follow are more "voluntary" by the neonate.

Another view that we question is that grasping and other limited motoric abilities, such as lack of finger movement, impede newborns' explorations of properties of objects with their hands.[9,10] A counterview—and the thesis of this chapter—is that neonates may explore many properties of objects through grasping and mouthing because of one or more of the following:

- These behaviors are exercised *in utero*, beginning during the second trimester of pregnancy, and therefore control of these responses by newborns may be underestimated at this time.
- Skin or sense receptors are in place and are functional *prenatally*, so that the processing of touch stimulation should be possible *postnatally*, if not earlier.
- The nerve pathways in the hand and mouth are well-developed, lending further support to the view that these sensory parts of the newborn are capable of exploring and picking up information regarding touch.

In this chapter, data are presented regarding the differential grasping and sucking responses of the neonate to varying object properties. Data are also presented that document neonatal habituation (becoming less attentive to a familiar object) and dishabituation (becoming more attentive to a novel object placed in their hands), as well as behaviors that appear to be precursors of active touching or exploring by the newborn.

The Touch "Organs"

The largest fetal "organ," and the first to develop, is the sensory-rich skin, or the sense of touch. By the 30th week of fetal development (10 weeks before birth), neurological structures and pathways are developed sufficiently for the fetus to perceive pain.[11] Studies indicate that during painful or stressful procedures, such as during intrauterine needling or surgery, fetuses and preterm infants exhibit elevated levels of stress hormones and increased activity, which some interpret as pain responses.[12,13] However, because pain is a subjective experience, and because of the accepted view that responses to touch by fetuses and neonates are "reflexive responding," the perception of pain by fetuses continues to be debated.[14,15]

Studies done in humans and animals also reveal the responding of neonates to heat and to the skin being touched with fine-hair stimuli. (For a review, see Fitzgerald and Jennings.[16]) Interestingly, these studies[53,54] found that the younger the offspring, the lower the threshold for responding and the more exaggerated the neonate's response is to stimulation, suggesting that the newborn is in a more excitable, or perhaps more vigilant state initially than is the adult.[16] Also noteworthy are the facts that there are approximately 17,000 skin receptors in each hand[17] and that the hands and mouth have the highest concentrations of sensory receptors compared with other skin areas, further supporting the view that the neonate is capable of "feeling" in these areas.[18] Taken together, the hypothesis that neonates "feel" or perceive when their hands or mouths are stimulated appears more plausible than that their responses to touch or pain are reflexive or nonvoluntary.

Touch Perception

The exploration or manipulation of objects with fingers, hands or mouth is defined as *active touch*, which is one mechanism believed to underlie perception or how information about the environment is learned or detected.[19] Because the manual dexterity of newborns is not well-developed, some researchers of infancy believe that newborns are incapable of feeling and distinguishing object properties with their hands. Specifically, neonates are not expected to perceive texture, shape and weight, because, based on adult studies (see Klatzky and Lederman, 1993[55] for a review of adult studies), the perception of these properties requires active fingering, handling and/or lifting of objects, which are not behaviors that are observed readily in the newborn infant.[9]

When information is detected through the activity of the hands, fingers and/or mouth, it is referred to as *haptic* (relating to or based on the sense of touch) perception. Unlike the other sensory systems, the haptic system is unique in that it can be used to explore *and* to alter the environment[19]: That is, the hands and mouth can not only feel the properties of an object, but they can *change* them, whereas the eyes can only see objects and the ears can only hear sounds, for examples. Active touching assumes purposeful exploration and involves input from skin receptors *and* kinesthetics (movement of muscles and joints),[20] such as lifting and holding, squeezing, finger tracing, prodding or poking. Finger tracing and prodding are activities not typically performed by neonates.

Traditionally, the behavioral repertoire of the neonate has been described as limited to holding or grasping and perhaps opening and closing of the fingers.[9] In observations that we made with our colleague Largie, after placing an object in the hands of 1- to 2-day-old newborns, we documented that some neonates turned their hands or wrists (back-and-forth hand movements) and lifted their hands to their faces or mouths.[21] Other haptic behaviors reportedly exhibited by neonates include squeezing[18,22] and slow finger stroking of objects.[23] Although limited or crude in terms of the information that can be provided to the neonate, these grasping behaviors are likely to aid the infant in abstracting information about objects: For example, temperature (cold or warm) can be detected through simple skin contact with the object, such as grasping with the palm or pressing the object to the lips. Hand squeezing and sucking could reveal the substance of the object (whether it is rigid or soft), as well as its texture (rough or smooth) and shape. Turning the hand or wrist, as well as lifting the hand holding the object to the face or mouth area, could facilitate perception of the weight of the object.

What follows is a detailed review of the research of these behaviors exhibited by newborns in relation to objects: Mouthing studies are reviewed first, followed by hand studies.

MOUTHING STUDIES

The infant's mouth and tongue comprise a highly specialized system used to ingest nutrients, express emotions and promote self-comfort, such as sucking on a breast, pacifier, finger or thumb. A MEDLINE® search covering the last 35 years revealed more than 1200 studies published on these topics in relation to infant sucking. However, few studies were found regarding the mouthing of objects by infants for the purposes of exploring, perceiving or learning about properties of objects (eg, texture, hardness, temperature).

Fewer than one dozen studies emerged when the same literature search was conducted for the perception of objects by newborns through mouthing or handling activities. (However, more than 100 entries were found when the keyword included "infants" rather than "neonates.") We review the scant literature on neonatal haptic perception in what follows immediately and in the next section.

One of the earliest studies of newborn "active oral touching," conducted by Lipsitt and Kaye (1965),[24] revealed that newborns altered their sucking rate as a function of the type of stimulus. Newborns were given a rubber nipple, a rubber tube or a combination of rubber nipples and tubes on which to suck over consecutive trials. Overall, the newborns sucked the nipples longer than they did the tubes, which suggested that they preferred the nipples and, therefore, that they must have perceived the nipples and tubes as different object properties. Almost 20 years later (1983), using polygraph recordings, Rochat examined the sucking responses of newborns and 1- and 4-month-old infants presented nipples that varied in shape (elongated versus round) and material (rubber versus a brass component attached to the surface of the rubber).[25] His findings included increased scanning with the infants' tongues and lips and decreased sucking from the newborn period to 4 months of age, which suggested developmental or age differences in mouthing (or exploratory) behaviors. Additionally, the newborns differentiated 2 nipple types (round and round with a hole), as indicated by their sucking preferences, and the 1-month-old infants detected the material changes. These findings support the view that from early in development infant sucking and mouthing behaviors serve exploratory functions and facilitate the detection of object properties.

In a follow-up study (1987), Rochat reported that 2- to 3-day-old newborns applied more sucking pressure to soft objects than they did to hard objects.[18] However, with their hands, they squeezed hard objects harder than they did soft objects. In the same study, similar mouthing and handling behaviors were observed for 2- and 3-month-old infants, although, interestingly, the squeezing responses of these older infants were of lesser duration and frequency than those of the newborns. Rochat concluded that neonatal mouthing and grasping are voluntary behaviors, not just reflexive activities. In other words, if the younger infants in these studies were merely responding to stimulation, and not attending to the objects' hardness or softness, then sucking and grasping behaviors should have been comparable in duration and pressure, irrespective of the stimulus type.

Studies of young infants' cross-modal (touch-to-sight) abilities revealed that 1-month-old infants recognized object properties visually that they had previously mouthed on the basis of texture information, such as "nubby" versus "smooth,"[26,27] or substance, such as "hard" versus "soft."[28] Within hours after birth, neonates have also been noted to match the shape of an object previously mouthed with its visual shape.[29]

Newborns' mouthing responses to objects that varied in texture[30] or temperature[31] have also been studied. Infants of depressed mothers were also assessed. These infants are of particular interest because they are reported to be less engaged in exploring objects.[32,33] Infants who show less exploratory behavior tend to have cognitive deficits later in life, including lower IQs.[34,35,50]

In the "texture" study, middle socioeconomic status pregnant women (mean age, 29 years) were assessed for depression until 12 depressed and 12 nondepressed mothers agreed to participate.[30] After delivery, the mothers were contacted and a laboratory visit was scheduled. The newborns averaged 12 days of age at testing (7 males/5 females in each group), and all were born full-term and medically uncomplicated. Held by one of 4 "blinded" experimenters on his or her lap, the neonates were presented with nubby- and smooth-textured fingertips to suck. The "nubby" stimulus, a sterile rubber fingertip (Swingline® Rubber Fingertips) of the kind worn by bankers and others for counting bills or turning pages, was covered with .10 cm nubby protrusions spaced every .20 cm. The "smooth" stimulus was simply the nubby fingertip turned inside out, which revealed a smooth, even surface like that of a rubber glove. Each experimenter wore the nubby fingertip and the smooth fingertip on the middle finger and index finger of his or her hand—counterbalanced, so that sometimes the nubby fingertip was on the experimenter's middle finger and sometimes on the index finger.

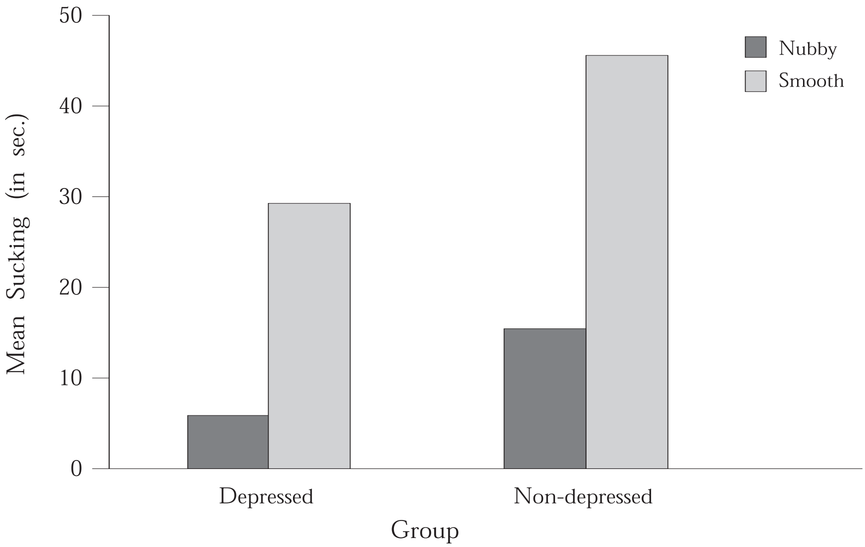
The smooth and nubby fingertips were presented to the neonates for mouthing one at a time, in an alternating fashion across 6 trials, so that each infant had 3 chances to explore the texture of each fingertip orally. Each trial started with the newborn's first suck of the fingertip and ended when the infant released the sucking grip. The amount of time (in seconds) spent sucking the smooth and nubby fingertips was recorded and analyzed.

- Interestingly, the infants of depressed *and* nondepressed mothers sucked the smooth-textured fingertips significantly more than they sucked the nubby-textured fingertips, suggesting that they detected the different textures because they preferred the smooth (perhaps more familiar) surface. However, across the 6 trials, the neonates of the depressed mothers sucked about 50% as long as those of the nondepressed mothers. Moreover, the newborns of the depressed mothers spent 33% less time sucking the nubby fingertip and approximately 60%

less time sucking the smooth fingertip compared with the newborns of nondepressed mothers (Figure 1). These findings suggest the following:

- From sucking, neonates discriminated a smooth texture from a nubby texture.
- Neonates preferred to suck smooth textures, which might have resulted from a familiarity preference, such as sucking on a bottle nipple, pacifier or finger. It was unlikely that any of these infants had explored a nubby fingertip previously.
- Newborns of depressed mothers were less inclined to suck textures, as evidenced by their lesser sucking, in particular, on the more-novel nubby texture.

Figure 1. Newborns of depressed mothers sucked the "nubby" and "smooth" objects for shorter periods than did the neonates of nondepressed mothers.[30]



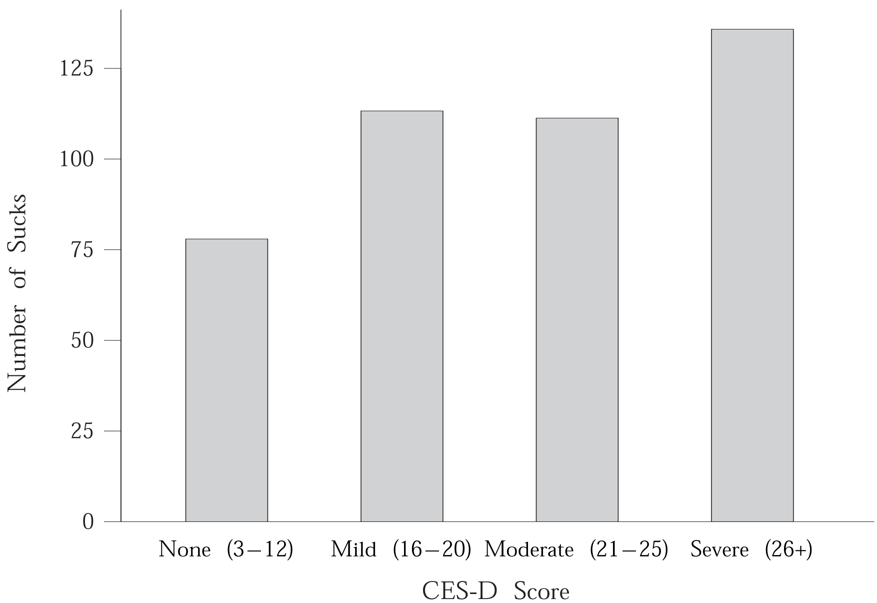
In summary, by approximately 12 days of life, infants not only perceived differences in texture through sucking, but they also controlled the amount of time they spent sucking objects presented to them, supporting the view that sucking is a voluntary behavior very much under the control of the very young infant. Also, it was apparent that neonatal behaviors may have been influenced indirectly by maternal depression via the mothers' altered biochemistry during pregnancy. (See Field,[31] for a review of the effects of maternal depression on the newborn.)

In an effort to assess the newborns' perceptions and discriminations of temperature, the second study (M.H-R., T.F., M.D. and S. Largie, unpublished data, 2003) examined neonates sucking a "cold-condition" nipple versus a "warm-condition" nipple. In this study, women who had just delivered normal full-term infants were visited in the neonatal unit of a university hospital, and those who consented were assessed for symptoms of depression. Twenty-two depressed mothers and 20 nondepressed mothers and their full-term newborns (mean age, 1.5 days old) were enrolled. All 42 neonates were presented with 8 alternating trials of a smooth bottle nipple kept in refrigerated water ("cold condition") and an identical nipple kept in room-temperature water ("warm condition"). The nipples were replaced throughout the study to maintain their temperature. To prevent the infants from sucking in air, the experimenters pushed their fingers through the nipples and presented the nipples on the fingers for the infants to suck. The testing occurred with the neonate in an awake and alert state while lying on his or her back in a nursery bassinet. The "blinded" experimenters first touched the newborns' mouths with the nipples and then inserted the nipples into the infants' mouths. The number of sucks, which served as the dependent measure, was recorded.

Interestingly, unlike in the "texture alone" study,[30] in this temperature study the infants of depressed mothers sucked more frequently (mean, 117 sucks) than the neonates of the nondepressed mothers (mean, 79 sucks). Also interesting was that the duration of sucking was affected by the temperature of the nipples on the first trial. When the cold nipples were presented first, infants sucked longer on all subsequent presentations, regardless of the mothers' depression scores. Why a cold stimulus led to greater sucking is unclear: Perhaps sucking a cold nipple was more stimulating or soothing, much like sucking a sweetened pacifier reduces crying in newborns undergoing painful procedures.[36] Nevertheless, this question warrants further investigation.

Although the duration of sucking increased for all presentations, if the first trial was done with a cold nipple, neither group showed a preference for sucking one nipple over the other. This outcome was puzzling and suggested one of two conclusions: Either the newborns did not discriminate the cold nipple from the warm nipple, or perhaps they did perceive the temperature difference, but simply did not prefer sucking one longer than the other. Also interesting was that mothers who suffered from more severe depressions, as indicated by higher depression scores on the Center for Epidemiological Studies of Depression (CES-D) scale,[37] had infants who sucked the nipples for longer durations (Figure 2). The possible reason: The neonates of depressed mothers were sucking for self-comforting purposes, and not for exploratory motives, in that both the cold and warm nipples were of a smooth texture. As is known from at least 3 studies of neonates, infants prefer to suck on smooth textures and nipple shapes.[18,24,30] At birth, infants of depressed mothers are reported to be more irritable[38,39] and have higher cortisol ("stress-hormone") levels than do infants of nondepressed mothers.[31,40] Thus, the "sucking-for-comforting" hypothesis seems plausible.

Figure 2. The sucking responses of neonates to cold- and warm-temperature nipples based on the severity of mothers' depression scores. (M.H-R., T.F., M.D. and S. Largie, unpublished data, 2003)

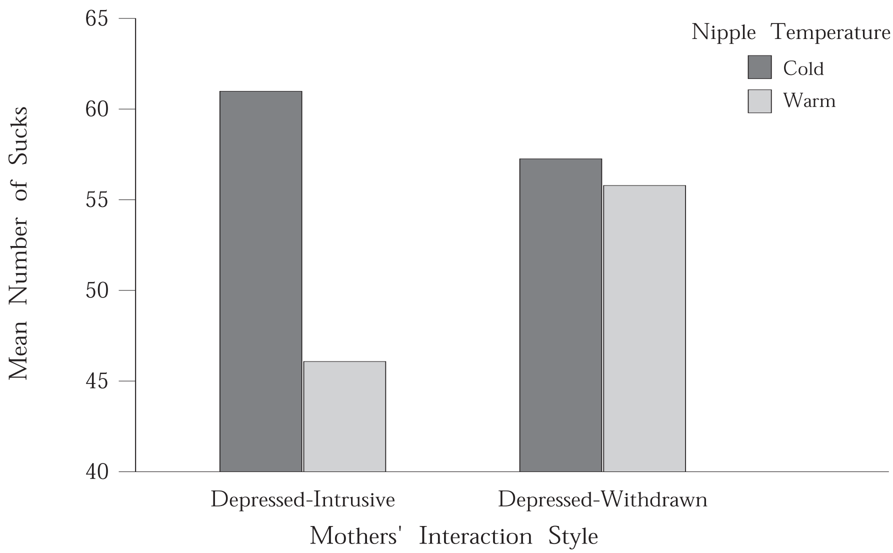


CES-D = Center for Epidemiological Studies of Depression scale.

The mothers in this study were also assessed on the Behavioral Inhibition Scale/ Behavioral Activation Scale (BIS/BAS).[41] Commonly, individuals who exhibit behavioral "inhibition" are characterized as anxiety-prone, and they often withdraw from novelty. Contrastingly, those who display behavioral “activation” are more impulsive and inclined to approach or engage in activities.[42,43] Differing biochemical profiles have also been reported for infants of intrusive mothers versus infants of withdrawn mothers, with the intrusive group showing higher dopamine and serotonin levels than the withdrawn group, and the withdrawn group showing higher cortisol levels than the intrusive group.[44] However, to date, no studies of perception have been conducted with neonates of inhibited or withdrawn mothers. We hypothesized that, if the mothers’ biochemistry influences neonatal behavior, different sucking responses would be evident for infants of intrusive mothers versus withdrawn mothers. (M.H-R., T.F., M.D. and S. Largie, unpublished data, 2003)

Of the 42 mothers enrolled in this study, 12 met BIS/BAS criteria for behavioral inhibition (withdrawn) and 12 met criteria for behavioral activation (intrusive). Ten of these 24 women were deemed nondepressed (6 intrusive; 4 withdrawn): Hence, this measure examined the influence of inhibited mothers’ versus withdrawn mothers’ effects on newborn sucking *only*. Analyses of the neonates of the “intrusive” mothers revealed that these infants sucked the cold nipple more than the warm

Figure 3. Frequency of sucking on cold and warm bottle nipples by neonates of depressed-intrusive mothers versus depressed-withdrawn mothers. (M.H-R., T.F., M.D. and S. Largie, unpublished data, 2003)



nipple (Figure 3), which suggested that this subgroup perceived the cold nipple as different from the warm nipple. One explanation for this interesting finding is that neonates of intrusive mothers may be more reactive to stimulation and/or are more stimulus-seeking because of their higher dopamine levels, although the infants' biochemistry profiles were not measured for this study.

If the infants of the intrusive mothers found the cold nipple more stimulating, this would support the "stimulus-seeking" hypothesis *and* explain the findings. However, because these are *post hoc* analyses based on small sample sizes, replication studies will be required before conclusions can be drawn about the interactions with objects by neonates of intrusive mothers. In any event, the fact that differences *were* found in sucking preferences between these 2 groups suggests the need for studying the perceptual abilities of neonates who might be predisposed to varying biochemical profiles or inherited maternal traits.

HAND STUDIES

Findings gleaned from studies of adults form the bases for studies of infants' hand explorations and perceptions. The literature on adults reveals that they use *explicit* finger and hand movements to detect specific aspects of objects.[20,45,46] For example, adults rub their fingers repeatedly on objects' surfaces when exploring their textures.[20,45,46] However, to detect hardness of a substance, they press or squeeze objects.[20,45,46] For the perception of temperature, adults simply make contact with the surface of the object, such as by placing a hand on the object's surface.[20,45,46] To detect general information about an object's shape or size, they enclose or mold their fingers around the object, but to detect precise shape, they trace the object's edges with their fingers.[20,45,46] They determine an object's weight by displacing or lifting the object with one of their hands.[20,45,46]

Based on these studies of adults,[20,45,46] as well as on our knowledge of infants' limited fine-motor movement control, Bushnell and Boudreau established a timetable for when infants might detect the properties of specific objects.[9] In particular, these investigators stated that infants under 4 months of age should perceive *temperature* and *size* information because the hand behaviors required to detect these stimuli (holding or grasping) are within young infants' behavioral repertoires. However, detection of an object's *texture*, *weight* and *hardness* (although hardness may be detected from grasping or squeezing) is not expected to occur until between the fourth and ninth months of life, as this is when infants are readily observed scratching, rubbing, squeezing and waving objects. Importantly, at approximately 9 or 10 months of age, infants master the process of "sitting," and thus are able to support themselves while holding objects,[47,48] which would allow them to hold an object with one hand while the fingers of the other hand trace the object's edges for perception of *exact shape*.[9] These studies suggest that infants may perceive some of the properties of objects using different finger and hand movements than those used by adults.

Perception of hardness: Studies of the handling abilities of very young infants provide both support and refute the timetable proposed by Bushnell and Boudreau.[9] In the study by Rochat, a soft or hard small tube connected to an air-pressure transducer was placed in the right hands of newborns and 2-month-old and 3-month-old infants, and the frequency of squeezing each tube (as measured by a pressure transducer) was recorded.[18] Regardless of age, the infants squeezed the hard tube more often than the soft tube. However, these infants showed different grasping patterns—squeezing and releasing the soft tube, in contrast to clutching the hard tube.

These findings suggest that the perception of hardness by hand may occur as early as during the newborn period, and that infants show "exploratory" behaviors similar to those shown by adults when detecting information about substance. However, the fact that infants modulated their hand activities depending on the object's hardness suggests that newborns possess control of their hand behaviors. Moreover, these findings contradict the view that neonatal grasping is a reflex response.

Perception of touch: Borrowing the experimental procedure proposed by Rochat,[18] Molina and Jouen compared the hand activities of newborns when handling smooth and rough textures.[22] As in the study by Rochat,[18] pressure transducers were inserted into rubber tubes.[22] One tube was covered with cloth ("smooth texture"), while the other tube was covered with small plastic pearls that had been sewn onto cloth ("rough texture"). The cloth- or the pearl-covered tubes were placed in the newborns' right hands (N = 22), and hand pressure was recorded. The findings of this study included the infants exhibiting more hand activity during the presentation of the "smooth" tube than during presentation of the "rough" tube, as well as that they applied continuous high-frequency pressure and discrete low-frequency pressure when holding the rough tube. As with the study by Rochat,[18] these findings suggest that neonates modulated their hand behaviors according to the property of the object.[22] These findings[22] also suggest that the perception of texture may be achieved earlier than the 4-month time frame noted by Bushnell and Boudreau,[9] and that the neonates might have detected the textures via squeezing the tubes, unlike the adults who used rubbing of their fingers across the object's surface. Perhaps in the absence of fingering activities, newborns grasp and squeeze objects to explore and perceive their properties.

Perception of shape: A study by Streri, Lhote and Dutilleul examined newborns' discrimination of 2 shapes (rectangular versus triangular) by hand.[23] The procedure consisted of presenting one of the 2 objects to one of the newborn's hands over consecutive trials until the infant's object-holding time declined. This procedure is known as "habituation." The 24 infants were habituated in equal numbers with the shapes. The duration of holding (in seconds) was recorded over the period of trials, and, as expected, the neonates either held the object progressively less over the trials or showed an habituation response. Habituation suggests that the infant becomes familiarized or perhaps "bored" with the same issue or object. Subsequent to this habituation, the neonates were presented with the alternate- (or novel-) shaped object for 2 test trials, and holding time again was measured. If infants noticed the novel shape, it was expected that they would hold the object longer, or "dishabituate." As expected, infants held the novel shape longer (compared with the last 2 trials during habituation), suggesting that their newborn hands, in fact, processed "shape" information.

If the findings by Streri, Lhote and Dutilleul[23] are conclusive, they refute the time line for the detection of shape by infants, as well as suggest that neonates use exploratory procedures that differ from those described for shape perception by adults. You will recall that adults trace the edges of objects with their fingers to perceive shape.[20,45,46] This behavior is not evident in infants until late in the first year of life.[9] Streri, Lhote and Dutilleul[23] also videotaped their neonates during the procedure: Coding of these videotapes revealed the newborn infants bringing the objects close to their faces or their other hand, squeezing the object and some evidence of slow finger-stroking. Perhaps one or all of these behaviors facilitated the perception of the objects' shapes by the neonates. Additional trials with neonates, which study their finger and hand activities with varying object shapes, are necessary to determine the underlying mechanisms involved in shape perception by newborns.

Perception of temperature: Yet another study examined the perception of temperature by neonates.[49] Because newborns grasp objects, and temperature detection requires at least minimal touching of the object, we hypothesized that neonates would be able to differentiate cold tubes from warm tubes placed in their hands. The tubes were small (4 cm in length x 1 cm in diameter), of the same weight (5 g), filled with cold water or warm water and changed frequently to maintain consistent temperatures throughout the testing. Forty newborns, who had a mean age of 27 hours, participated in this trial. Twenty of these neonates were born to depressed mothers, but all were born full-term and medically uncomplicated. Testing occurred in the neonate's hospital bassinet, which was inclined to a 45° angle. Infants were awake during testing and had shown grasping when the experimenter placed his or her finger in the neonate's hands. Following the tactile habituation procedure established by Streri, Lhote and Dutilleul,[23] these neonates were presented with one of the 2 "temperature tubes" to hold by hand. Half the newborns were assigned to hold the warm tube, while the other half held the cold tube, until the duration of holding declined with repeated trials. Subsequently, the neonates were given the alternate-temperature tube to hold for

Figure 4. A newborn of a non*-depressed mother showing hand activity with an object during the 1st minute of a temperature trial: 1) the neonate holds his hands at mid-chest prior to start of trial, 2) the vial is placed in the newborn's hand and he raises the right hand that contains the vial, 3) he lowers the right hand with the vial after a few seconds and 4) raises the right hand with the vial again.*
(Photos taken by Maria Hernandez-Reif, PhD).

1) No object in hand 2) Right hand with object raised 3) Right hand with object lowered 4) Right hand with object raised again

2 test trials: For example, after holding the warm tube over numerous trials and showing little interest in continuing to hold it, the infant was presented with the novel cold tube and the duration of holding it was recorded. During the procedure, the experimenters also coded the infants' hand activities as "active exploring" (hand opening, closing, squeezing, turning or lifting hand to mouth or face area) or "passive exploring" (exhibiting only one of the "active-exploring" hand behaviors, or if they displayed any of the behaviors ≤50% of the trials, or infants who showed no hand activities during the procedure).

As expected, the amount of time spent holding the same-temperature tube declined over repeated trials, but then, when presented with the alternate-temperature tube, both groups of neonates (of depressed mothers and of nondepressed mothers) held the novel-temperature tube longer, suggesting that these newborns detected the different temperatures presented. It is important to note, however, that the newborns of the depressed mothers differed in several important respects from the neonates of the nondepressed mothers: First, the infants of the depressed mothers took twice as long to habituate, which suggests that they were slower in processing the temperature information by hand. In the literature on visual habituation, a longer time to habituate has been associated with less optimal cognitive functioning.[50] Secondly, rather than showing a decline in the amount of time they held the same-temperature tube during the first few trials, the neonates of depressed mothers showed an increase in this amount of time. Again, in the visual habituation literature, this is referred to as "sensitization."[50] Sensitization has been linked to an inability to control arousal, and has been reported for infants who take longer to habituate.[51,52] Sensitization may occur because the infant finds the object stimulating or because the infant is already aroused or excited and becomes more excited when stimulated. Infants who exhibit this behavior may prove more reactive to stimulation, have poor self-regulatory capacities and/or have difficulty focusing or attending. Another observed difference was that the newborns of depressed mothers showed less-active touch, indicating that perhaps they were less interested in exploring objects with their hands. Less handling or manipulation of objects by infants "at risk" has been correlated with longer-term cognitive deficits.[35]

Perception of weight: Weight perception has also been assessed in newborns of depressed and nondepressed mothers.[21] Because neonates have been reported to lift their hand to their face and mouth[23] and because studies in the adult literature discuss hand lifting as the mechanism underlying weight perception,[20,45,46] we hypothesized that neonates would perceive an object's weight change. However, because infants of depressed mothers have proven less exploratory,[32,33] we also hypothesized that infants of only nondepressed mothers would perceive the weight change.

As in the study on "Perception of temperature,"[49] the handling of objects was assessed by presenting the same object over consecutive trials until the holding response by the neonate declined. Twenty-seven full-term neonates born to depressed mothers, and 23 full-term newborns of nondepressed mothers participated in this trial (mean age, 43 hours). The stimuli consisted of one tube stuffed with cotton and weighing 2 g (lightweight) and another tube stuffed with pellets and weighing 8 g (heavyweight). Over consecutive trials, half the infants were presented with the same lightweight tubes, while the other half were presented with the same heavyweight tubes. When the amount of time spent holding the tubes decreased, the groups of newborns were tested with the now-novel (opposite) weight tubes. The handling activities of the neonates were coded as described in the "Perception of temperature" study described earlier.[49]

Figure 5. A newborn of a depressed mother showing little hand activity with an object during the 1st minute of a temperature trial: 1) the neonate holds his hands at mid-chest prior to start of trial, 2) the vial is placed in the newborn's hand and he raises the right hand that contains the vial, 3) the vial remains in the inactive hand of the neonate for the entire trial until he becomes irritable, cries and later drops the vial (Photos taken by Maria Hernandez-Reif, PhD).

1) No object in hand

2) Right hand with object raised

3) Right hand remains raised but inactive

A surprising 85% of the neonates of depressed mothers were coded as showing *no* hand activity. Therefore, it was not surprising that, as a group, the newborns of the depressed mothers failed to notice the novel weights. Contrastingly, 78% of the neonates of the nondepressed mothers showed hand activity. The latter group exhibited weight discrimination, which was demonstrated by longer holding times on the novel weights.

Summary

Newborns clutch or grasp objects that are placed in their hands and they suck objects that offer no nutritional value. For decades, these neonatal behaviors have been defined as "reflexes," or as "involuntary responses" to stimulation.

The studies reviewed in this chapter, to the contrary, suggest that grasping and sucking objects appear to be "voluntary behaviors" of the newborn that serve as exploratory behaviors for detecting the properties of the objects. From studies of sucking and mouthing objects, newborns displayed perception of objects' hardness, texture and shape. Newborns also perceived temperature by mouth, but this was not evident for newborns of nondepressed mothers. Studies of grasping and handling revealed that newborns detected all properties of the objects presented to them, including temperature and weight perception by hand. The behaviors of these newborns that apparently were used to perceive the objects included squeezing, grasping or clutching, slow finger stroking, hand turning and hand lifting of objects to the mouth or face. Taken together, these findings suggest that neonates explore objects actively with their hands and mouth, often using behaviors similar to those applied by adults to detect or perceive specific properties of objects. Moreover, in the absence of sophisticated fingering abilities, squeezing alone may enable the detection of gross aspects of objects, such as shape information.

The less optimal mouthing and handling behaviors of the newborns of depressed mothers were also reviewed. Their perception might have been impaired by poor finger and hand movements or inactivity. Toys for the newborn should be developed to foster mouth, hand and finger activity, especially for infants "at risk" who may show delayed perception.

Further study is needed on the sense of touch and the perception of touch by neonates. Surprisingly, neonatal touch studies are rare, and touch perception by neonates is still viewed as almost nonexistent. Touch is the most well-developed sense organ at birth. Like the other modalities—smell, taste, vision and audition—touch and touch perception need additional research.

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CHAPTER 3: MATERNAL TOUCH EFFECTS ON INFANT BEHAVIOR

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Abstract

Although the positive effects of massage therapy on infant behavior and growth have been well documented, few studies have evaluated the reinforcing effects of different types of tactile stimulation on infant behavior or the distinctions between maternally delivered and infant-originated tactile stimulation. The study detailed in this chapter assessed 3 types of tactile stimulation delivered at 2 levels of tactile pressure. Results of this study revealed that the type of touch preferred most by infants was "intense stroking." Conversely, the type of touch preferred least by infants was "intense poking." The methods used in this study provide a reliable means of quantifying tactile pressure.

Introduction

Touch is an important element in the interactions between infants and their caregivers. The amount of maternal touch that occurs during brief interaction periods has been estimated to range from 33% to 61% of infant-caregiver interactions.[1,2] Additionally, the frequency of touch appears to vary with the child's developmental level: Day-care teachers have been noted to touch infants more than toddlers or preschoolers.[3]

TOUCH EFFECTS ON INFANTS

When the behavioral states of infants have been compared across several conditions: alone, mother's face only, mother's voice only, mother's touch only and a combination of mother's voice, touch and face,[2] infants exhibit the lowest frequency of fussing and crying during the "touch-only" condition. Furthermore, using touch during the maternal "still-face" procedure has been shown to reduce the frequency of fussing, crying and grimacing among 3-month-old to 5-month-old infants, as well as to maintain more smiling and gazing.[1] These effects have also been noted in 3-month-old infants of depressed mothers.[4]

MASSAGE THERAPY EFFECTS ON NEONATES AND YOUNG INFANTS

The positive effects of massage therapy (ie, rhythmic stroking) on infant behaviors and growth rates have been documented in many studies.[3-12] Massage has enhanced growth rates among preterm, cocaine-exposed, HIV-exposed and full-term neonates.[5,6] Massage therapy has also reduced the signs of stress in normal, preterm, cocaine-exposed and HIV-exposed neonates.[13] In addition, massaged preterm and cocaine-exposed neonates have received higher motor scores on the Brazelton Neonatal Assessment Scale when compared with control neonates who did not receive massage.[14,15] Massage has also been associated with improvements on "…emotionality, sociability, and soothability temperament dimensions…"[7] *and*, most especially, on sleep organization in full-term infants.[8] Furthermore, 3-month-old infants who were massaged by their fathers greeted them with more eye contact, smiling, vocalizing, reaching and orienting responses, and showed fewer avoidance behaviors, than did those infants who were not massaged by their fathers.[9,16]

Lastly, massage has been shown to affect infant learning: Infants who received massage prior to an audiovisual habituation task performed better than those infants who received either play or no stimulation before the audiovisual habituation task.[10]

TOUCH AS A REINFORCER FOR INFANT BEHAVIORS

The role of touch as a reinforcer for various infant behaviors has also been explored.[11,12,17] One of the methods used to assess reinforcers is to follow the behavior by an event and measure whether the behavior increases. If the behavior increases from the event that followed, the event is termed a "positive reinforcer." Contingent tactile stimulation—alone or along with visual and/or auditory stimulation—has been found to increase infant behaviors that produce it.[11,12] In fact, contingent touching of the infant's face, abdomen and/or limbs has been found to increase vocalizations, smiles, eye contact and approach behaviors in infants 1.5 months of age to 9 months of age.[11,12,17,18]

UNRESOLVED ISSUES IN THE LITERATURE REGARDING INFANT TACTILE STIMULATION

Although the literature on tactile stimulation has yielded valuable information about the effects of tactile stimuli for infant behavior and learning, unresolved issues remain. Firstly, only one study explored the differential reinforcing effect of different types of tactile stimuli.[12] Without measuring tactile pressure, these authors compared the effects of tickling and poking, versus stroking, that occurred following the eye-contact responses of 2- to 4.5-month-old infants. The investigators found that continuously contingent rhythmic stroking was a more-effective reinforcer for continuous infant eye contact than was continuously contingent arrhythmic poking plus tickling. However, there was no separation of the poking-plus-tickling stimulus: Thus, the reinforcing effects of the distinct stimulus components could not be assessed. Combining tickling with poking may mask the individual effects of each component: For example, if tickling was a highly effective reinforcer and poking was neither reinforcing nor aversive, combining them into a single contingent treatment might, at best, yield only a moderate reinforcing effect. Such moderate effects may not be representative of the true effects of either of the 2 component stimuli because different types of touch may have different effects.

Maternal stroking has been noted to occur very often during mother-infant interactions.[19] Maternal stroking seems to occur most frequently, followed by maternal tickling, while maternal poking is rare. Some have suggested that each of these forms of touch conveys a different message.[2] The more negative types of touch also occur more often during disturbed interaction: For example, compared with nondepressed mothers, depressed mothers show more frequent jabbing and poking of their infants.[20] In turn, such jabbing and poking seem to be associated with negative affect and gaze aversion exhibited by infants.[21]

Other relevant stimulus qualities, such as duration, pattern and pressure of touch need further investigation. Specifying the pressure of tactile stimuli is important because it may help determine the quality and/or quantity of behavioral effects. Without accurate measures of the attributes of tactile stimuli, such as pressure, it may prove difficult to predict the effects of these stimuli on infant behaviors. Specifying and quantifying the *qualities* of the touch stimulation would advance the sciences of touch measurably.

Exploring the Effects of Different Types and Intensities of Touch: Current Study

OVERVIEW

This study analyzed the effects of 3 different types of tactile stimulation at 2 levels of tactile pressure. Stimuli were considered reinforcers if the infant's target behavior, leg kicking, increased. Secondly, the relative efficacies of different tactile stimuli as positive reinforcers were evaluated.

SUMMARY OF METHODOLOGY

The experiment was conducted using 6 different orders of the stimulation on an A-B-A-C-A-D–phase design. During the first A phase, a baseline rate for the leg kicks per 30 seconds was assessed by instructing the mothers to behave as they would normally around the child; that is, by ignoring the leg kicks. Each of the B, C and D phases consisted of 2 or 3 alternating treatments at one of the 2 intensity levels: for instance, mild stroking versus mild poking versus mild tickling; intense stroking versus intense poking versus intense tickling. During the learning phases, every leg kick produced the touch stimulus. The second and third A phases were reversals of the phase that had preceded it immediately. During the reversal phases, nontarget behaviors received contingent stimulation. For example, nonkicking behaviors were followed by tactile stimulation. The *frequency of stimulation* was equated with that of the previous treatment phase by ensuring that the mothers provided the earlier contingent stimulus for their child's nontarget (ie, nonkicking) responses at least as often as they did for the earlier target (ie, kicking) response in the corresponding time period of the previous treatment phase: For example, if a mother delivered the touch contingent on the target behavior 20 times during the first 30 seconds of the treatment phase, she was required to deliver the same touch noncontingently at least 20 times during the first 30 seconds of the reversal phase.

The sample split equally along gender lines and included 10 Hispanic and 2 African American infants who were 2 months of age to 5 months of age (mean, 3.6 months). The experiment was conducted in the infants' homes. Each child sat on their infant seat 3 feet from a video camera, which recorded his or her behavior as well as the touch stimulation. Each mother sat next to her child (Figure 1) so that she could touch her infant according to the instructions given. The experimenter, who was located on the other side of the room, scored the child's behavior as shown on the computer-monitor screen. The leg-kick measurement device consisted of an infrared beam that was projected 5 inches above the child's calves. When the child kicked and either or both legs crossed the beam, a leg kick was registered. The

Figure 1. Representation of positioning of mother and child during experiment examining maternal touch intensity and infant response[21]

microphone of the meter that measured sound level was positioned directly on the infant's skin. The mother was instructed to administer the touch within a 2-inch radius of this very-sensitive microphone that detected the loudness (in decibels [dBs]) of the sounds that were made as the mother's skin and the infant's skin rubbed against each other during contact. More-intense touching produced higher dB readings than did less-intense touching on the sound-level meter. The mother could monitor the intensity of her touch via an analog display on the sound-level meter. She was instructed to keep her touch intensity between –10 and –5 dB for the mild-touch condition and between +5 and +10 dB for the intense-touch condition.

The target behavior was an infant leg kick, defined as the leg going from a bent-at-the-knee position to a straight position, or the reverse (straight to bent). The leg-kick response was chosen because it occurs reliably in 2-month-old to 5-month-old infants. Occurrences of the leg-kick response, and of the touch response and amplitude, were represented automatically by a highly visible blip on a computer monitor.

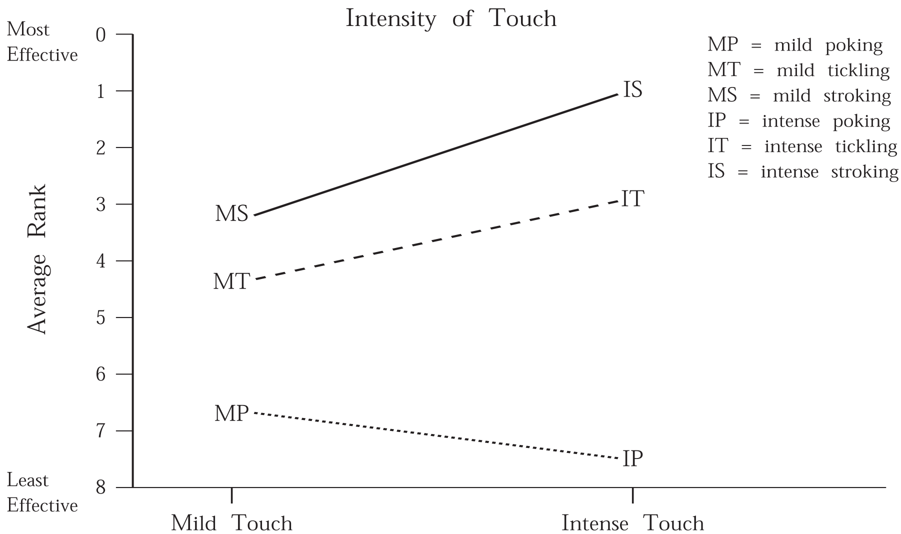
Stroking, tickling and poking were produced by the infants' leg kicks. Thus, initially, the touch was used as a reinforcer for the infant response and directly reflected infant preferences for the different types and intensities of touch. The duration of every touch, 3 seconds, was measured by a timer operating within the data-acquisition program. Stroking was defined as soft, rhythmic, continuous touching of the infants' limbs or abdomens using one hand. Tickling consisted of arrhythmic touching of the infants' limbs or abdomens using the fingertips of one hand. Poking was comprised of a one-finger continuous touch of the infants' limbs or abdomens. Additionally, there were 2 levels of pressure for the stroking, tickling and poking treatments.

SUMMARY OF FINDINGS

With the exceptions of mild poking and intense poking, which appeared only occasionally, the other forms of touch proved reinforcing. The most-preferred type of touch was intense stroking, while the least-preferred type of touch was intense poking.

Results of this study indicated that there were numerous differences among the treatments. Firstly, intense stroking proved to be a more-effective reinforcer than did intense poking, mild poking, mild stroking and mild tickling. Additionally, intense tickling proved more effective than intense poking and mild poking. Lastly, mild stroking proved more effective than intense poking and mild poking, while mild tickling proved more effective than intense poking and mild poking. These results are depicted in Figure 2.

Figure 2. Interactions between type of touch and touch intensity in experiment examining maternal touch intensity and infant response[21]



Conclusions

Results of the current experiment help expand our understanding of the effects of maternal touch on infant behavior. Firstly, this study quantified the *pressure* of maternal tactile stimulation. Finding a reliable way to quantify the pressure of touch represents a milestone in the field of touch research, as the intensity of touch can now be monitored with accuracy. Secondly, results of this study yielded valuable information about the effects of different types of touch. While tickling/tapping, stroking and occasionally poking can all be reinforcing to the infant, intense stroking was more effective than tickling/tapping or poking as a means of increasing the rate of infant leg kicks. Higher pressure stroking and tickling/tapping appeared to be associated with more frequent kicking, while higher pressure poking seemed to be associated with less frequent kicking. This information can help parents understand the types and pressures of touch that may be used most effectively during their interactions with their infants.

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CHAPTER 4: TOUCHING DURING MOTHER-INFANT INTERACTIONS

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Abstract

The primary objective of this chapter is to provide an overview of the research on touch as it occurs in social contexts (ie, during interactions) between adults and infants. In particular, this chapter focuses on face-to-face and still-face interactions, and stresses the touching of infants by their respective mothers. Studies are summarized that reflect on the contributions of parental touch and adult touch to early interactions and the developing relationship with the infant, as well as how touch is used in different ways depending on the interactive context or modalities of communication available to parents. These reviews focus on the first 3 months to 6 months of the healthy, typically developing infant's life. Special emphasis is given to this period because it is well-researched, and dyadic communications and face-to-face interactions are prominent at this time. Another objective of this chapter is to communicate the importance of parental touch in early social and emotional development, specifically with regard to its roles in communication and development. Further objectives are to highlight the advances that have been made in this area of investigation, noting some of the new and emerging directions being taken as a result of these investigations and to delineate some of their important contributions.

Parental touching and holding are important in early infant development.

Photo used by permission of SL Labs.

The Importance of Touch

Long-held evidence shows the importance of tactile stimulation for the normal development of nonhuman species. Examples include the survival functions of maternal washing of the young[1] and the specific beneficial effects of handling, licking and grooming on survival,[2,3] growth, development and resistance to disease,[4-7] as well as increased exploratory behavior.[8] The classic body of work done by Harlow on rhesus monkeys substantiated the importance of tactile stimulation by demonstrating that the development of social attachment was more dependent on physical contact than it was on reducing the feeding drive.[9] Additional data from primate and rodent models have implicated physical contact and touch (tactile stimulation) as significant concomitants of the infant's ability to regulate its own responses to stress.[10-12] More complete coverage of the animal research can be found in a chapter by this author[13] and in the texts written by Montagu[14] and Field.[15]

While the importance of touch for the normal development of *nonhuman* species is not in question, the importance of touch to *human* infants has also been recognized. Classic observations regarding maternal deprivation of human infants and the lack of tactile stimulation by human adults has underscored the value of tactile contact including reports of infants who were deprived of mothering for lengthy periods of time as well as institutionalized infants who were given only essential care with no extra attention from the staff.[16,17] This work, at least in part, led to more systematic work on maternal attachment, bonding and deprivation. Unfortunately, the literature on maternal deprivation is replete with methodological problems, permitting only cautious interpretations. Recent research, however, suggests that extreme forms of limited touch affect children's growth and development.[18,19]

Despite advances and the acknowledgment of the importance of tactile stimulation, the *specific* contribution of tactile stimulation to early development (ie, during the first year of life) remains relatively undefined. Evidence, however, suggests that touch regulates physiological and behavioral reactions during early infant development.[14,20] That is, touch can aid in controlling the infant's state of arousal (behavioral state; ie, maintaining alertness, reducing drowsiness, and more). Touch is also an effective stimulus for soothing human neonates.[21,22] For example, tactile contact and vestibular-proprioceptive stimulation are often paired to soothe the baby (eg, Byrnes and Horowitz, 1981; Korner and Thoman, 1972[22]).

The effects of touch/contact have also been seen in studies where touch has been used to induce or change behavioral state. In many studies, touch is used between intervals of a study to maintain alert state in babies, to calm them or as an attention-getting stimulus.[23,24] In the neonate, touch has been shown to reduce stimulation, thereby acting like a control system to maintain state.[25] According to Brazelton, touch can also stimulate the infant, thereby illustrating how touch can both instigate and maintain communication.[25] Nonverbal maternal behaviors also provide a means of modulating the overall level of stimulation to which the infant is exposed, potentially facilitating regulation of its own state and level of arousal.[26]

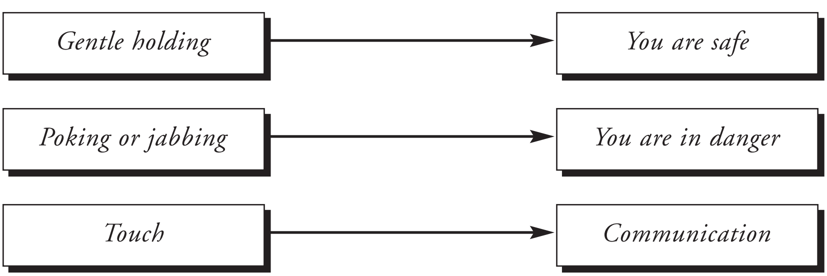
Based on reviews of the literature, more emphasis has been placed on the *physical* benefits of touch to high-risk infants and the development of the perception of touch, while less attention has been devoted to touch as it relates to infants' *social and emotional* development.[13] Moreover, there has been a general lack of research on the tactile modality versus auditory and visual modalities in perceptual research as well as facial and vocal channels in social-emotional research.

Touch, Emotion and Communication

If touch is so fundamental, its role(s) in social-emotional development should not be overlooked, and its ability to communicate deserves attention.[13] Emotions can be communicated through touch: That is, *touch conveys meaning* (eg, soothe, calm, active, happy). Although there are very few systematic studies that support such claims, touch appears to convey emotion very directly, and the type of touch conveys particular emotions. Emotions (ie, feeling states or messages) that might be communicated through touch include love and caring, sympathy, empathy, anger and a sense of security. According to Montagu, for example, through *feeling* we refer frequently to emotional states, such as happiness, joy, sadness, melancholy and depression, and by the term we often imply a reference to touching.[14] According to Virel (an anthropologist and neurologist), the skin may be seen as a mirror of the organism's functioning: "Its color, texture, moistness, dryness and every one of its other aspects, reflect our own state of being, psychological as well as physical. We blanch with fear and turn red with embarrassment. Our skin tingles with excitement and feels numb with shock; it is a mirror of our passions and emotions."[27]

Tronick has explored ideas (Figure 1) along the same lines, arguing that "…certain forms of touch, such as gentle holding, might convey the message, you are safe, whereas other forms of touch, such as poking or jabbing, may convey the message, you are physically threatened."[28] Touching seems to communicate; to bring out meaning: Montagu said, "Although touch is not itself an emotion, its sensory elements induce those neural, glandular, muscular, and mental changes which in combination we call an emotion."[14]

Figure 1. Different types of touch convey different meanings.



In a study designed to examine the effects of touch on infants' emotions, Hertenstein and Campos had mothers stimulate their 12-month-old infants tactilely in specific ways while objects were presented to them.[29] The study conditions included the following: a group of mothers who tensed their fingers around their infants' abdomens and inhaled (designed to elicit negative emotion); a group of mothers who relaxed their grips around their infants' abdomens and exhaled (designed to elicit positive emotion); and a control condition, where there was no tactile stimulation. Infants in the former condition touched the objects presented to them less frequently and exhibited more negative emotional displays. Contrary to the expectations of Hertenstein and Campos, there was no effect on positive emotion in the condition where the grip was relaxed.

Touch is also involved in mother-infant attachment and the affectional systems.[30-32] The amount and quality of physical contact (ie, touching, proximity) between the mother and her infant are essential to their relationship.[14,33] Contact behaviors are integral features of emotional communication between mothers and infants, and higher levels of touch are related to secure positive attachment.[30,31] Key components of current theories of attachment include physical proximity and proximity-seeking measures. In her examination of the relationship between kissing, hugging, patting and attachment behavior in infancy, Landau argued that there is an intricate relationship between infant affectionate behavior and attachment.[32] More studies are needed, however, to relate specific types of touch to attachment constructs, such as proximity.

Maternal sensitivity, long considered a key contributor to synchronous and mutually reciprocal interactions, has recently been related to optimal patterns of attachment.[34] The key characteristics of maternal sensitivity and responsiveness often involve physical closeness and physical touching behaviors. In addition, the frequency and duration of touch are also considered by some researchers to be an index of mothers' attachment.[35-37] One of the routes used to examine the more direct role(s) of touch in communication and social-emotional development is to study the interactions between mothers and their infants systematically and to examine touching during these interactions specifically.

Mother-Infant Touching During Social Interactions: General Findings

Examples abound of how touch is related to tender, loving care—from the beginnings of life at the breast; to being held and cuddled, rocked to sleep, stroked and swayed to reduce distress; to being tickled and played with, inciting giggling and laughter; and to being hugged for affection and comfort. Even during the newborn period, the importance of physical contact between parents and their neonates has been demonstrated. For example, research studies have examined specific patterns of touching when first handling newborns,[38-43] the shorter- and longer-term effects of early and extramaternal contacts,[39,40,44] types of early maternal tactile contact[45,46] and the effects of infant massage.[47-49] On the bases of these studies and others, it seems clear that touching as a sensory system and as a means of communication is important to that first relationship—between parent and infant—as well as individually important to the infant.

A typical face-to-face interaction between a mother and her infant.

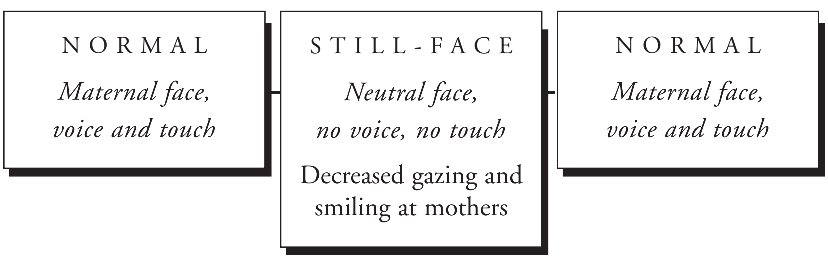
Photo by author.

As infants develop over the first few months of their lives, social interactions become increasingly more frequent and represent a means of communicating and learning. Face-to-face interactions are a frequent way that mothers and infants interact. Commonly, researchers have focused on the mothers' faces and voices as means of communication during these interactions.[52,61] However, while mothers' facial and vocal expressions are important, they are only 2 of the many behaviors that are used to express and communicate. Researchers have only recently begun to explore the role of touch in early interactions.[57,65-67,78] In the past, the focus was on the more distal gaze and affect behaviors—to the relative exclusion of touch and gesture.[13] Yet, touch is employed by mothers quite commonly, along with their vocal and visual expressions, during face-to-face interactions and during play: For example, during face-to-face interactions, the infant and adult (primarily the mother) are seated at eye-level to each other during a series of brief interaction periods. The caregivers interact spontaneously, using their facial, vocal and tactile expressions, while the infants respond to, and even initiate, interactions. Face-to-face interactions have been one of the primary means used to study infants' social communications,[50] emotional expressions and responses to stressful episodes,[51] and the development of social expectations.[52] However, typically, researchers have analyzed maternal and infant facial and vocal behavior[50,61] but not touch, although incidental reports reveal that maternal touch occurs during 33% to 61% of brief interaction periods.[50,53,54] Other measures, such as posture,[55] manual hand actions[56] and gesture,[57] have also been documented. Contextual features, such as location during play, position, inclination of position and proximity of contact, are other examples of important factors influencing infants during face-to-face play.[58,59]

Mother-Infant Touching During Social Interactions: Still-face Studies

The still-face (SF) procedure,[60] a modification of the face-to-face procedure, has been a valuable tool when examining the role of touching (Figure 2). The mother-infant interaction is divided into 3 brief periods of 90 seconds to 120 seconds each. In period 1, mothers interact normally, using facial expression (face), voice and

Figure 2. Still-face (SF) procedure.



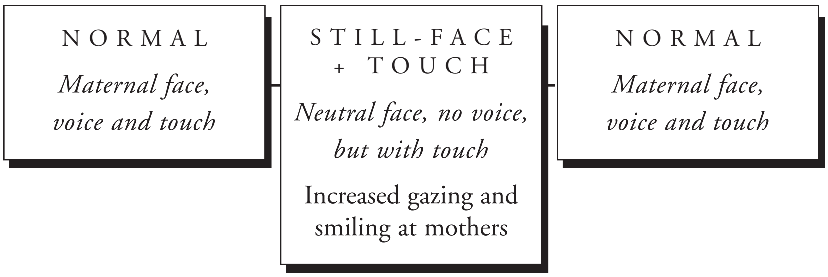
touch ("normal"). In period 2, mothers assume a "neutral," nonresponsive SF and provide neither vocal nor tactile stimulation. While in period 3, they resume "normal" interaction. During the SF, compared with the "normal" periods, infants typically decrease gazing and smiling at mothers,[61-63] increase neutral to negative affect and increase vocalizing.[64,65]

Gusella, Muir and Tronick compared the responses during SF periods between groups of infants wherein some received maternal touch in the preceding "normal" period, while others received only maternal face and voice.[61] These investigators found that 3-month-old infants smiled and gazed less at their mothers during the SF period than during the "normal" periods (compared with a "no-change" control group who received 3 "normal" periods), but that their behavior was significantly different from the control group only when maternal touch was permitted during the "normal" period preceding the SF. That is, these 3-month-old infants exhibited the SF effect only when maternal touching was part of the prior "normal" periods and their attention declined over time without the tactile stimulation. This suggests, according to Gusella, Muir and Tronick,[61] that maternal touch during the "normal" periods facilitated the maintenance of attention in these very young infants.

Indirect evidence that supports the importance of touch in early interactions is derived from a study undertaken by Field et al.[51] These investigators compared the responses of 4-month-old infants to an SF episode versus those to a separation sequence. Results showed that these infants found the SF sequence more stressful: For example, these infants demonstrated more motor activity, gaze aversion and distress brow and crying, and less smiling. More maternal tactile-kinesthetic behavior was shown following the SF period: That is, maternal proximal and comforting behaviors were potentiated. These findings support the view that infants are sensitive to maternal cues and suggest both the soothing role and the communicative nature of touching.

Studies examining infants' responsiveness to their mothers' touch and their sensitivity to touch when other forms of stimulation are absent provide important insight into why mothers use touch during the first 6 months of life. My colleagues and I have conducted several studies that have helped elucidate these important issues. By comparing a standard SF with one where mothers could touch during the SF period (Figure 3), Muir and I showed that by adding touch, infants did not become distressed, they showed increased smiling and they maintained the high levels of gaze that are typical in "normal" interactions.[65] This new role for touch in moderating the SF effect has been replicated several times.[33,66,67] Moreover, Muir and I demonstrated that it was the tactile stimulation, not the visual stimulation, from the adults' hands that was responsible for the effects.[33]

Figure 3. Modified still-face (SF)-with-touch procedure.[65]



Beyond the general issues of infants' responsiveness and sensitivity, Muir and I went on to address 2 additional questions: Are infants sensitive to *subtle* manipulations of maternal touch? And, are mothers able to use touch to obtain specific responses from their infants? Infants' sensitivity to changes in their mothers' touch has been demonstrated through the SF procedure by providing a group of mothers with differing verbal instructions.[33,65,67] This is what might be referred to as "changes in context": For example, it has been shown that mothers can use touch to elicit specific behaviors from their infants—such as maximizing their infants' smiling[67] and shifting their infants' attention to their mothers' hands.[33] The resulting changes in infants' behaviors, as a function of the changes in the mothers' verbal instructions, implies that there were changes in maternal touch.

As an illustration, in a study by LePage and my lab, experimental infants who received only touch from their still-faced mothers smiled as much as did control infants who received "normal" periods of face-to-face interaction during the period when mothers were asked to obtain the most smiling from their infants.[67] Moreover, mothers who were asked to touch their infants on only one area of their bodies tended to use one type of touch most frequently, and there was a significant association between the area of the body touched and the type of touch the mothers used. Lastly, using sequential analyses to examine how touch contributes to the reciprocal and contingent aspects of communicative exchange, LePage and I were able to show that cyclical patterns of mother-and-infant behaviors were demonstrated "around" maternal touching.[67] Before their mothers touched them, infants were likely to be gazing at either their mothers' hands or their mothers' faces. After their mothers touched them, however, the infants were more likely to gaze at their mothers' hands. Smiling was frequent and was always accompanied by gazing at mothers' faces or hands, rather than occurring simply in isolation. These findings suggest that infants may have been directed to the active component of the hands and that they were enjoying the tactile stimulation that they were receiving, which was reflected in their smiling both before and after being touched.

Using an SF-with-touch procedure and making comparisons to a no-change control group, Arnold and I examined whether touch and gesture alone are used to obtain specific infant responses.[57] Following a period of "normal" interaction, the mothers in the experimental group received the following additional instructions: try to get your infants to imitate you; engage your infants in a playful interaction; use touch *only* to attract and maintain your infant's attention on your face with as much eye-to-eye contact as possible. We found that the infants were sensitive to changes in maternal touch and hand gestures, and that, when instructed, the mothers appeared successful in eliciting specific behaviors from their infants using only nonverbal channels of communication: For example, maternal touch and hand gestures attracted the infants' attention to their mothers' faces even when the mothers' faces were still and expressionless during the period when the mothers were instructed to attract their infants' attention to their faces. During the period when the mothers were instructed to engage their infants in a playful interaction, the infants in the experimental group smiled more frequently in comparison with the infants in the control group. Moreover, within the experimental group and across the periods, the infants also smiled more during this playful interaction period compared with the period when the mothers were asked to get their babies to imitate them.

It is important to note that for the previous 2 studies mentioned,[57,67] the changes in maternal touch were *inferred* on the bases of changes in the infants' behaviors. The *actual* patterns and types of touching were not measured directly. Therefore, Arnold[73] and I[13,72] have now examined some of the specific changes in touching using the Caregiver-Infant Touch Scale.[113,68] Some of these findings are described in a following section that deals with patterns of touching during social interactions.

In a different but original direction, LePage used a modification of the SF-with-touch procedure to investigate infants' abilities to perceive a tactile contingency (or the lack of a contingency) during social interactions.[69,70] Infants in the "contingent" condition were reinforced with standardized tactile stimulation (SF interaction, with touch as the reinforcer) for gazing at the experimenter's neutral face. Infants in the "noncontingent" condition received the same tactile stimulation as their matched counterparts regardless of their behaviors. All infants in the contingent condition learned the contingency: For example, their level of gazing at the experimenter's neutral face was higher, and gazing away was lower, relative to infants in the noncontingent condition. LePage demonstrated that 4- and 7-month-old infants could perceive and learn a contingent relationship presented through the tactile modality during social adult-infant interactions, underscoring the idea that infants of this age are both sensitive to, and reinforced by, touch.[69]

Mother-Infant Touching During Social Interactions: Influences of Modality

While facial, vocal and tactile components are used frequently during social interactions, less is known about how they are used in combination, how they are used to achieve goals, and, if they do convey messages, how this is accomplished. Moreover, examination is warranted regarding how touching is integrated with the other communication channels that are available to parents.[13,71,72] Although it is important to understand each component's discrete and independent roles, the context when much of early development occurs is social, and information is typically specified multimodally for the developing infant: That is, touch is often combined with other modalities of interaction. Consequently, how the modalities are used in combination becomes an important issue: That is, do combinations of modalities communicate more clearly? Are messages embedded in touch? After examining infants' sensitivity to subtle changes in maternal tactile behavior we investigated the influence of "modality." We studied this by comparing mother-infant interactions in touch-only periods (ie, SF periods where touching only was permitted) to conditions where mothers could use all modalities including touch.[57,71-73] We used changes in infants' gaze and affect to imply responsiveness to changes in their mothers' behavior.

Our general research objectives were threefold.[71] If infants are sensitive to maternal touching, we needed to answer the following questions:

- How do infants' reactions differ when all modalities are used?
- Is touch used differently during unimodal versus during multimodal interactions?
- Can the same behavioral goals be achieved?

Using the same interaction periods as used by Arnold and my lab,[57] results indicated that when mothers were restricted to using only touch, they employed *more* touch to compensate for the absence of other modalities of interaction. Contrastingly, when all modes of interaction were available, mothers employed varied communication strategies. Importantly, while these infants smiled and gazed at their mothers' faces more often during interactions involving *all* modalities, mothers were nonetheless successful in directing infant attention and eliciting smiling using only touch and gesture.

Using a different set of instructions, Arnold compared both experimental and control groups in touch-only circumstances versus conditions where mothers were permitted to use all of the modalities of communication available to them.[73] Arnold discovered that while there was more touching done by mothers in the "tactile" group, mothers in the "all-modes" group nevertheless employed touch frequently (greater than 68% of the time). Mothers in the tactile group gestured more frequently during the period when they were instructed to get their infants excited and happy. Notably, the absence of group differences in gesture during the period when mothers were instructed to attract their infants' attention to their faces suggests that, despite availability of face and voice, mothers in the all-modes group employed gestures as an attention-getting strategy. Infants in the all-modes group also gazed more at their mothers' faces during all periods, except during the "normal" period. There were no differences in gazing away: That is, infants in the tactile conditions did not visually disengage more frequently.

Taken together with the studies that examined infants' sensitivity to changes in maternal touch, these 2 studies,[71,73] examining the influence of modality, illustrate that dramatic changes in infants' responses to subtle perturbations can occur within a restricted communicative context, underscoring the importance of nonverbal behaviors (ie, touch and gestures). Maternal behavior, therefore, changes as a function of instructional context. Moreover, 5-month-old infants are sensitive to subtle changes in maternal touch and hand gestures.

Table 1: Brief summary of some of Stack and colleagues' past findings I

1. Mothers frequently touch their infants during face-to-face interactions
2. Positive affective responses to their mothers during face-to-face, touch-only interactions
3. Touch moderates still-face effect: Maintains and directs infant attention (gaze) and elicits positive affect (smiling), influences negative affect
4. Across age
5. Across experimenter and mother
6. Touch (not visual) stimulation of hands that is responsible for the effects
7. Active (not static) touch that is responsible for the effects
8. Infants are responsive to touch and are sensitive to subtle changes in maternal tactile behavior
9. Modality: In general, infants smile and gaze at their mothers' faces during interactions involving all modalities, mothers are nonetheless successful in directing infant gaze / attention and eliciting smiling using only touch and gesture
10. Maternal behavior changes as a function of instructional context

These findings underscore the value of studying touch and how it can illuminate our understanding of communication

Mother-Infant Touching During Social Interactions: Beyond the Still-Face

Several studies have addressed touch—directly or indirectly—through procedures that either do not use the SF or that attempt to bring together multiple behaviors in some unified way: For example, in one of the few attempts to separate the social components of maternal behavior systematically, Roedell and Slaby explored the preferences of 24-week-old infants for 3 adults who interacted in different ways.[74]

One adult (distal) smiled, talked, sang and made facial expressions. Another adult (proximal) carried, rocked, bounced, patted and stroked the infant, but remained silent with a neutral face. A third adult (neutral) was silent, unresponsive and made no eye contact. Over a 3-week period, infants increased their time spent near the distal adult, while the infants made no changes in their relationship to the proximal and neutral adults. Moreover, infants chose to look more at the distal adult than at the proximal adult. Unfortunately, in this trial there were no measures of affect, the adult was not permitted to maintain eye contact in the proximal condition and the infant did not need to establish eye contact with the proximal adult in order to receive stimulation. This lack of "natural social interaction" may have contributed to the poor responses elicited by the proximal adult, and may have driven the infants to look away.[65]

During a free-play interaction with toys, Leiba examined interactions longitudinally between mothers and their 5-month-old and 12-month-old infants.[75,76] One component of the coding scheme employed by Leiba was displays of passive affection (ie, touching and maintaining close physical proximity) and active affection (ie, hugs, kisses, rubs). She found that while mothers engaged in longer bouts of active affection with their children at 5 months of age, compared with their children at 12 months of age, the frequency of both passive and active affectionate displays increased at 12 months of age (from that at 5 months of age). No age differences were found in the amount of time spent in close physical proximity, implying that close physical contact was important regardless of age.

A typical layout for a floor-play session with an arrangement of standardized toys.

Photo by author.

Rhythmic touch is also preferred over nonrhythmic touch in dyads,[77] and infants are more responsive when touch is added to face and voice.[78] To reinforce the position that touch can elicit specific responses, Wolff studied the development of smiling and found that, between the fourth and sixth weeks of life, "patty-cake" becomes an efficient stimulus for smiling.[79] To ensure that it was the proprioceptive-tactile stimuli rather than extraneous stimulation that elicited the smile, Wolff played the game in such a way that the infant could not see or hear the elicitor during the test.[79] The smiles evoked in this manner were described as broad, the intensity of smiling was high and it was difficult to habituate the response with repeated stimulation. Patty-cake, of course, is not the only game that elicits such positive responses from infants: There are other parent-infant games that also involve much touching and physical contact—lap games, tickle games, "I'm-gonna-get-you" games, finger-walking games and even bouncing games and "horsey" games.

As yet another example, the contention made previously by Gusella, Muir and Tronick that touch may have served to maintain attention during an SF procedure[61] is consistent with observations made by Roggman and Woodson.[80] They compared a pair of 3-minute play sessions during which mothers refrained from touching their 3-month-old to 4-month-old infants during one session but not during the other. These investigators reported that maternal touch facilitated attention during face-to-face interactions. However, it is important to note that in the studies by Roggman and Woodson[80] and by Gusella, Muir and Tronick,[61] touch was confounded by concurrent stimulation from both visual and auditory modalities.

In a study that examined distinct types of infant smiles and their relationship to the social context in which they typically occur, Dickson, Walker and Fogel[81] coded for basic, play and Duchenne smiles during parent-infant interactions. These investigators found that it was the physical play that included tactile stimulation that elicited the most "play smiles" (45% of the time), and that these play smiles occurred less often during object play, vocal play and book reading.

Lastly, in their examination of infant-affective and behavioral states across a series of conditions—"normal play," "baby can only see mother," "baby can only hear mother," "baby can only feel mother's touch" and "baby is alone"—Tronick found that the lowest levels of infant fussing and crying were displayed in the "touch-only" condition.[28] Interestingly, Tronick also showed a low level of scanning, high levels of object attention and less smiling by the infants than during the "normal" and "face-only" conditions. Consistent with the findings reported by my colleagues and my lab,[33,57,65,67] touching had calming effects on the infants, as reflected in their decreased fretting, and seemed to permit an openness to the stimulation, as reflected in the high levels of attention and continued smiling. On the bases of these findings and others, Tronick suggested that touch is a component of the mutual regulatory process of the caregiver-infant dyad, and he contends that touch may serve a regulatory function.[28,82]

The importance of multiple measures and the examination of patterns of responses from mothers and infants have been emphasized in recent research. Previously, emphasis was placed on facial expressions, with the result that attention to touch, gestures, postural changes, vocalizations and the relations between measures has been inadequate.[82] According to functionalist theories of emotion, it is insufficient to rely solely on facial expressions as indications of affect and arousal. Emotional signals are context-specific and are shaped by the immediate goals of organism-environment relationships.[83,84] The implications of these findings are threefold:

- must include multiple measures
- must focus on the importance of context
- must include approaches that address discrete measures, relations between measures and the interaction itself (eg, patterns, sequencing)

According to Toda and Fogel,"emotional" responses in young infants cannot be judged entirely from the status of the face: Rather, these responses must involve the whole body and the patterns of temporally organized actions in context.[55,56] Weinberg and Tronick provide some support for these contentions.[85] In their study, which examined mothers and their 6-month-old infants, these investigators examined multiple modalities, including the infants' gazes, vocalizations, gestures, facial expressions and self-regulatory and withdrawal behaviors. They found evidence of behavioral clusters or "affective configurations" that they argued conveyed information about the infants' states and intentions. Increased emphasis on coding and integrating touch and gesture are warranted to better understand their roles in communication.

Mother-Infant Touching During Social Interactions: Patterns of Touching

Although the importance of the studies discussed previously is not in question, these past findings are limited in at least 2 ways. Firstly, the functions and adaptability of touch have largely been *inferred* based on evidence taken from infant responses to their caregivers, rather than from *direct* measures of caregiver touch. Secondly, even in those studies in which touch was assessed directly, the measures of results have largely been the *duration* of all touching[61] or they have been the levels of *intensity*.[65]

Despite the fact that the overall levels of touching are, in fact, important, they do not inform us about the *qualitative* aspects of touching or how particular types of touch may be used more or less often under specific circumstances. It makes a difference, for example, whether one strokes, caresses, pats or pokes. Moreover, all touch may not be used or interpreted similarly: Different types of touch and the way the touch is applied may have different meanings. The way in which touch is used, and how one is touched, reflects in some way how touch is communicated or transmitted. Both the quality and quantity of tactile stimulation, as well as the parameters, become important.[68,86-88]

To illustrate these issues, my colleagues and I developed the Caregiver-Infant Touch Scale (CITS) to measure the different types of touch and the associated quantitative characteristics (eg, intensity and speed) in social contexts, such as mother-infant play, and to examine changes across age.[68] The CITS is designed to code touch, second by second, from videotapes of play and interactions. After assessing its psychometric properties, we applied the CITS in an experimental paradigm (SF-with-touch procedure) that was known to produce reliable shifts in infants' social responses.[68] This application was designed to test not only the scale's sensitivity in describing differential maternal tactile stimulation, but also to determine whether mothers used different types of touch as a function of different perturbation periods. Following a period of natural face-to-face interactions, mothers and their 5-month-old infants participated in 3 SF-with-touch periods. The SF-with-touch perturbation periods included the following: normal touch, touch to maximize infant smiling and touch restricted to one area of the body. A baseline comparison group received 4 periods of natural face-to-face interaction.

Analyses revealed several important findings. Firstly, the natural and *all* SF (touch-alone) periods were significantly different, and there were clear differences among all SF periods. Specific patterns or profiles of touching were shown across perturbation periods: For example, when asked to maximize infant smiling, mothers used more-active types of touch (eg, lifting and tickling), more surface area and greater intensity and speed. During the SF period when mothers were asked to touch their babies in only one area, there was increased stroking and far less shaking. Touching was also less intense, and most types of touch were judged to be executed more slowly during this period. Thus, the more tactilely active profile was revealed during the period when smiling was maximized. This finding supports the notion of heightened activity during playful interactions. From these results it is clear that mothers' profiles of touching change during brief interactions, as a function of experimenter instruction, suggesting that what was being communicated through touch was different.

In her comparison of tactile and all-modes experimental and control groups in the 4 instructional contexts described previously, Arnold also examined these periods for type of touch.[73] Among her findings was that, within the tactile groups, mothers of 3-month-old infants touched their babies more often than did mothers of 5-month-old infants. Interestingly, there were also differences in the type of touch used, as a function of instructional period: For example, relative to the controls, more stroking was used in the excited and happy periods, and more tickling and shaking were used in the attention-to-face period. Notable effects were also found for the area of the body on which the touch occurred. Lastly, effects were also demonstrated in comparisons across modalities.

Table 2: Brief summary of some of Stack and colleagues' past findings II

11. Mothers change their touching during different conditions
12. Different types of touch are used in different contexts and for different purposes
13. Different types of touch are used across infants' age
14. There is a relationship between the type of maternal touch and the area of the infants' bodies being touched

These findings underscore the value of studying touch and how it can illuminate our understanding of communication

Consistent with the theme that mothers use qualitatively different types of touch during interactions with their babies, Tronick reported that mothers use affectively positive types of touch with their 6-month-old infants.[28] In this study, mothers used stroking, rhythmic touching and holding with their 6-month-old babies for the largest proportion of time, followed by tickling and kissing. "Negative" forms of touch, such as pinching and poking, were rarely observed.

Together, these findings suggest that simple touch "duration" is not a sufficient index with which to characterize adult behavior. Qualitative and quantitative variations in touching occur for a variety of reasons and are important to measure and describe. What is also clear is that mothers use different patterns of touching for different functions.[68]

Mother-Infant Touching in At-Risk Populations

There is abundant evidence regarding the effects of touch in preterm infants: This is addressed in another chapter in this book. Evidence from those few studies that have examined touch in early development directly supports the claim that touch is important to the quality of the parent-child relationship and to the overall development of the infant. This conclusion is also revealed in studies that involve at-risk infants: For example, Polan and Ward found support that physical affection and physical interaction were reduced in mothers of failure-to-thrive infants.[89] Similarly, positive touch stimulation has enhanced positive affect and attention in infants of depressed mothers.[66] Paradoxically, in their study of parenting stress, depression and anxiety and its relationship to behaviors exhibited during interactions between mothers and their infants, Fergus, Schmidt and Pickens found that mothers who reported more symptoms of depression touched their infants more frequently relative to nondepressed mothers.[90] However, they also found that the pattern of interaction shown by these depressed mothers was more intrusive and overstimulatory in nature. Moreover, these investigators reported that more poking and tickling were used, and these symptomatic mothers, who were diagnosed with mild-to-moderate levels of depressive symptoms, attempted more attention-getting strategies, such as finger snapping. Similarly, Cohn and Tronick described depressed mothers as using more poking and jabbing with their infants, touching behaviors that were associated with negative affect and gaze aversion on the part of the infants.[91] Combined, these studies point to the importance of the types of touch that are used by mothers with their infants, and subsequently converge to suggest that touch might be an important parenting measure.

Using a sample of young mothers during a 3-minute interaction with their infants, Malphurs and colleagues demonstrated that mothers who had depressive symptoms were more likely to use negative types of touch, such as rough tickling, poking, tugging and pulling, and were more likely to be classified as "intrusive" as compared with "withdrawn" or "good," their other 2 possible classifications.[92] In a related study, Lundy and colleagues reported no differences in the types of maternal touching between depressed and nondepressed mothers and their newborns during a postfeeding period within the second 12 hours following delivery.[93]

Sensory-impaired infants reveal yet another way with which touch can be used as an important communicative channel. In these cases, whether the infant is visually or hearing impaired, the tacto-gestural modality might be seen as assuming some of the roles that vision or audition might have otherwise subsumed. Of course, both the visual and tactile channels are of significance to the deaf infant.[94] Yet, according to Meadow-Orlans and Steinberg, when compared with mothers of 18-month-old hearing infants, mothers of same-age deaf infants used less-frequent and positive touch, and they were less sensitive and more intrusive.[95] Nonetheless, as Koester, Papouek and Brooks discovered, when deaf mothers use these more-intrusive touch behaviors with their infants a style of communication is formed to which infants respond.[98] MacTurk and coinvestigators also found that maternal visual-tactile responsiveness was lower in mothers of deaf infants at 9 months: However, this level of visual-tactile responsiveness contributed to positive interactions at 18 months.[97]

As part of the Concordia Longitudinal Risk Project,[98,99] Bentley[100] examined the relationship between maternal risk status and mother-child touch behavior in an intergenerational sample of mothers who had a history of childhood aggression and social withdrawal. Although the mothers' childhood levels of aggression and/or social withdrawal did not predict total positive touch behavior significantly, and little negative touch was observed, the findings revealed that the age of the child was associated with the frequency that the mothers touched: That is, mothers of younger children engaged in more touching behaviors than did mothers of older children, underscoring the important role of touch in early development.

In an empirical study published in 2000, Weiss and colleagues examined maternal touch in a sample of low-birth-weight infants during a feeding situation at 3 months of age and its subsequent relationship to attachment status at 12 months of age.[101] While no relationship was found between the frequency and overall duration of touch used at 3 months with infants' attachment classifications at 1 year, the investigators did demonstrate that healthy 3-month-old infants who received more nurturing touch were more likely to be classified as "secure" at 1 year: Heavier weight and minimal perinatal risk contributed to the effects. In another study by Weiss and colleagues, the investigators attempted to establish links between the early tactile experiences of low-birth-weight children and subsequent later mental health and social adaptation, highlighting the contribution of touch to psychosocial development.[102]

Father-Infant Touching During Interactions

Although the majority of "touch" studies involving infants conducted to date have involved mothers or female adults, there is an accumulating literature involving fathers. It is known that fathers engage in more vigorous, physically stimulating play with their infants,[103-106] and it is believed by some that their style of play serves to create a critical means for the development of attachment.[107] According to some research, fathers' actual touching of their infants is rare immediately after birth, while physical closeness and gazing at the infant are more typical.[108] This observation of less-frequent touching by fathers, as compared with mothers, has also been noted in the neonatal intensive care unit.[45]

There have been only a scant few studies of fathers' systematic touching of their infants in different cultures: As an example, Hewlett observed the Aka pygmies of the tropical forest region of the southern portion of the Central African Republic.[104] While Aka fathers held their infants substantially less often than did their mothers, several "positive" patterns did emerge. The fathers who held their infants often did so in a context-specific situation (eg, during leisure time). Interestingly, however, it was the Aka fathers who were more likely to engage in minor physical play, such as tickling and bouncing, with their infants. Aka fathers did not engage in the vigorous types of play characteristic of American fathers.

In their observations of Italian fathers, New and Benigni described fathers' interactions with their infants as more distal, rather than proximal, and involving more looking and talking.[109] The touches of Italian fathers were described as "awkward" and "brief," while their holding was often limited to times when the mothers were preparing the feedings. Their physical contacts typically included tickling and poking.

The characteristics of holding and play in different cultures can also be a revealing means of examining some aspects of physical touch and affection during parent-infant interchanges. In a study describing Indian (New Delhi) mothers' and fathers' holding patterns, Roopnarine and colleagues found that mothers held their babies more than did their fathers, and they were more likely to pick them up, feed them and comfort them while holding and display affection while holding.[110] However, the overall duration of holding was reported as less than what is typically reported for the North American family. This could be explained by the fact that, on a daily basis, many other family members and friends hold the typical Indian baby. When fathers were holding their infants, affection was commonly displayed. Tickling and lap bouncing were found to be rare occurrences between Indian parents and their infants. However, playing "peekaboo" was seen more commonly among the mothers and their infants. Lastly, these infants themselves were more likely to vocalize to, smile at and follow their mothers, compared with their fathers, but there were no differences in the amounts of touch or approach behaviors between the mothers and the fathers.

Taken together, findings from this brief overview of some of the father-infant interaction studies where touch is considered have shown that touch is important—and even intrinsic—to fathers and to other cultures. Touch can also be used differently in some situations or be more frequent. These results converge to suggest that touching is used to bring people together, for closeness and intimacy and for proximity and play. More research with fathers is warranted, particularly pertaining to fathers' use and styles of touching during interactions.

Summary and Conclusions

Taken together, interaction studies have provided important insights and have advanced our knowledge of the young infant's sensitivity to manipulations in facial, vocal and now tactile expressions. These findings emphasize the complexity and sophistication of mother-infant dyadic interactions and the importance of including measures of touch. Moreover, through these studies, an abundance of new findings has been revealed: For example, mothers frequently use touch during normal face-to-face interactions with their infants (65% of the time).[54,65] For brief periods of time, touch alone can maintain infants' attention and elicit positive affect at least as well as can vocal and facial expressions.[111] In addition, infants are sensitive to subtle changes in maternal touch,[56,57] and therefore prefer stimulus compounds that include touch.[78] Results from these studies have also enlightened us about infants' sensitivity to maternal behavior; in particular, their sensitivity to their mothers' touch. Moreover, the influences of modality have been demonstrated,[57,71-73] and different patterns of touching are shown under different instructional conditions.[68,73] Most importantly, perhaps, these studies have provided evidence for a functional context for touch that is not limited to the regulation of distress. Rather, these findings indicate a role for touch in social-emotional development, and they imply that touch serves an important communicative function. However, the processes and mechanisms through which touch communicates require additional research attention.

Touch is emerging as a diverse and adaptable modality that, although often used alone, accompanies other modalities and channels of communication. Touch is used frequently during the first year of life, serving a multitude of purposes:

- maintaining the infant's state
- providing comfort and warmth
- serving as a means of social communication
- adjusting posture
- acting as an important means of developing the early parent-infant relationship

In essence, touch is considered an integral part of the complex communication system that exists between parents and infants. However, more research is needed to describe and determine its specific contributions.

Although facial and vocal expressions are important forms of communication, they are only 2 of the many behaviors that are used to express and communicate. Far less data exist regarding "tactile expressiveness" and communication through touch. Field[18] reaffirmed the observation that the communicative functions of touch have been *neglected* relative to the other senses and to facial and vocal expressiveness—points also made by Frank,[112] myself[13] and subsequently by Hertenstein.[86] Moreover, in her article in *Human Development*, Field[18] argues the important role for touch in understanding and improving infants' well-being, emphasizing that significant effects on growth, development and emotional well-being are suggested from numerous studies and many observations of extremes of limited touch in infants and children. However, little is known about the long-term effects of parental touch and touch patterns on the subsequent mental health, social and emotional development and adjustment in healthy infants or more vulnerable groups of children.

The findings discussed in this chapter emphasize the points that the tactile modality provides an important means for parents and infants to develop and maintain a connection with each other, as well as with the environment and to the self. They also illustrate the flexibility and adaptability of touch, as well as the adaptability of the communication system, such that both partners can modify their behaviors to adjust and compensate for the situation: Therefore, both partners are responsive to each other. It has also been made clear that patterns of touching may be different. Given that the contexts within which much of early development occurs are social and multimodal, *how* touching is integrated with other communication channels that are available to parents is an important research pursuit in our search for unraveling the mysteries and challenges of the sense of touch.

Beyond the aforementioned, several additional questions and pivotal issues are prominent and have emerged from the extant literature.[13] Firstly, what is being communicated through touch? Secondly, assuming that communication is occurring (based on the evidence to date), and that touch is serving a multitude of important roles and functions, the next issue involves determining how to measure this process. Establishing clear roles for, and contributions to, social and emotional development are important. Thirdly, it is absolutely essential to address the quantitative and qualitative characteristics (patterns) of touch and their salience over age, as well as the changes that occur in infants' and caregivers' communicative behaviors (eg, affective, gazing and touching behaviors) over time. Fourthly, particularly throughout the first few years of life, the infant (and its parents) is developing, changing and adjusting. It is important for future research to pursue and be aware of how development itself plays a role in the changes we see related to touch, physical contact and affection. Fifthly, relationships between patterns of touching and/or discrete types of touch and emotional/affective displays are required. Sixthly, the long-term implications for touch and its contributions to development and adjustment are important endeavors, yet they present difficult research challenges. The last 2 issues stress the importance of studying individual differences and examining different trajectories. Lastly, it is essential that the research be integrated into existing models and theory and that the development of new, more comprehensive models be added to the mix as the research develops. The value of such pursuits must not be overemphasized. Hertenstein has taken a positive step in this direction by describing a general mode for tactile communication.[86]

The future of touch is promising. While examining touching during mother-infant interactions is only one means through which to study touch systematically, it is an enlightening avenue that is invaluable to understanding social-emotional development in a comprehensive way and to developing the communication system between parents and their infants. This direction also offers important possibilities for cross-fertilization and convergence. Indeed, touch offers us a rich world to discover—one that has implications for a variety of fields of inquiry.

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CHAPTER 5: DIFFERENCES ACROSS CULTURAL GROUPS IN MOTHERS' NONVERBAL TEACHING METHODS

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Abstract

The primary purpose of the study described in this chapter was to determine how mothers used touch to "teach" their infants; that is, to help direct their attention and shape their actions. The study also examined the changes in mothers' preferred teaching methods from infancy through toddlerhood and described the cultural differences in nonverbal teaching strategies. Mothers in 4 American cultural groups—Caucasian, Japanese, Filipino and Hawaiian—participated in the study, which assessed how the individuals in each of these groups touched, held, repositioned and physically interacted with their infants and toddlers (3 months to 36 months of age) during videotaped mealtimes and how they organized the mealtime setting. The teaching methods used by the different groups and the results of this study are explored in detail in this chapter.

Introduction

Parents teach children in many ways.[1] They instruct children directly, they explain to them how things work and they show them how to solve problems. Parents naturally encourage their children to see and respond to reality in the same ways that they do and to adopt the same "goals for action" that they pursue. Parents also model actions that they want their children to copy. In addition, they structure their children's day-to-day lives so that they will engage in activities that the parents feel are important and so that their children will come into contact with good teachers and role models.

Bruner described carefully how parents teach their infants nonverbally.[2] He noted that they hold and move their babies' limbs in ways that are valued culturally, and that they direct their infants to attend only to certain objects and perform only certain "goal-directed actions." For example, mothers teach their babies that "bells are for ringing" by wrapping the baby's fingers around the stem of the bell, shaking the bell and showing excitement when the bell rings. The baby then takes on this goal for action and stops "mouthing" bells in order to ring them. Similarly, babies learn to bang with mallets, to stir with spoons, to match shapes to slots and to say "hi" and "bye-bye" into telephones.

Harkness and Super pointed out that parents teach their children by structuring their environments.[1] Different sets of parents in this study set up mealtimes quite differently. Mealtimes differed in one or more of the following ways: whether the family sat together at a table; whether adults and children ate together; how many adults were present; how many other children were present; whether infants/toddlers were constrained to high chairs, held on laps or allowed to roam; whether mothers attended exclusively to infants; and whether the television was turned on. Parents effectively convey the messages of their cultural and social groups and their personal beliefs and habits by carefully (albeit, often subconsciously) structuring their children's environments and activity settings and by guiding their children's actions.

Current Study[3]

METHOD

Data Collection

Families were recruited from 2 preschools and one elementary school in Honolulu, Hawaii, for a study of dual-earner families. Parents set up a camera provided to them, pointed it at their typical mealtime area and turned it on for at least 20 minutes during mealtimes. Videotapes from 80 families who had at least one young child (ages 3 months to 36 months) were viewed and coded for this study.

Participants

Twenty families were studied from each of the following 4 American cultural groups: Caucasian American, Japanese American, Filipino American and Hawaiian American. The mothers in these families had stated on a prestudy questionnaire that they identified most closely with that cultural group.

Within each cultural group in this sample, 10 families had an infant less than 23 months of age, while the other 10 families had an older toddler, from 24 months to 36 months of age. Equal numbers of male and female infants/toddlers were studied within each cultural group. The groups did not differ significantly in terms of average age of the infants, gender of the infants, number of people present at the meal, number of parents present at the meal and number of siblings present at the meal.

Coding

After repeated viewings of a set of these videotapes, a coding system was developed to define observed forms of touch, seating patterns for the infants and other setting features. Two observers coded the mothers' actions during 10 minutes of each videotaped mealtime. They coded the 10 minutes that followed the first 3 minutes of each videotape, thereby omitting coding on that part of the tapes during which families typically adjusted to the camera while setting up their meals.

Analysis

A one-way analysis of variance was used to compare age groups to each other, cultural groups to each other and males to females. Data were analyzed to compare the effects of mealtime setting features, the amounts of touch and the forms of touch. Comparisons involved the extent to which mothers touched infants in particular ways in these groups.

RESULTS

How Do Mothers Shape ("Teach") Infant Attention and Actions Through Holding and Touch?

During meals, the mothers used the following 4 major forms of touch, which reflect 4 forms of teaching:

- *Instrumental touch*—consisted of actions performed *upon* the baby for purposes of feeding, cleaning, comforting or caring for the infant: For example, a mother adjusted her infant's bottle, spoon-fed her, wiped her face and repositioned her to feed her more easily. With instrumental touch, parents showed their infants the routines of mealtime: The spoon was put into the bowl, picking up food. Then, the food-laden spoon was put into the infant's mouth. The mouth then got wiped with the spoon or washed with the cloth. Lastly, at the end of the meal, the infant's hands got wiped. The babies developed expectancies about these actions and signaled to their mothers to do them by performing their steps in these sequences (eg, holding up their "dirty" hands for wiping).

- *Directive touch*—consisted of the mother *physically shaping* what she wanted the child to do, or *physically blocking* the child from performing unwanted actions. Infants participated more actively during cases of directive touch. For example, a mother shaped her baby's hand around the handle of his feeding spoon and then moved his hand toward his mouth. Another mother pushed her baby's hands away when he reached for his oatmeal. In this way, children *took on* their parents' "goals for actions."

- *Responsive touch*—consisted of actions by a mother to help her child *complete actions* the child initiated: For example, a mother gave her baby a toy the infant had reached for and helped the baby place a puzzle piece she had struggled to place. Mothers often *converted* responsive touch into more *directed* structuring by subtly shaping their infants' self-initiated actions to bring them more *in line* with what the parents wanted: For example, when a baby spooned oatmeal onto his high-chair tray, his mother moved a bowl underneath and subsequently complimented him for "putting" the oatmeal in the bowl.

- *Supportive touch*—consisted of comforting and affectionate, playful touching, such as kissing, hugging, patting the infant on the head, nuzzling, rocking, tickling, jiggling and actions involved in playing games. These actions maintained (supported) the mother-child relationship and kept the baby focused on the mother.

What Kinds of Nonverbal Teaching Did Mothers Use Most Frequently?

It was determined that mothers touched their infants an average of 2.11 times per minute. As Figure 1 shows, most instances of touch consisted of "instrumental touching" (at an average rate of 1.33 instances/minute), during which the babies experienced *passively* how feeding or cleaning should proceed. The second most frequently used forms of touch were "supportive" (affectionate) and "responsive" touch combined (at an average rate of 0.55 instances/minute). Touch was used least frequently to "direct" or "restrict" infants (at an average of 0.24 instances/minute).

Did Forms of Teaching Change as Infants Got Older?

As indicated in Figure 2, mothers used significantly more nonverbal teaching ("touch") with infants than with toddlers and more verbal instruction with toddlers than with infants. Mothers touched infants statistically significantly more than they touched toddlers (3.4 touches/minute versus 0.8 touches/minute, respectively; $P<.0001$). They used "affectionate" touching statistically significantly more with infants than with toddlers (1.10 touches/minute versus 0.12 touches/minute, respectively; $P<.04$). They also touched infants for "instrumental" purposes (to feed and care for them) statistically significantly more than they touched toddlers ($P<.0001$) for these purposes.

Figure 1. Observed forms of touch during mealtimes among mothers and their infants in different cultural groups.[3]

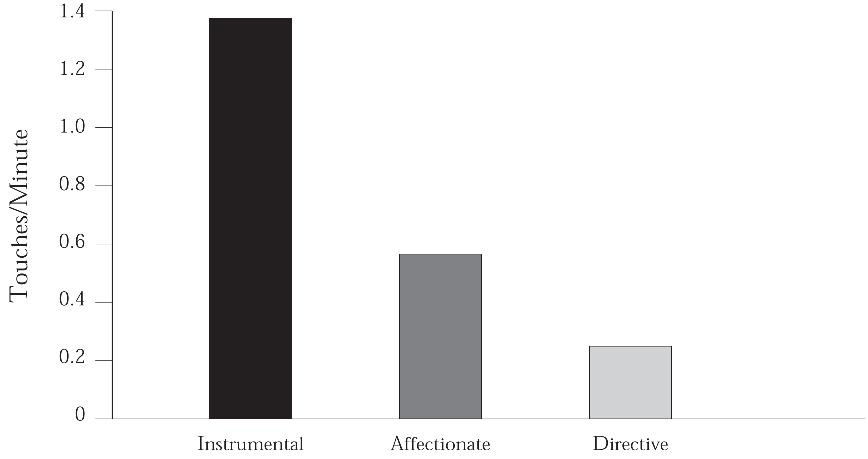
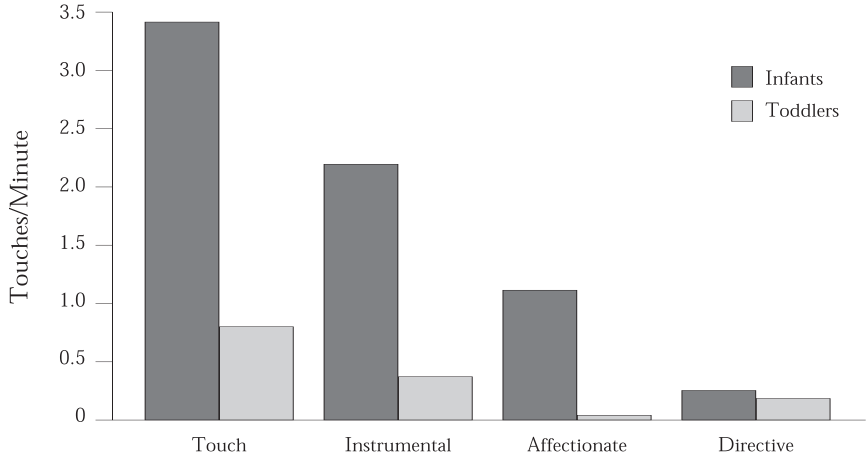


Figure 2. The types of touch and the frequency with which mothers from different cultural groups touched their infants versus their toddlers during mealtimes.[3]



Naturally, from early infancy to late toddlerhood, mothers' teaching methods changed from mainly performing actions and routines on the *passive* child—demonstrating the structure of the valued routine—to shaping the infant and toddler into participating *actively* in this shared routine. This then progressed to instructing the child verbally to perform the steps of the routine without using much touch or positioning in these instructions. Instruction becomes removed increasingly from the child's body.

Did Parents From Different Cultural Groups Structure Mealtimes Differently?

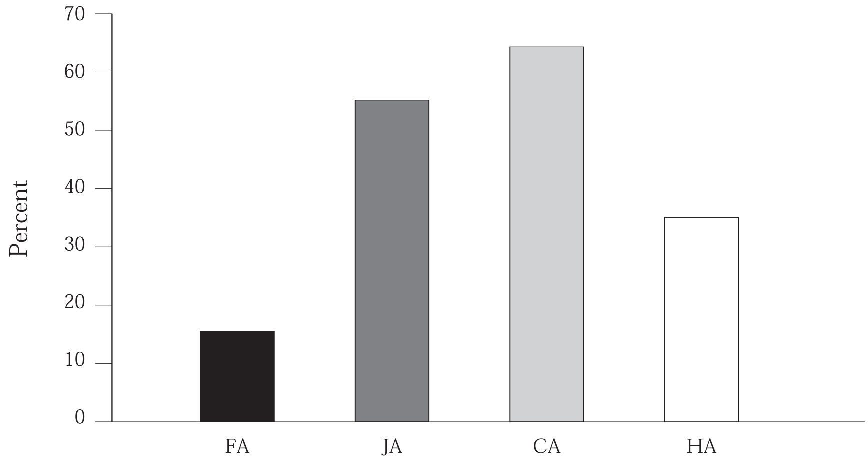
The manners in which mothers from the various cultural groups involved in this study structured their mealtime settings affected how they interacted with their infants. The structuring of the activity setting *and* guiding children through the activities are ways of conveying cultural preferences and messages.

Caucasian American mothers and Japanese American mothers tended to place their infants and toddlers in high chairs in order to feed them (Figure 3). In addition, Japanese American parents tended to provide their babies with play toys during feeding. Caucasian American parents tended not to provide toys, explaining that they thought the toys would distract their babies from eating.

Throughout mealtimes, Japanese American mothers tended to sit directly in front of their children's high chairs and pay undivided attention to their babies. In most of these families, the baby was fed before the rest of the family sat down to eat, so that the mother's attention could be directed completely to the baby (Figure 4). In the remaining Japanese American families, the father interacted with the older children while the mother fed the baby.

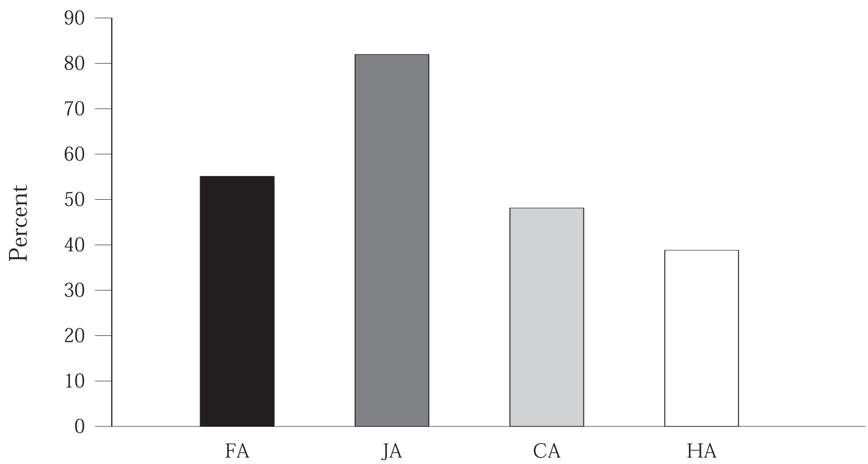
Caucasian American parents tended to place the high chair at the periphery of the larger family meal gathering. Cacausian American infants were commonly given finger foods and were attended to sporadically. These parents attended most consistently to their children who were verbal, as meals were seen as times for exchanging information.

Figure 3. Cultural-group differences regarding mothers placing their infants or toddlers in high chairs during mealtimes.



FA = Filipino American; JA = Japanese American; CA = Caucasian American; HA = Hawaiian American

Figure 4. Cultural-group differences among mothers devoting undivided attention to their infants during mealtimes.



FA = Filipino American; JA = Japanese American; CA = Caucasian American; HA = Hawaiian American

Filipino American mothers tended to hold their infants and toddlers on their laps, facing outward. From this position—being fed from behind—Filipino American babies were touched much more frequently than were infants from the other cultures studied. Since she could not see her child's facial cues, the Filipino American mother fed her child on her own schedule and not in relation to readiness cues from her child.

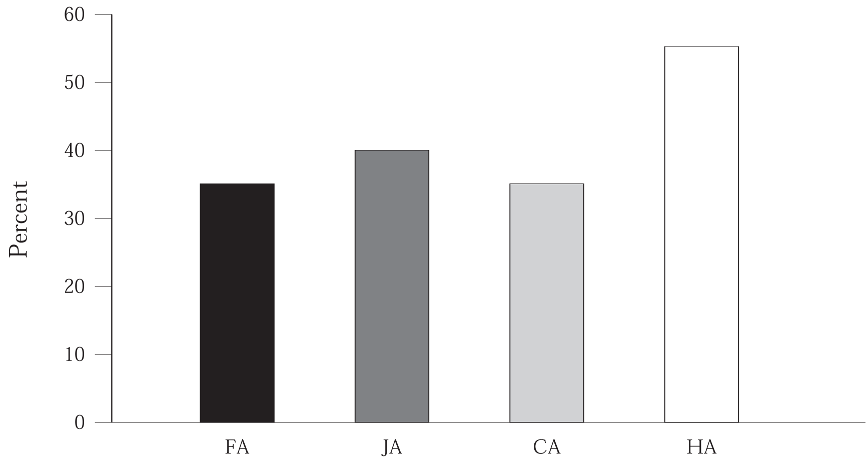
Hawaiian American parents held their babies on their laps to feed them. They also "passed" their infants to other adults and older children sitting around the meal table. They allowed their toddlers to "roam" during meals (Figure 5), and they were permitted to come and go to a central adult holding the toddler's food bowl. In this way, the child experienced maximum autonomy in deciding what and when to eat. Roaming occurred more frequently in the Hawaiian American group than in any of the other groups studied.

Did Mothers From Different Cultural Groups Use Different Nonverbal Teaching Methods?

Filipino American: As seen in Figure 6, Filipino American mothers touched their infants the most frequently (average, 3.17 touches/minute). This outcome was largely because they held their infants on their laps more frequently, and physically manipulated their infants into performing desired actions. Filipino American mothers used the "directive" form of teaching/touching more than did mothers in the other groups: For example, these mothers kept feeding their babies even after the infants signaled that they did not want any more food. They also stopped their babies from touching objects or food, spoon-fed their older toddlers and discouraged self-feeding.

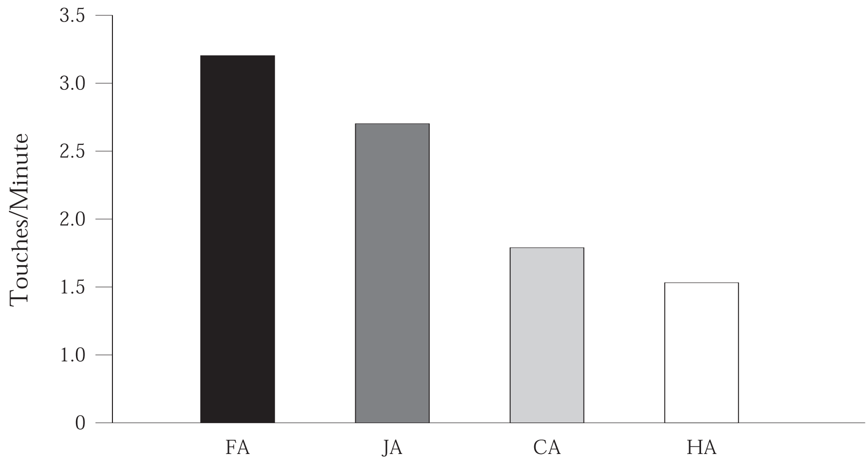
Japanese American: Japanese American mothers touched their infants the next most frequently (mean, 2.57 touches/minute). During mealtimes, they placed their infants in high chairs more frequently than did Filipino American or Hawaiian American parents, and then attended to them carefully. Japanese American mothers used the "responsive" form of teaching/touching more often than did mothers in the other groups. They facilitated exploratory play and helped their children complete self-initiated goals. And, although they did not block their children's unwanted actions, they reshaped them subtly until they were more acceptable.

Figure 5. Cultural-group differences among mothers who allowed their infants to roam or to sit in an open chair during mealtimes.



FA = Filipino American; JA = Japanese American; CA = Caucasian American; HA = Hawaiian American

Figure 6. Cultural-group differences in rates of touching among mothers and their infants during mealtimes.[3]



FA = Filipino American; JA = Japanese American; CA = Caucasian American; HA = Hawaiian American

Caucasian American: Caucasian American mothers touched their infants third most frequently (mean, 1.51 touches/minute) during this study. They attended more carefully to their husbands and verbal children, and therefore less carefully to their infants and toddlers. Caucasian American mothers encouraged self-reliance by providing finger food, and they allowed their infants to explore and play with their food. They encouraged their toddlers, in particular, to develop "goals for action" that were the opposite of expected actions by laughing at these actions.

Hawaiian American: Of the 4 cultural groups studied, Hawaiian American mothers touched their children least during mealtimes (average, 1.21 touches/minute). They allowed the most free-ranging wandering and exploration, and their children were often "out of touch." They also attended more to other adults who were present during mealtimes. At times, the Hawaiian American mothers encouraged "rascal"-type violations of social expectations. At other times, they scolded their toddlers for disrupting the group.

Were Parents' Preferred Teaching Methods Supported by How They Structured Mealtimes?

Trial-and-error, exploratory learning—during which children were encouraged to learn by doing—was facilitated by the following conditions: children being free to move around; parents providing toys, utensils and finger foods to infants; parents allowing, and even praising, their child's explorations; and parents not monitoring their children closely, particularly as parents engaged in other conversations. Hawaiian American parents allowed these conditions to occur the most frequently, while Filipino American parents allowed these conditions to occur the least frequently.

Shaped, exploratory learning—during which infants were allowed to initiate their own "projects," but were then structured into turning these into conventional actions—was facilitated by the following conditions: infants being "restrained" in high chairs where they could be monitored; mothers attending to their infants carefully; mothers helping their infants reach their signaled goals; and parents providing toys, utensils and food to restrained children, and letting them play with these items. Japanese American parents allowed these conditions to occur the most frequently.

Adult-directed learning—during which parents introduced and shaped the skills to be learned by their infants—was facilitated by the following conditions: infants and toddlers being "restrained" to a parent's lap; mothers monitoring their infants and toddlers carefully; parents providing their children with few objects to play with; mothers intervening quickly to stop their children's unwanted actions; and mothers shaping their infants and toddlers physically to perform the actions that the parents want. Filipino American mothers allowed these conditions to occur the most frequently.

Cultural Messages About Touch

Parents in the various cultural groups studied in this study conveyed different messages about togetherness and independence during mealtimes. Filipino American mothers and Japanese American mothers were highly affectionate and highly controlling toward their infants during mealtimes. They, in fact, taught their infants that being a member of a tight-knit family group involves both the warmth of belonging and the obligations of conforming to group ways.

Although Caucasian American mothers were more distant relationally, they allowed their infants a greater sense of autonomy and choice. This autonomy involved reduced closeness but increased individual self-expression through talk. Whereas, even though Hawaiian American mothers enabled autonomy, they also allowed their infants to seek more contact when their babies wanted such contact.

These groups of American parents also sent messages to their infants about the appropriate ways to make contact with others. Caucasian American parents, in particular, emphasized making contact through talking during mealtimes. They effectively "separated" mealtime members into formal, boundaried spaces at the dinner table, and then tried to close the distance with conversation. Therefore, it is not surprising that Caucasian American children learn to talk early, loudly and often.

Conclusions

In this study,[3] the mean rate at which American mothers touched their infants and toddlers during mealtimes was very low. Mealtimes may be settings during which parents encourage independence and discourage touch. The low rate of touching, the decrease in touch as children got older and, in particular, the decrease in affectionate touch may reflect current American patterns of increasing physical distance among people as they mature.

Touching their infants was most frequent among the most traditional mothers; that is, those who held their infants on their laps. However, these were also the most "directive" mothers. Touching was least frequent in mothers who rely on baby furniture, such as high chairs and booster chairs: High chairs emphasize the "separateness" of baby and mother, while they also constrain the infant. While they allow the baby to sit and eat by himself/herself, freeing up the mother, they also keep the infant from seeking more contact when he/she wants it.

Mothers who sat on the floor or on low chairs while their infants or toddlers roamed touched their children more, in large part because the infants approached the adults for more touch. Babies who roamed and "grazed" experienced autonomy in choosing when to come for more food. In addition, such infants were free to approach adults to request touch, which could not be done by the infants who were constrained in high chairs.

Acknowledgments

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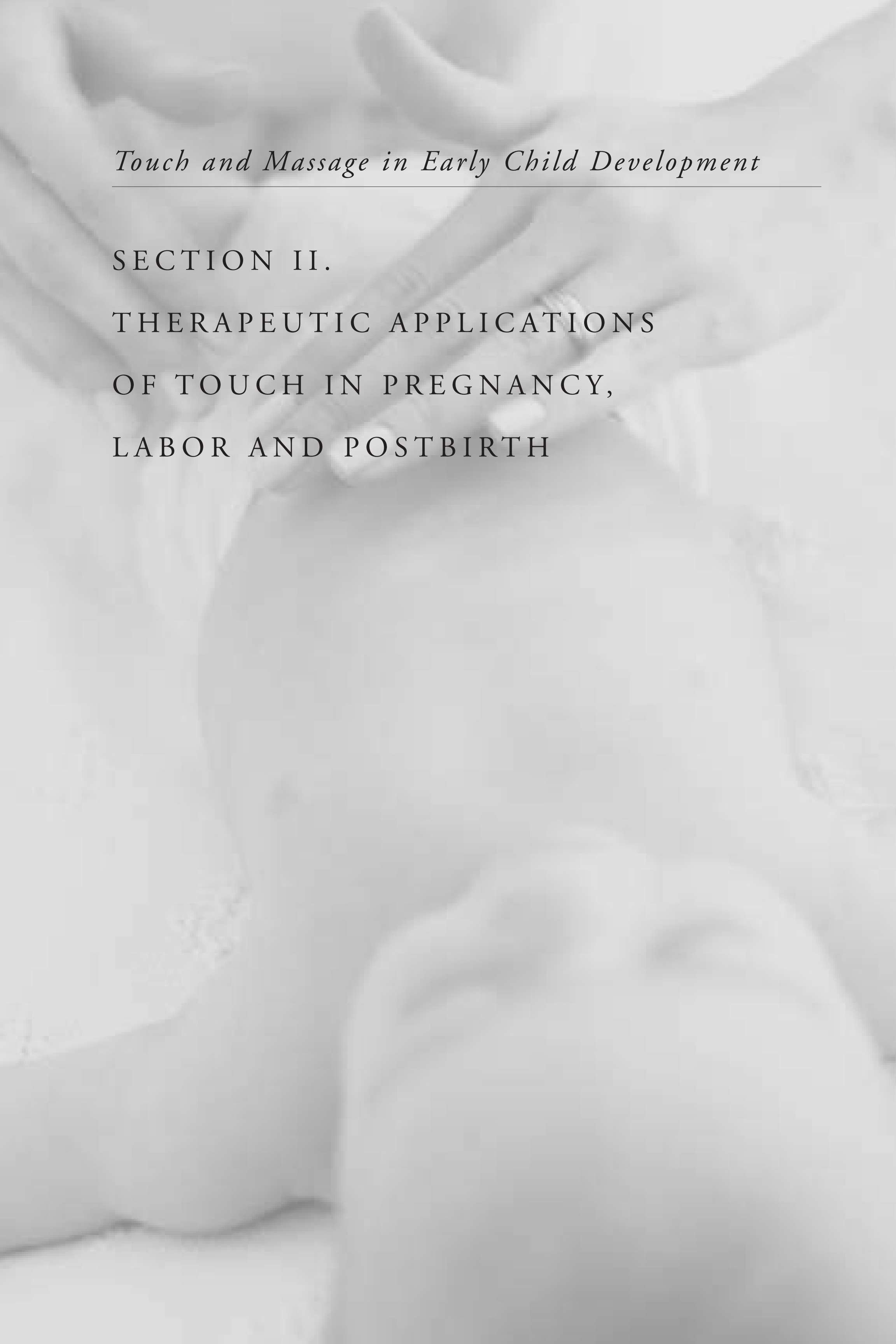

SECTION II.

THERAPEUTIC APPLICATIONS OF TOUCH IN PREGNANCY, LABOR AND POSTBIRTH

CHAPTER 6:

PREGNANCY, LABOR AND INFANT MASSAGE

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Miguel Diego, MA
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Abstract

Massage therapy during pregnancy benefits the mother-to-be and the fetus. Massage during labor also benefits the expectant mother, reducing her labor pain and shortening her labor. Elderly volunteers who massaged infants lowered their own stress hormone levels, as well as improved the health of the newborns. In addition, depressed mothers who massaged their infants experienced decreased depression. In this chapter studies are reviewed on massage therapy during pregnancy and labor, as well as infant massage for full-term and preterm infants, and the benefits experienced by both those who *give* and those who receive the massages.

Massage During Pregnancy

In our study on pregnancy massage, the massage therapy was expected to decrease stress hormones and anxiety, leg pain and back pain. Improvements in mood and sleep were also expected. In this study, 26 pregnant women were assigned to a massage therapy or a relaxation therapy group for 5 weeks.[1] The therapies consisted of 20-minute sessions twice weekly. Both groups reported feeling less anxious after the first session and less leg pain after the first and last sessions. Only the massage therapy group, however, reported reduced anxiety, improved mood, better sleep and less back pain by the last day of the study. In addition, urinary stress hormones (ie, norepinephrine) decreased for the massage therapy group, these women had fewer obstetric complications and their infants experienced fewer postnatal complications, most especially a lower incidence of prematurity.

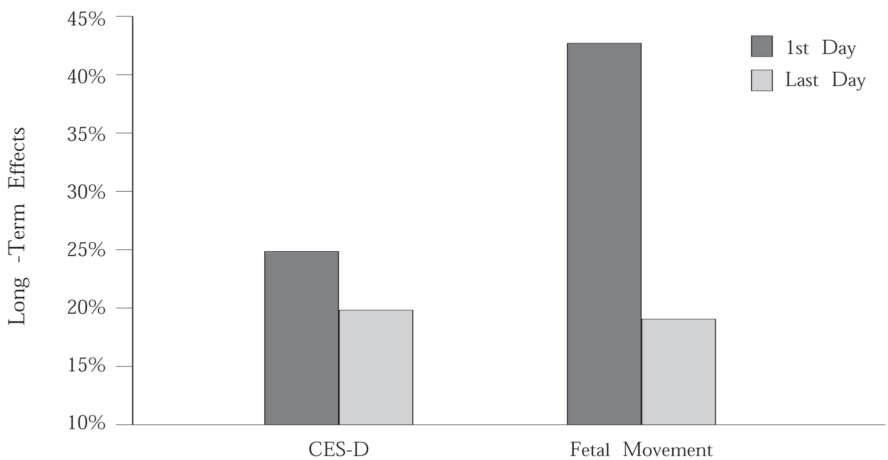
Prenatal depression has been noted to affect the developing fetus. In one of our studies, depressed pregnant women who had elevated cortisol and norepinephrine (stress hormones) gave birth to newborns who had depression-like symptoms[2]: These newborns also had higher levels of cortisol and norepinephrine,[3] as well as greater relative right frontal electroencephalogram (EEG) activation, thereby mimicking their depressed mothers' stress hormone profile and EEG patterns.[4]

In an attempt to reduce maternal depression and its negative effects on the fetus and neonate, we conducted a study on massage therapy with depressed pregnant women (Field et al, 2003, unpublished data). These depressed women were randomly assigned to a massage therapy, relaxation therapy or a standard treatment control group and were compared with each other and with a group of nondepressed women at the end of pregnancy. The massage and relaxation groups received two 20-minute therapy sessions each week, given by their significant others, during the last trimester of their pregnancies. Data analyses revealed the following (Figure 1):

- Immediately after both types of therapy on the first and last days, the women reported lower anxiety and reduced leg and back pain.
- Both therapy groups had more optimal postnatal complications scores than did the depressed control group, although only the massage therapy group had more optimal obstetric complications scores including a lower incidence of prematurity.

- The massage therapy group had lower depression scores.
- Fetal movement decreased for all 3 groups.
- The massage therapy group had better Brazelton Neonatal Behavior Assessment Scale (BNBAS) scores, including those representing habituation, motor ability, range of state, withdrawal and depression scores.

Figure 1. In depressed pregnant women, massage therapy during the last trimester was associated with lower depression scores and decreased fetal movement. T.F., M.D., M.H-R., S. Schanberg, C. Kuhn, unpublished data, 2003



(CES-D = Center for Epidemiological Studies of Depression scale)

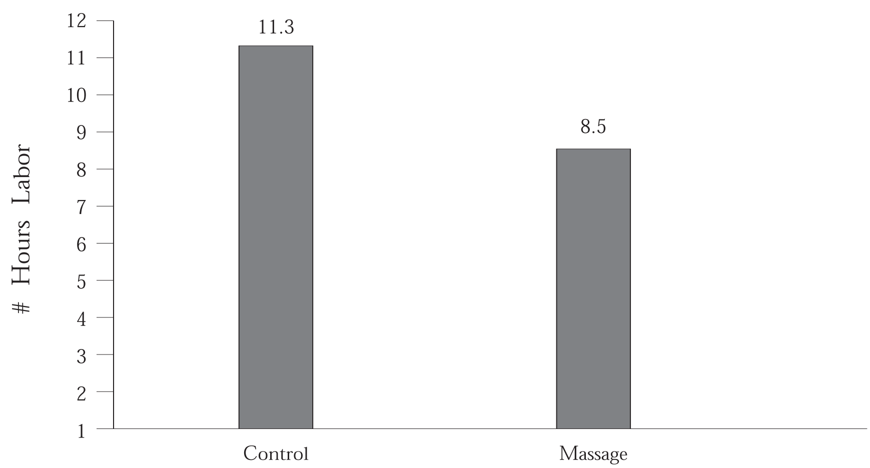
These data suggest that depressed pregnant women and their offspring can benefit from these alternative therapies, particularly massage therapy.

Massage During Labor

Touch and massage have been used effectively during labor in nearly every culture for hundreds of years.[5] In contrast, physical support during delivery has been available only recently to Western women.[6] In the past, the massage and support provided during labor were used to improve or correct the position of the fetus, to stimulate uterine contractions, to "…prevent the fetus from rising back up in the abdomen…" and to exert mechanical pressure to aid in the expulsion of the child.[7] However, today the focus tends to center more on relaxation to reduce anxiety and alleviate pain.[5]

This study compared significant others massaging their pregnant partners during labor versus partners simply being present and doing what came naturally during labor (typically, coaching the breathing exercises they had learned in prenatal classes).[8] Massage coupled with breathing exercises, versus breathing exercises alone, was expected to reduce anxiety and pain, as well as the length of labor. Twenty-eight women were recruited from prenatal classes and assigned randomly to receive massage and coaching in breathing from their partners during labor, or to receive coaching in breathing alone. The mothers who received massage reported decreases in depressed mood, anxiety and pain, showed less agitated activity and anxiety, and exhibited more positive affect following the first massage. In addition, the mothers who were massaged had significantly shorter labors (Figure 2), less labor medication, shorter hospital stays and less postpartum depression.

Figure 2. Mothers who received massage therapy from their partners during labor, in addition to coached breathing exercises, had significantly shorter labors than those who received coached breathing exercises alone.[8]



Infant Massage

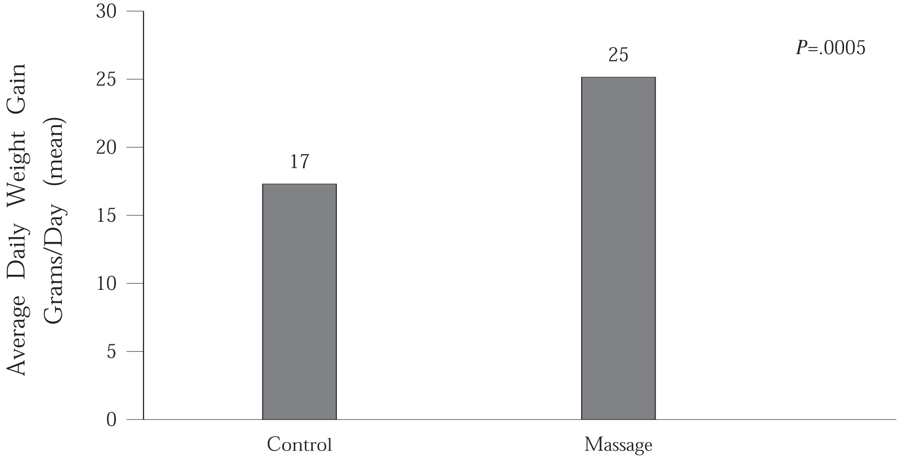
Infant massage is practiced in most countries of the world, especially in Africa and Asia.[9,10] In many countries, including Nigeria, Uganda, India, China, Bali, Fiji, New Guinea, New Zealand (the Maiori), and the Soviet Union, infants are given a massage with oil after the daily bath and before sleep time for the first several months of their lives.

Infant massage has been discovered and researched only recently in the Western world. Suddenly, in the United States, there are massage therapy schools in almost every city teaching parents how to massage their infants. The techniques they are learning and using are based on the teachings of 2 massage therapists who trained in India.[9,10] Indian infant massage involves a daily routine that begins during the first days of life. The infant is laid on his or her stomach on the mother's outstretched legs, and each body part is stretched individually. Warm water and soap are applied to the legs, arms, back, abdomen, neck and face. The massager looks like she is scrubbing clothes on an old washboard and the process seems extremely rigorous. After they are massaged and swaddled, the infants then sleep for prolonged periods.

Although data have not been collected on infant massage as it is practiced in India, some infant massage therapists have attributed the precocious motor development of these infants to their daily massages. Infant massage therapists have made several claims based on anecdotal data, including that the massage provides both stimulation and relaxation that helps respiration, circulation, digestion and elimination.[11] They have claimed that infants who are massaged sleep more soundly, that the massage relieves gas and colic, and that it helps the healing process during illness by easing congestion and pain.[12] Furthermore, they assert that infant massage helps enhance parent-infant bonding and warm, positive relationships, reduces distress in the infant following painful procedures (such as inoculations), reduces pain from teething and constipation, reduces sleep problems and makes parents "feel good" while they are massaging their infants. Infant massage therapy groups have also reported that infants who have special needs—such as those who are blind and deaf or those who are paralyzed, have cerebral palsy or are premature—seem to become more aware of their bodies, among receiving other benefits.

Figure 3. Premature babies do not like light touch, probably because it feels like tickling. Babies who gained weight in the studies of infant massage were those who received deeper-pressure massage that stimulated both tactile and pressure receptors.[13]

Figure 4. Massaged infants gained 47% more weight per day than control infants.[14]



Preterm Infant Massage

Most data available on the effects of infant massage come from studies of preterm/premature infants. During the last 2 decades, several studies were conducted on what we called "tactile/kinesthetic stimulation" (due to the negative connotations attached to the word "massage"). A meta-analysis of data from 19 of these studies revealed that 72% of the massaged infants were affected positively.[13] Most of them experienced greater weight gain and better performance on developmental assessments. In those studies that did *not* report significant weight gain, investigators had used a light-stroking procedure. Babies do not like light touch (Figure 3), probably because it feels like tickling. The babies who gained weight had been given deeper-pressure massage, thereby stimulating both tactile and pressure receptors.

One of the studies used in this global analysis was conducted in our laboratory at the Touch Research Institute in Miami.[14] In that study, massage therapy was given to preterm newborns 3 times per day, for 15 minutes per session, for 10 days. As shown in Figure 4, the massaged infants averaged 47% greater weight gain than infants who were not massaged, even though the groups consumed equal amounts of formula. The massaged infants were awake and active more of the time, even though we expected they would sleep more. They were also more alert and responsive to the examiner's face and voice, and they showed more organized limb movements on the BNBAS. Finally, they were discharged from the hospital 6 days sooner, saving approximately $3000 per infant in hospital costs. The comparable cost savings today in the US would be $10,000 per infant. If every one of the 470,000 premature infants born each year in the US was massaged, the hospital cost savings would approximate $4.7 billion per year. That dollar figure could double based on more recent data, suggesting that the same weight gain can be achieved in 5 days, versus 10 days, of massage therapy.[15]

Replication studies have been conducted in Israel[16] and the Philippines.[17] In the study performed in the Philippines,[17] which was done with an exact replication of the Field et al methodology,[18] preterm infants who were massaged gained 45% more than infants who were not massaged. In the study conducted in Israel,[16] a 31% greater weight gain and more organized sleep were reported for the massaged, versus the control, preterm infants. In addition, the mothers who provided the massage experienced less postpartum depression. These studies approximated the weight gain data (47% and 31%, respectively) published by Field et al[14] and

Scafidi et al.[19] A recent study by Dieter et al[15] suggests that a 46% greater weight gain can be achieved in preterm infants following only 5 days of massage.

At approximately the same time that the previously mentioned premature infant studies were being done,[14] colleagues at Duke University Medical School were conducting similar studies on rat pups.[20] They separated rat pups from their mothers to explore touch deprivation. The researchers stroked the deprived rat pups with a paintbrush—much like the mother rat would tongue-lick them—so that the pups would grow normally. In several studies, the team at Duke noted that growth hormone decreased when the pups were separated from their mothers. This decrease was noted in all body organs, including the heart, liver and brain. These values, however, returned to normal once the pups were stroked with the paintbrush. The more recent discovery of a growth gene that responds to touch suggests a strong genetic influence on the relationship between touching and growth, although the underlying mechanism is unclear at this time.[21]

This observation, plus the results of a study done in Sweden,[22] led myself and my colleagues to some theories about mechanisms that might explain the touch/weight-gain relationship. The investigators in Sweden reported that stimulating the mouths of the newborn, as well as the breasts of the breastfeeding mothers, led to an increase in food absorption hormones, such as gastrin and insulin.[22] Schanberg and I argued that massage therapy delivered to several parts of the body would lead to an even greater increase in food absorption hormones, which could itself explain the weight gain.[23] Assays on the insulin levels before, during and after massage therapy suggested that insulin levels were elevated in those preterm infants who received massage therapy versus those who did not (a 61% increase versus a 4% decrease, respectively, in insulin levels).[23] Of course, future studies could assess the relative changes caused by several food absorption hormones and other vagal stimulated changes, such as an increase in gastric motility.

Massaging Infants With Oil

To determine whether massaging infants with oil enhanced the effects of massage, a study was conducted in which 60, 1-month-old, full-term infants were randomized to one group that was massaged with oil, while the other group was massaged without oil.[24] Results of this trial showed that the infants massaged with oil experienced greater soothing and calming effects. The infants who received massage with oil were less active, showed fewer stress behaviors, demonstrated less head averting and had greater declines in saliva cortisol levels. In addition, vagal activity increased more following massage with oil versus massage without oil.

Massaging Infants Who Have Colic and Sleep Problems

"Colic" and sleep problems are the complaints presented most frequently to pediatricians by parents of infants. In a study on these problems, we taught parents, whose infants attended a university nursery school, to massage their 3-month-old to 6-month-old infants for 15-minute periods prior to bedtime.[18] The massaged infants, versus a group of control infants, became less irritable, fell asleep faster, experienced fewer night awakenings and spent more time in quiet, alert states during the daytime.

Parents who participated in this study, and who years later encountered the investigators on campus, suggested that their marriages had been "saved" by having received help to calm their infants and get them to sleep. Others expressed chagrin that their children, now as old as 7 years, still needed a massage in order to go to sleep.

Depressed Mothers Massaging Their Infants

In our studies, we routinely teach parents to massage their infants so they can be massaged on a daily basis *at no cost*. In addition, these parents are told that they, too, might benefit from *giving* the massages. A study in which depressed mothers were taught to massage their infants resulted in decreased maternal depression and less distress behavior and disturbed sleep patterns in the infants.[18] For this study, the infants' mothers were asked to perform 15-minute massages once daily for 2 weeks. At the end of the study period, the massaged infants fell asleep faster, slept longer and were less fussy. The mothers enjoyed better face-to-face interactions

Figure 5. Mothers massaging babies.

with their infants. During these interactions, the infants were positioned in an infant seat on a table facing their mothers. Video cameras, which were partially hidden, filmed the mothers' faces and torsos and the infants' faces and bodies. The videotapes were subsequently coded for the mothers' and infants' eye contact, facial expressions and vocalizations. Based on their filmed behaviors, improved mother-infant interactions were documented.

Fathers as Massage Therapists

A recent Australian television show featured American fathers giving massages to their infants. Since this film was broadcast, a study was conducted on Australian fathers massaging their infants.[25] In this study, fathers who had first-born babies were given a 1-month training program in a bathing-massage technique. During home observations after 3 months, the fathers showed greater involvement with their infants. At this time, the massaged infants also greeted their fathers with more eye contact, smiling, vocalizing and reaching responses and less avoidance behavior.

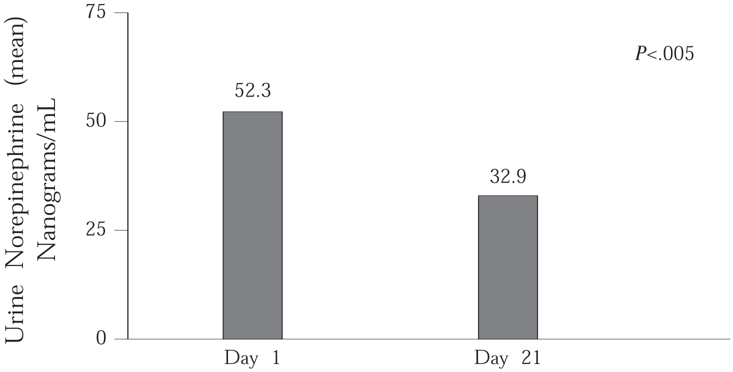
In a study we conducted, infants were given massages by their fathers for 15 minutes prior to their daily bedtimes over a 1-month period.[26] By the end of the study, the fathers who massaged their infants were more expressive and showed more enjoyment and warmth during floor-play interactions with their infants than did a control group.

Elderly Volunteers as Massage Therapists

Teaching infant massage to elderly volunteers is a no-cost way to deliver massage therapy. In a study we conducted, elderly volunteers massaged infants and toddlers in a nursery school environment.[27] The study was designed to measure the effects of massage therapy on the elderly volunteers giving the massage. Surveys indicate that failure-to-thrive and depression are fairly common among the elderly, with a frequency of 5% to 26%.[28] Symptoms of depression in the elderly are similar to those found in younger persons.[29] In addition, the elderly can experience frequent nighttime awakenings, increased levels of stress hormones and immune system problems.[30] Pet therapy (ie, having and holding pets) has been effective with the elderly,[31] and in our study massage therapy was also effective. In this study the elderly volunteers were randomly assigned to either *give* infants massages or to *receive* massage therapy themselves (Figure 6).[27] At the end of the first month, the volunteers then received the opposite treatment. Each of these sessions was

Figure 6. In the grandparent-aged volunteer study, participants gave massages to infants and received massage therapy themselves.[27]

Figure 7. Levels of stress hormones decreased in volunteer grandparents after giving infant massages.[27]



15 minutes in length for the infant massages and 30 minutes for the grandparent-volunteer massages. The latter sessions were longer simply because a full-body table massage for an adult requires more time. Both the infant and the elderly volunteer massages occurred twice per week for 4 weeks. Following the baseline and end-of-study sessions, the grandparent volunteers reported lower anxiety levels, fewer symptoms of depression and improved mood after both giving and receiving massages. Their stress hormones also decreased after giving massages (Figure 7). After only 1 month of giving or receiving massages, their scores on a lifestlye questionnaire improved. They had more social contacts, made fewer trips to their doctors' offices and consumed less coffee. These changes probably helped improve their sleep and their self-esteem. A somewhat surprising finding was that these improvements were greater after 1 month of *giving* the infant massages than after 1 month of *receiving* massages. Thus, massage therapy was effective not only for the infants receiving them but also for the adults who were giving these massages.

Summary

In summary, massage therapy appears to facilitate growth and development from as early as the fetal stage. Massage therapy given during pregnancy contributes to lower prematurity rates, probably via the mechanism of reduced cortisol levels (a stress hormone) in the mother, leading to lower cortisol levels in the fetus. Massage therapy given during labor lessens labor pain, shortens labor and thereby reduces the stress on the mother and fetus. During the neonatal stage, infants benefit from reduced irritability and more organized sleep, if they are born at term, or enhanced growth, if they are born prematurely and/or experience exposure to cocaine or the human immunodeficiency virus (HIV). Using elderly volunteers, mothers or fathers to deliver the massage is not only cost-effective, but it also benefits the person giving the massage by lowering stress hormones and likely improving health, given that cortisol kills immune cells. These data highlight the importance of adding massage therapy training to birthing classes and in newborn nurseries and neonatal intensive care units (NICUs). According to a recent survey, 38% of NICUs across the US offer massage therapy in their programs (Field et al 2003, unpublished data). Like most other programs, however, only consumer demand will make massage therapy a standard.

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CHAPTER 7:
SKIN-TO-SKIN CARE FOR BREASTFEEDING DIFFICULTIES POSTBIRTH

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Abstract

This chapter reports the results of a study evaluating the status of breastfeeding (BF) for mother-infant dyads having BF difficulties postbirth and given skin-to-skin care (SSC). The hypothesis was that SSC would facilitate successful BF. The focus was on *exclusive* BF (only human milk) as well as on duration, because both measures correlate positively with health benefits. The study involved 50 healthy, fullterm, mother-newborn dyads experiencing BF difficulties between 11 hours and 24 hours postbirth. Participants experienced "SSC with BF" (SB) for 3 consecutive BFs (SB1–SB3) and one BF (SB4) 24 hours after SB1. Two dyads withdrew during the hospital phase. At SB4, of the 48 remaining dyads, 39 (81.3%) were BF exclusively, while 9 (18.7%) were BF partially. At 1-week follow-up, 35 dyads (72.9%) were BF exclusively, 5 (10.4%) were BF partially, 6 (12.5%) were not BF and 2 (4.2%) were lost to follow-up. At 1-month follow-up, 25 dyads (52.1%) were BF exclusively,

9 (18.8%) were BF partially, 13 (27.1%) were not BF and 1 (2.1%) was lost to follow-up. These mother-infant dyads were a select group because they were already experiencing BF difficulties. Thus, the fact that 81.3% of these dyads breastfed exclusively during the early postpartum period is impressive, because this compares favorably with 71.9% based on data from the Ross Mothers' Survey,[1] and the 75% designated as Objective 16–19 for Healthy People 2010.[2] Important insights were also gained about ways to strengthen the intervention, including allowing infants to have uninterrupted sleep and awaken spontaneously, placing infants in SSC at first oral cues and protecting the BF process from interruptions.

Introduction

In the United States (US), women have become increasingly motivated to breastfeed their newborn infants. This motivation emanates from increasing evidence-based information about the benefits of breastfeeding (BF) for their infants *and* even themselves,[3-7] as well as the recommendation that BF be exclusive (using human milk only) for the first 6 months of the infant's life, with the subsequent introduction of complementary foods and continued BF thereafter through at least the first year.[8,9] Although the incidence of BF has increased gradually since 1984, *exclusive* BF, which yields the most benefits, decreased from 87.9% in 1971 to 71.9% in 1998.[1]

In addition to the health benefits of BF, sources of motivation for health-care providers and hospital systems to encourage BF include:

- the seminal workshop on BF and human lactation sponsored by former US Surgeon General C. Everett Koop, MD[10]
- the Innocenti Declaration[11]
- the inclusion of objectives for BF in Healthy People 2000[12] and Healthy People 2010[2]
- the Baby-Friendly Hospital Initiative[13-15]
- the Blueprint for Action on Breastfeeding (2000) set forth by former US Surgeon General David Satcher[7]
- the strategic plan for implementing the Blueprint[16]

However, the intention and motivation to breastfeed do not, of themselves, guarantee success. In fact, mothers frequently fail to successfully initiate and continue BF, often through no fault of their own. Some healthy infants, also through no fault of their own, do not attach to the breast successfully during the first day—a problem often leading to BF failures. Other infants attach but in a less-than-optimal fashion: They attach to the nipple, but not to the areola (the area beyond the nipple). Attaching this way, such infants cannot compress the milk-containing sinuses in the breast with their gums, and thus they receive very little milk. Instead, their gums compress the mother's nipple, causing redness, blisters, fissures, pain and, of course, maternal concern and stress.[17,18] Maternal stress affects the synthesis, ejection and release of milk negatively.[19] Infants naturally become hungry, fussy and disorganized, and they, too, seem stressed. Between periods of sleep from exhaustion, they cry intermittently, which is unhealthy for newborn infants.[20,21]

Stress occurring during the early postpartum period may present serious consequences for newborn infants. In a randomized, controlled trial of 84 fullterm infants, salivary cortisol reached inappropriate levels at 6 hours postbirth in the control infants who were separated from their mothers and received standard procedural care in the hospital nursery for hours 1 through 5.[22] In contrast, the infants who remained with their mothers, as compared with the control infants, exhibited significantly lower levels of cortisol at 6 hours, indicating a healthy recovery from the high levels of cortisol present at birth. Conceivably the inappropriate responses exhibited by the control infants might result in persistent similar responses to stress across the life span. This has been documented in animal models, wherein newborn rat pups that had the least maternal contact (licking, grooming, and arched-back nursing posture) suffered inappropriate stress responsivity. These inappropriate responses to stress can lead to cognitive dysfunction,[25,27] stress-related diseases[23,24,26,27] and susceptibility to addiction.[28]

For dyads who have difficulties with BF, skin-to-skin contact (SSC)—otherwise known as "kangaroo care"—may be a useful, stress-reducing intervention. With SSC, the mother holds her diaper-clad infant skin to skin and underneath her clothing, using a blanket draped across her infant's back for warmth, if needed. SSC is recognized as an

Skin-to-skin contact may be a useful, stress-reducing intervention for dyads who have breastfeeding difficulties.

With skin-to-skin contact, the mother holds her diaper-clad infant underneath her clothing, with a blanket across the infant's back, if needed, for warmth.

important kind of touch by leaders in this area of scientific investigation.[29-32] Studies of SSC also support its safety and beneficial effects in the care of preterm infants and their mothers: Examples include exclusive BF and a loss of only 6.3% of birth weight,[33] increased milk volume,[34] and, at follow-up, a longer BF duration.[33,35] SSC is now used in many neonatal intensive care units (NICUs), and it has been used as an intervention to promote BF.[36] Only 2 small anecdotal studies,[37,38] however, have been reported in which SSC was used as an intervention for mothers and their fullterm infants who were identified as having difficulties with BF.

Harris reported that mothers and their fullterm infants who were having difficulties with BF during the first few days postbirth often had a history of interruption of peaceful mother-baby interactions during the immediate perinatal period (the first 2 hours postbirth).[37] Harris then described how to treat these difficulties that the mother-infant dyad were having with BF: She reported that if the mother and baby are placed together, skin to skin, in a deep bathtub filled with water no warmer than 38°C (100.4°F), even as late as 1 week postbirth, almost all infants will move gradually to the breast, self-attach correctly with minimal assistance within 30 minutes and breastfeed successfully thereafter.

In the second study, a small pilot trial, 5 mothers and their fullterm infants who had difficulties with BF were given SSC for 30 to 60 minutes.[38] As a result, each infant in 4 of these dyads not only located their mother's breast during SSC and attached independently, but they also attached correctly. The fifth dyad was not successful, perhaps because at least 10 extended-family members were chatting loudly in the room during this time. The first 3 dyads, who had not yet breastfed successfully by 18, 20 and 40 hours postbirth, were reported by Meyer and Anderson.[38] However, none of the 5 dyads was followed after their initial, successful BF.

Providing extended SSC postbirth in the hospital results in significantly better BF outcomes for mother and fullterm infant dyads.[39] In fact, when healthy fullterm infants (if unmedicated) were placed on their mothers' abdomens immediately after birth and were allowed to remain there (ie, with SSC), they reached the breast, they attached unaided and they began to nurse successfully within 30 to 60 minutes postbirth.[31,40] Importantly, one third of 70 fullterm infants born at home and given unrestricted BFs and essentially continuous SSC from birth lost no weight.[41] Even when mothers and preterm infants, 34 to 36 weeks gestation, were separated during the first 30 to 40 minutes postbirth and were then reunited for almost continuous SSC thereafter, the infants achieved successful BF during the first few hours with minimal assistance.[33]

Despite this compelling evidence, implementing SSC so soon after birth is difficult, even in certified Baby-Friendly Hospitals because of increased budget constraints.[15,42-44] Unfortunately, when BF difficulties become evident, they are often refractory to a variety of interventions. For these reasons, we conducted the exploratory research reported here, using SSC during BFs (SBs) to answer the following questions:

- In what percentage of these dyads will SBs be successful?
- What percentage of birth weight is lost at hospital discharge?
- What patterns of BF success will occur during the 3 SBs?
- How often will each mother breastfeed between the end of SB3 and the beginning of SB4?
- At study entry, how much BF-related pain will mothers have already experienced?
- Following study entry, how much BF-related pain will mothers experience during each SB?
- How exclusive will BF be at 1 week and at 1 month postdischarge?
- What will be the mothers' evaluations of their BF experiences with their infants?
- Do changes occur in the levels of maternal salivary cortisol after experiencing SBs?

Methods

SAMPLE

Fifty culturally diverse mothers—in the postpartum unit of a large teaching hospital in the upper-midwest US—who had chosen to breastfeed, but who were experiencing BF difficulties, were enrolled following their informed consent. Two mothers withdrew from the study soon after enrollment: One mother withdrew—before the first SB—because the father did not want her to participate. He said "we have had too many interruptions already." The second mother withdrew—soon after the first SB—because her pediatrician told her that her infant would never be able to nurse due to constricted nasal passages. Thus, data from 48 mothers and their healthy infants are reported here (Table 1). Only 6 of the 13 multiparous mothers had breastfed a previous child.

INSTRUMENTS

Demographic and obstetrical data were collected from the medical records of the mothers and their infants regarding the following: prenatal maternal behavior; previous experience with BF; the birth experience; maternal and infant demographics and medical condition; and any previous formula feedings and/or experiences with SSC with the current infant.

Six instruments were used to measure difficulty and success of BF. The Mother-Baby Assessment (MBA), a 10-point measuring tool of maternal and infant BF behavior,[45] was used to observe the progress of the mother-infant dyads as they learned to breastfeed. The MBA has five sequential assessment steps: signaling, positioning, fixing, milk transfer and ending. For this study, "difficulty" was defined as a score of 7 or less. Three Visual Analogue Scales (VASs) were used in the hospital for maternal self-reports of nipple pain, breast pain and BF success. VASs are single-item indicators that ask respondents for their global ratings of specific concepts based on factors salient to them.[46] After the mothers went home and because we were interviewing them by telephone, the VASs were converted to Likert scoring systems. These interviews were done at 1 week and at 4 weeks. The Index of Breastfeeding Scale (IBS) is a measure of duration but, more importantly exclusivity, and was developed in 1988 by an interagency group of representatives from organizations such as the World Health Organization (WHO) and the United

Table 1. Maternal and infant demographic characteristics (n=48).

Variable	Mean	SD(±)	Range
Age (year)	29.0	5.9	18–41
Education (year)	14.9	2.1	10–18
Gestation (week)	39.0	0.95	37–41
Birth weight (gm)	3396	455	2490–4415
Discharge weight (gm)	3171	412	2365–4050
Length of stay (hour)	56.1	29.2*	36.5–230
VARIABLE	N	%†	
Maternal race			
African American	16	33.3	
White	24	50.0	
Asian/Pacific Islander	6	12.5	
Other	2	4.2	
Marital status			
Married	32	66.7	
Single	16	33.3	
Employment status			
Full time	29	60.4	
Part time	7	14.6	
Unemployed	8	16.7	
Student	4	8.3	
Delivery method			
Vaginal	35	72.9	
Cesarean section	10	20.8	
Vacuum/forceps	3	6.3	
Analgesia/anesthesia used			
None	4	8.3	
Pain medication	2	4.2	
Epidural	30	62.5	
Spinal	1	2.1	
Pain medication and epidural	11	22.9	
Smoking‡			
Yes	2	4.2	
No	46	95.8	
Parity			
Primipara	35	72.9	
Multipara	13	27.1	
Infant gender			
Male	24	50.0	
Female	24	50.0	

* SD is large because one infant was admitted to NICU due to hyperbilirubinemia.
† Column percent may not equal 100 due to rounding.
‡ During this pregnancy.

Nations Children's Fund (UNICEF). These representatives were known for their expertise in the area of BF measurement. This group referred to the IBS as a "schema" for definitions of BF.[47] We have since added the acronym and now refer to the schema as "The IBS" in order to facilitate its clinical usefulness. "Exclusivity" is defined as BF with no complementation and no supplementation.[48] Complementation means BF plus formula.[48] Supplementation means formula *not* replacing a BF.[48] The basic IBS is equivalent to the schema and has 6 categories: exclusive; almost exclusive; high, medium, and low partial; and token.

For purposes of data collection in this study, the IBS was adapted to form 8 categories by subdividing the medium partial category into medium high and medium low and adding a category called "none." Therefore, the 8 newly formed categories were called exclusive, almost exclusive, high partial, medium high partial, medium low partial, low partial, token and none. BF exclusivity was coded on a scale of 1 through 8, where "1 = exclusive" and "8 = none." We also added percentages to each category. During analyses for this report, these 8 categories were *collapsed* into 4 categories: exclusive (including exclusive and almost exclusive) 100%, partial (including high, medium high, medium low, and low) (<100% to >5%), token (5% to >0%), and none (0%). The almost exclusive category essentially did not occur in this study.

The fourth instrument was the LATCH, a BF evaluation tool designed for professional assessment based on either observations or questions to solicit responses by the mothers.[49] The LATCH evaluates the following 5 components of BF: how well the infant latches correctly onto the breast; amount of audible swallowing heard at the breast; type of nipple; comfort level of the mother regarding breasts, nipples and position; and the amount of help required to position the infant. Each of the 5 components is scored numerically as a 0, 1, or 2; total possible points = 10. The higher the score, the greater the success and satisfaction with BF, and the more likely the mother will continue with BF.[50]

The fifth instrument, the Maternal Breastfeeding Evaluation Scale (MBFES), is designed to measure both positive and negative aspects of BF that mothers have identified as important in defining successful BF. This tool consists of 3 subscales: maternal enjoyment/role attainment, infant satisfaction/growth and lifestyle/maternal body image.[51] Total possible score is 150 with higher scores indicating greater satisfaction with BF. In addition, we recorded notes regarding potentially confounding events that occurred prior to enrollment (eg, maternal-infant separation and formula feedings) and over the course of the 2-day protocol (eg, maternal distress, procedures such as circumcision or use of a pacifier and the reason for its use).

PROCEDURE

Eligible dyads were enrolled in the study whenever research staffing appeared adequate to cover all data-collection points. The original age for eligibility was approximately 12 hours postbirth. However, because many of the enrolled infants seemed very sleepy at 12 hours, eligibility was expanded after dyad 29 to include infants who were between 12 and 24 hours, a time during which the effects of obstetric medications may have diminished. Recruitment was accomplished in the following manner. The researcher screened dyads for eligibility using the nurse assignment sheet, on which BF difficulties were noted and in collaboration with the nurses. Then, after selecting the mother whose infant's age was closest to the target postnatal age, the researcher approached the mother to explain the study, request her participation and obtain informed consent. If this mother did not consent, the same recruitment procedure was followed for the mother whose infant was next closest to the target age.

Following enrollment on day 1 and approximately 30 minutes before the next BF was expected, the first of 3 consecutive SBs (SB1 to SB3) took place. The fourth SB (SB4) occurred on day 2, approximately 24 hours after SB1 to control for the circadian rhythm of cortisol. Also at this time, the progress of BFs between SB3 and SB4 was evaluated. SB4 generally occurred at a time approaching hospital discharge for the mothers who delivered vaginally and had 2-day stays. At each SB, the diaper-clad infant was placed in SSC on the mother's chest and covered across his/her back with the mother's clothing and a blanket. Quiet, privacy and freedom from interruption were provided as best possible to facilitate maternal relaxation, an apparently important factor in achieving the benefits of SSC for infants.[52]

Maternal saliva was collected first, before and after SB1 and SB4. Data were collected for the VASs immediately before SB1 and after each SB. The MBA and the LATCH were completed immediately after each SB. The IBS was used to measure level of exclusivity before SB1 to learn what had occurred since birth, immediately after each SB to measure each feeding and prior to SB2, SB3 and SB4 to measure relevant events that occurred during the interfeeding intervals (SB1 to SB2 and SB2 to SB3) and during the longer period of time between SB3 and SB4.

If successful BF did not begin after 30 minutes of SSC, a nurse researcher provided assistance. The end of each SB was defined in one of 3 ways: at the conclusion of a successful BF; at the conclusion of a successful BF after assistance was given; or at the conclusion of an unsuccessful BF despite assistance. In the latter case, whenever possible, another SB opportunity was provided within 2 hours of the end of the previous feeding. To avoid disturbing the infant and causing crying, pre- and postfeeding weights were not done.

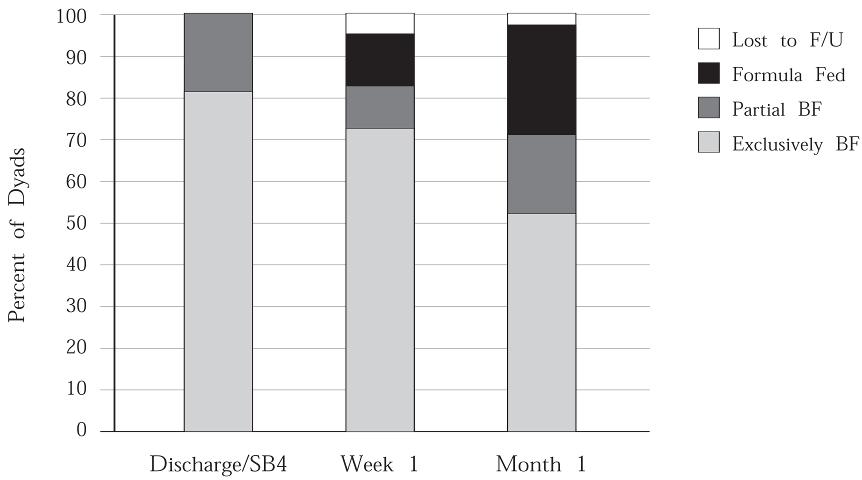
The MBFES was administered after SB4. In addition, the most recently recorded infant weight was obtained. At 1 week and 1 month postnatal ages, mothers were contacted by telephone to evaluate the following: BF exclusivity, using the IBS; BF satisfaction, using the MBFES; and nipple pain, breast pain and BF success, using the Likert scoring system. Data were analyzed using descriptive statistics. The research protocol for each dyad lasted approximately 1 month. The data reported here were collected from February 2002 to December 2002.

Results

At SB4, 48 dyads remained in the study. Of these 48 dyads, 39 (81%) were BF exclusively, while 9 (19%) were BF partially. At 1 week, 2 of the 48 dyads were lost to follow-up, 35 were BF exclusively, 5 were BF partially, and 6 were being fed formula. At 1 month, we re-established contact with one of the dyads lost at 1 week. Thus, only 1 dyad was lost to follow-up, 25 were BF exclusively, 9 were BF partially, and 13 were being fed formula (Figure 1).

Using the last weight measurement before discharge, the average percent of infant weight loss was 6% (SD = ± 3%; range = –2% to 21%). Three of these infants lost more than 10% of body weight (11%, 14% and 21%). The infant who lost 21% was feeding poorly because of “tongue thrust” and did not begin regaining weight until after formula feeding by bottle was introduced. No obvious reasons for the weight loss were identified in the other 2 infants. Forty-one mothers (85%) reported a successful BF after SB1, 40 mothers (83%) reported the same after SB2 and 42

Figure 1. Percentages of dyads who were exclusively BF, partially BF, formula fed and lost to follow-up at discharge/B4 at 1 week and at 1 month follow-up (n = 48).



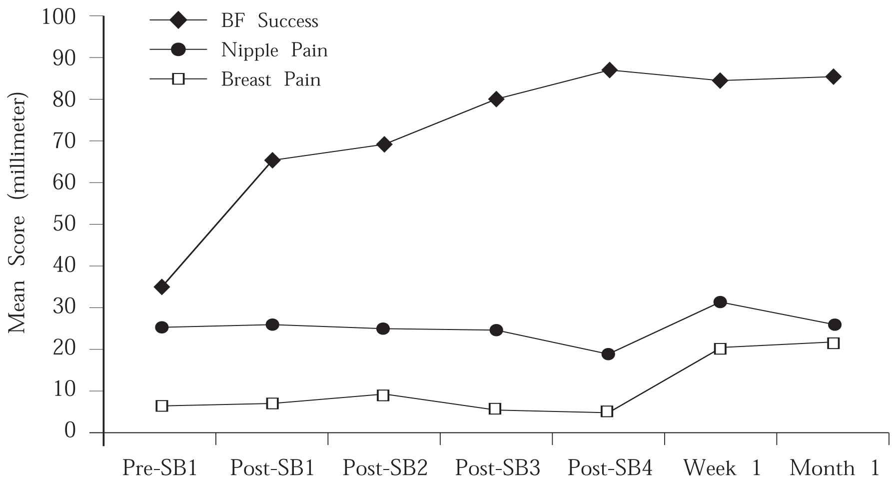
SB = skin-to-skin care with breastfeeding; F/U = follow-up; BF = breastfeeding

mothers (88%) reported a successful BF after SB3. Between the end of SB3 and the start of SB4, 27 mothers (56%) breastfed their infants an average of 8.5 times (SD = ± 4.42; range = 3 to 22).

Based on reports made by the mothers, breast pain was generally low, rose at week 1 and had begun to subside at month 1 (Figure 2). Nipple pain was only slightly higher than breast pain, and had an essentially parallel curve. Mothers' perceptions of BF success increased rapidly with each SB experience and then decreased slightly at week 1 and at month 1. Satisfaction with BF increased over time for the 28 mothers who completed the MBFES at SB4, week 1 and month 1 (120 ± 9.1, 121 ± 14.8 and 122 ± 14.6, respectively).

Saliva samples were collected before and after SB1 and SB4 from the last 20 dyads enrolled. However, samples from only 5 mothers have been assayed to date. In these 5 mothers, mean cortisol decreased from pre-SB to post-SB during each SB1 and each SB4, and was the lowest after SB4. Overall, pre-to-post change scores at SB4 were greater than at SB1 (Table 2).

Figure 2. Mothers' reports on visual analogue scales for BF success, nipple pain and breast pain before SB1, after each SB (1–4) and at 1-week and 1-month follow-up (n=24). Scores represent complete data sets at all 7 times.



SB = skin-to-skin care with breastfeeding; BF = breastfeeding

Table 2. Maternal salivary cortisol levels(μg/dL) before and after SB1 and SB4 (n=48).

	Mothers										
	1		2		3		4		5		Cortisol
SB	H	C	H	C	H	C	H	C	H	C	Mean (SD±)
Pre-1	0920	.26	1000	.61	1100	.53	0900	.48	1010	.43	.46(.13)
Post-1	1100	.19	1130	.60	1213	.34	0935	.32	1420	.09	.31(.19)
Pre-4	0920	.20	0955	.56	1015	.82	1120	.75	1000	.44	.55(.25)
Post-4	1000	.15	1245	.26	1050	.63	1330	.22	1130	.19	.29(.19)

SB = skin-to-skin breastfeeding; H = military time; C = cortisol; SD = standard deviation.

Discussion

These mother-infant dyads were a select group who were chosen for study because they had been identified approximately 12 hours postbirth as being at greater risk for BF failure than most. Nevertheless, 81% (n = 39) of these dyads breastfed exclusively during the early postpartum period. This percentage compares favorably with the 75% for any BF (Objective 16–19 for Healthy People 2010)[2] and the 71.9%, also for *any* BF, for 1998 as calculated by Cadwell,[1] using data from the Ross Mothers' Survey.[53]

Encouraging results were also observed on other measures: For example, 94% (n = 45) of the infants lost ≤10% of their birth weight before hospital discharge. SSC was successful for at least one of the first 3 SBs for 42 (88%) of the mothers. On average, mothers breastfed 8.5 times between SB3 and SB4 (a period of approximately 14 hours). This frequency of BF falls within the range recommended in the guidelines of the Academy of Breastfeeding Medicine,[54,55] which suggest 8 to 12 BFs during the first 24 hours to 48 hours postbirth. In addition, maternal perception of success with BF doubled from baseline after the first skin-to-skin BF (SB1) and remained high thereafter. Upon study enrollment, several mothers had reddened nipples, small blisters and nipple cracks. By SB3, however, their ratings of nipple pain had decreased, suggesting that the SB feedings were less injurious. The perception of breast pain was generally rated low throughout the study protocol. Although saliva from only 5 mothers has been assayed to date, 4 of these mothers exhibited decreases in salivary cortisol levels from pre-SB to post-SB, with the lowest levels at SB4, suggesting lower levels of stress related to SB.

Conclusions are tentative because of the small sample size (N = 48), the one-group design and the brief follow-up period. However, in the process of conducting this study, we have gained numerous insights. These insights may be helpful in understanding some of the problems underlying poor BF outcomes in the US, as well as some of the reasons why many mothers do not choose to initiate BF, do not continue BF once begun, do not advise others to BF and do not plan to BF their subsequent children.

Firstly, although our study was conducted in a women's hospital that has an excellent reputation for providing outstanding care, the BF attempts made by these mothers and their infants were interrupted with astonishing frequency—as often as

19 times in 3 hours and 13 times in just 1 hour. Most guidelines recommend 8 to 12 BFs in the first 24 hours to 48 hours.[8,13,55] However, it must be quite difficult to BF this often, given the frequency of interruptions observed in this study. Some of these interruptions, however—taking the baby to the nursery for the genetic screening heel stick; auditory screening; the physician's physical examination; and the injection of the hepatitis B vaccine—are considered necessary in our present culture, and therefore are part of standard care. Each of these interruptions is done at different times and cannot be done until the health care professional is available. Furthermore, of the 16 male infants who were taken to the nursery for circumcision, 15 (94%) were given nothing by mouth, except for acetaminophen (Tylenol™). These infants were then kept in the nursery, in continued separation from their mothers until the physician was available to perform the procedure. In one case, 5 hours had elapsed and the circumcision was still not performed. The decision was finally made to allow this infant to BF.

Other interruptions resulted from choices that were made, sometimes reluctantly, by the mothers: For example, some mothers allowed a BF to be interrupted so that their infants could be photographed, or sometimes they did not begin a pending BF if visitors arrived or were soon expected. They reported that they wanted to be hospitable, yet they also desired privacy at times and were reluctant to say this to their visitors. Mothers who have recently given birth have physical needs as well, such as pain that makes moving about difficult and feelings of fatigue that make them fearful that they will fall asleep if they continue to hold their infants.[56]

Although interruptions are sometimes mentioned in a list of problems in the literature regarding BF,[10,37,57] these studies have often been conducted without quantification or other emphasis. Thus, hospital personnel are probably unaware of the high frequency with which these interruptions occur. To some degree, this is because numerous personnel and visitors are responsible for these interruptions. Thus, no single person may be aware of the frequency with which these interruptions occur. If noticed at all, such interruptions may be viewed as having little, if any, harmful impact, rather than having a cumulative effect that might interfere seriously with the developing didactic process of mutual caregiving and mutual regulation.[58] The irony here is that the quiet times that are virtually free of interruptions—late evening and during the night—are also the times when the infants are usually in the nursery, rather than rooming-in with their mothers.

Secondly, infants' sleep was interrupted, as well, a phenomenon first documented with preterm infants by Duxbury and colleagues[59] and by Korones.[60] "It is by accident, rather than by intent, that infants are left at rest," said Korones (p. 94).[60] Before long, we realized that we, ourselves, were amongst the interrupters in our own study. We assumed incorrectly that we could predict the appropriate timing of the next BF. Instead, we learned that we could not predict this very well at all. The infants were the ones who knew, perhaps because they became fully rested and developed hunger pangs. Thus, we learned that the *next* feeding must be allowed to occur in a self-regulatory way, based on the quintessential indicators—infant cues, such as awakening, rooting and hand-mouth activity. If the infants were awakened, undressed and placed in SSC near their mothers' breasts, they often fell asleep again, which delayed the feeding and was upsetting to most mothers, or they failed to attach ("latch on") to the breast effectively. In contrast, if we waited until the infants awakened spontaneously from uninterrupted sleep and gave early oral cues, and if we then undressed them gently, they rarely cried. When we then placed them in SSC near their mothers' breasts, they usually sought and found the breasts rather quickly, attached appropriately with ease, and fed well. Under these circumstances, this successful and relatively independent effort sometimes occurred during the first SB.

Thirdly, being gentle, considerate and respectful can make all the difference, not only for the infants, but also for the mothers. Some mothers seem offended or embarrassed by the way some health care personnel assist them with BF. This may be one reason why many mothers who have chosen to breastfeed decide, while still in the hospital, that "breastfeeding is not for me." One common technique for "getting the baby on" is to take hold of the mother's breast with one hand and the back of the baby's head with the other hand, and, as the baby begins to open his/her mouth, to push the baby's mouth as far as possible onto the mother's breast.[61] This technique is employed with the good intention of having the baby latch onto the areola rather than the nipple. However, both the mother and her infant become tense during this process, and the latch is usually neither ideal nor fully effective. In the study by Mozingo and colleagues, mothers reported that this kind of "insensitive care" by health care personnel was the chief reason they decided to terminate BF within the first 2 weeks postbirth.[62] One mother in the study reported here referred to this as "aggressive treatment," and soon thereafter decided to feed with formula. Other mothers simply looked away and did not participate actively in trying to learn how to position their infants most effectively.

Lastly, as time passes without successful BF, concern for hypoglycemia in the infant intensifies, as do well-intended efforts by staff to rush the BF process or to resort to supplementary or complementary feedings with formula. However, according to the guidelines set by the Academy of Breastfeeding Medicine,[54,55] and those set forth by Eidelman,[63] concern regarding hypoglycemia is unwarranted for healthy, fullterm, appropriate-for-gestation infants who have no signs of illness. Eidelman emphasized that his guidelines apply to infants who have been screened carefully for risk and who are provided with what is generally considered ideal care, including the initiation of SSC and BF within the first 30 to 60 minutes postbirth,[(cf. 64)] BF that begins on cue before any crying, and BF that occurs every 1.5 to 2 hours in the first 24 to 48 hours. This kind of care maintains normal temperature[63] and stimulates suckling and milk production.[38] Similar care is also associated with reduced breastfeeding jaundice,[65] a later cause of mother-infant separation and even rehospitalization. An important caveat is that this kind of care is difficult to achieve consistently for all mother-infant dyads in current, typical hospital systems. Thus, the concern regarding infant hypoglycemia remains a valid concern.

The first day, and especially the first few hours, postbirth is a crucial time for the mother and her infant. Their future mutual comfort depends upon an investment of time and effort by the mother during this brief window of developmental opportunity when she *and* her infant are making major physiological adaptations—the infant to extrauterine life and the mother to her postpregnant state. To facilitate these processes, everything possible must be done to meet their needs in a timely, self-regulatory, gentle and respectful way, including helping visitors to understand. In so doing, hospital personnel can provide an additional benefit—modeling these kinds of humane behaviors for mothers and their families.

Closing Thoughts

In closing, we are concerned—*but also encouraged*—by what has been reported in this chapter. BF that is difficult or painful, or both, makes little sense to many mothers or to most observers. This current study is relevant to racial, ethnic and socioeconomic disparities because the most vulnerable women are those who are most likely to falter when difficulties with BF appear. They say, “How can I do this if it is so hard?” Perhaps we have identified, for the first time, a very practical approach to BF difficulties that have already begun: a brief intervention, within easy reach of practicing nurses, that can be used to assist mother-infant dyads who are in the midst of settings that do not routinely allow self-regulatory BF and mutual caregiving that begins with birth and continues thereafter.

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The Dr. Korones quotation has been used with permission of Ross Products Division, Abbott Laboratories Inc., Columbus, OH 43215. From Korones SB. Disturbance and infants' rest. In: Iatrogenic Problems in Neonatal Intensive Care: Report of the Sixty-Ninth Ross Conference on Pediatric Research (1976). Ross Products Division, Abbott Laboratories Inc.[60]

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SECTION III.

TOUCH IN PREMATURE INFANTS

CHAPTER 8: TACTILE STIMULATION OF NEONATAL INTENSIVE CARE UNIT PRETERM INFANTS

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Abstract

This chapter presents a review of studies on tactile stimulation of preterm infants in neonatal intensive care units (NICUs) and during the early months following discharge from the NICU. The studies describe the types of touch received by infants in the NICU as well as the supplemental tactile stimulation provided in the NICU, including still, gentle touch, studies of stroking/massage and studies of stroking combined with kinesthetic or vestibular stimulation. This chapter also summarizes those studies that have described the types of touch received by preterm infants in the early months following discharge from the NICU, as well as those trials that have evaluated the effects of home-based, supplemental, tactile stimulation programs.

Introduction

Annually, approximately 7.6% of live births in the United States are infants who are born prematurely and weighing less than 2500 g.[1] In the same 12-month period, 1.4% of live births are infants who weigh less than 1500 g, and therefore are considered very-low-birth-weight (VLBW) infants.[1] Goldson reported that 20% to 60% of LBW infants have some developmental disability, and 10% to 20% have significant adverse sequelae.[2] Recently, there is increasing recognition of the importance of providing appropriate types and amounts of environmental stimulation to these fragile infants during the early weeks of life to reduce stress and prevent complications, such as intraventricular hemorrhage (IVH), which can increase the risk for subsequent neurological and developmental problems. Although there has been debate over the years about whether preterm infants are understimulated or overstimulated in the neonatal intensive care unit (NICU), there is now a consensus that both problems exist.[3]

In recent years, there has been increasing recognition of the value of providing individualized, developmental care (DC) in the NICU as a strategy to reduce NICU-induced stress and promote optimal health and developmental outcomes in affected infants.[4-9] Although providing *appropriate handling* is generally considered an important component of DC, few studies have evaluated specific types of handling and tactile stimulation provided as a component of DC. Several researchers have suggested the need to identify the types of touch that might be provided to fragile preterm infants to afford them comfort and minimize the stresses associated with the NICU environment.[10] Tactile interaction with their infants is also important for parents of preterm infants, since the desire to maintain contact between parent and infant is a primary component of positive parent-infant attachment.[11] Parents of preterm infants often have limited interactions with their babies during the early weeks of life, and thus are at risk for problems in the development of secure parent-infant attachment relationships.

Most of the touch received by preterm infants who are hospitalized in NICUs consists of touch associated with medical or nursing procedures. These infants receive very little comforting touch.[12-18] Adverse effects of the touch associated with medical and nursing procedures include hypoxia, bradycardia, sleep disruptions and increased intracranial pressure (ICP).[14,17,19-24] Repeated episodes of hypoxia and increased ICP may place preterm infants at increased risk for complications, such as IVH and subsequent neurodevelopmental delays. Because of concerns about the adverse effects of handling associated with medical and nursing procedures, many NICUs have instituted minimal handling policies; that is, limiting the amount of handling provided to preterm infants by both parents and NICU staff members. Unfortunately, such policies are generally applied to *all* touch, thereby limiting potentially beneficial comforting and soothing touch as well as touch associated with medical and nursing procedures.

Types of Handling/Tactile Stimulation Received by Infants in the NICU

Studies that have focused on describing the types of stimulation experienced by infants in the NICU environment have generally concluded that preterm infants receive high levels of stimulation in the NICU, but that much of this stimulation is aversive, not contingent on the infants' cues and responses, and involves handling associated with medical and nursing procedures.[25-27] Preterm infants may be handled as much as 3.5 hours per day[28] or 5% to 38% of observation times.[12] Symon and Cunningham used time-lapsed video recordings of 12 preterm infants in an NICU on the first and third days postbirth.[28] The number of handling episodes ranged from 28 to 71, and ventilated infants received more handling than did infants who were not on ventilators. Contrary to the perceptions of nurses caring for these infants, there was no correlation between the infants' gestational ages (GAs) and their duration of handling.

In contrast to the frequent exposure to procedural touch, preterm infants in NICUs receive relatively little comforting or soothing touch, such as stroking. Using time-lapsed video recordings, Blackburn and Barnard[12] examined caregiving provided to 102 preterm infants: They reported that social stroking was the type of contact observed least frequently. During the 6, 24-hour observation periods, 25 of the infants received no social stroking. Werner and Conway reported similar findings based on 2, 55-minute observations of 11 preterm infants who were 23.5 weeks to 28.5 weeks GA.[18] Only 4.4% of the contacts observed were described as "comfort measures," such as soothing touch, while only 3 of the 11 infants received any comforting touch. Such touch was provided by only one of the nurses observed.

Harrison and Woods examined the types of touch provided by parents and grandparents during 3 visits to their infants in the NICU and found that the types and amounts of touch varied considerably.[29] The sample included 36 preterm infants who were between 25 weeks and 33 weeks GA at birth. The mean total duration of touch during the parental visits was 17.5 minutes, with a standard deviation of 22.6 minutes. Infants less than 28 weeks GA received less touch than did infants who were more than 28 weeks GA. Mothers touched more than did grandmothers, who touched more than fathers. The most frequent types of touch provided by the parents included holding, stroking, simple contact or rubbing. In another report from the same study, Harrison, Leeper and Yoon noted that there were no differences in infants' mean heart rate (HR) or oxygen saturation (OS) levels during parent touch, compared with baseline or posttouch periods, but there was more variability in these measures during the touch periods.[30] In addition, there were significantly more episodes of abnormally low OS levels during periods of parent touch than during baseline period.[30]

Miller and Holditch-Davis observed preterm infants from 7:00 pm to 11:00 pm in the NICU and compared the types of contacts provided to these infants by nurses and parents.[16] Nurses spent more time providing general care, such as feeding, changing, bathing and taking vital signs, or providing high-level care, such as respiratory care or needle sticks. Parents provided more contact, such as touching and holding.

Preterm Infants' Responses to Handling Associated With Medical/Nursing Procedures

Findings from studies that have evaluated preterm infants' responses to handling associated with medical and nursing procedures have consistently demonstrated adverse effects from such procedures, including hypoxia, bradycardia, sleep disruptions, increased ICP and behavioral agitation.[12-24,31] Long, Philip and Lucey tracked continuous recordings of the heart rates, transcutaneous O_2 ($tcPO_2$) levels and respiratory rates of 30 preterm infants for 20 hours per day during the first 5 days after birth.[21] Half the infants were assigned to an experimental group and half were assigned to a control group. Nurses and caregivers of control-group infants were not allowed to observe the $tcPO_2$ recordings, but nurses and caregivers of the experimental-group infants were allowed to observe these measures and, as a result, modified their care to minimize handling that was associated with decreased O_2 levels. Of the incidents of hypoxia that occurred in the control-group infants, 75% were associated with handling. Peters noted that even procedures such as auscultating heart rates or applying blood pressure cuffs were associated with hypoxia, O_2 desaturation or increased ICP.[23]

Several researchers have evaluated the effects of swaddling, tucking or containment as an intervention to reduce stress associated with aversive procedures in preterm infants. Corff found that preterm infants who received facilitated tucking during heel sticks demonstrated lower mean HR, crying time and sleep disruption time than infants in a control group.[32] Fearon, Kisilevsky, Hains, Muir and Tranmer studied the effects of swaddling in 15 preterm infants following a heel lance.[33] The swaddling resulted in increased OS scores, suggesting that this type of touch may help ameliorate the adverse effects of handling associated with medical and nursing procedures. Infants less than 31 weeks postconceptional age (PCA) returned to presampling facial activity patterns almost immediately after the heel stick, whereas those older than 31 weeks PCA demonstrated prolonged behavioral disturbance, as evidenced by facial activity indicating stress, which was reduced significantly by the swaddling intervention. These findings suggest that very small preterm infants may not have sufficient energy or neurological development to maintain behavioral responses to stressors, and, therefore, future research should control for the effects of gestational age when examining behavioral outcomes.

Studies Evaluating Supplemental Tactile Stimulation Interventions in the NICU

To reduce the stressors associated with the NICU environment and excessive handling associated with medical and nursing procedures, several researchers over the past 30 years have examined the effects of interventions designed to provide preterm infants with supplemental comforting touch. These interventions have included still, gentle touch, stroking/massage or stroking/massage combined with vestibular stimulation.

GENTLE TOUCH

Because of concerns that in the early weeks of life many preterm infants are too fragile to tolerate stroking or massage, several researchers have evaluated the effects of still, gentle human touch (GHT) or touch without stroking or massage. Jay provided gentle touch to 13 preterm infants ventilated mechanically for 12 minutes, 4 times a day, beginning when the infants were less than 96 hours old.[34] Compared with a matched control group, the experimental infants had higher hematocrits and required less O_2. Tribotti studied the responses of 4 stable preterm infants (33 weeks to 35 weeks gestation) to gentle touch provided for 15 minutes, 3 times daily, for 3 days.[35] During the first session, infants demonstrated decreased $tcPO_2$, increased respiratory regularity and a slight decrease in motor activity. By the third session, they exhibited increases in $tcPO_2$ and respiratory regularity, and a continued decrease in motor activity.

Findings from 4 additional studies of GHT have been published in 6 separate reports by Harrison and colleagues and by Modrcin-McCarthy.[36-41] Infants enrolled in these studies have ranged from 25 weeks to 33 weeks gestation, and the touch interventions have been provided for 5 days to 10 days, beginning 6 days to 9 days postbirth. The touch consisted of one of the investigators placing a hand on the infant's head and the other hand on the infant's lower back and buttocks for 10 minutes to 20 minutes. In the largest of these studies, the sample consisted of 84 preterm infants between 27 weeks and 33 weeks GA at birth.[38,39] In addition to the usual care given in the NICU, infants in the experimental group received 3 periods of GHT each day for 10 days, beginning when they were between 6 days to 9 days of age. Each GHT lasted for up to 10 minutes, but was discontinued if the infant demonstrated signs of physiological distress (HR <100 BPM or >200 BPM for 12 seconds or more, or arterial OS levels <90% for longer than 30 seconds). Fewer than 23 out of 1280 GHT sessions (<2%) had to be discontinued early. Infants whose GHT sessions had to be discontinued early had significantly lower GAs and birth weights, higher morbidity and neurobiological risk scores and spent more days on supplemental O_2 and more days in the hospital compared with infants who did not require early discontinuation of any GHT session. Continuous computerized recordings were made of infant HR, OS and O_2 concentration levels beginning 10 minutes before and ending 10 minutes after each touch episode. Infant motor activity and behavioral state were scored during these same time periods. Infants in the GHT and control groups were compared on several outcome measures, such as length of hospital stay, average daily weight gain and morbidity status.

No significant differences emerged in mean HR when the investigators compared baseline (B), touch (T) and posttouch (PT) phases. Significant decreases occurred in OS from B to PT and from T to PT, although the differences in the means during these phases were very small and not clinically significant. Significantly lower levels of active sleep, motor activity, behavioral distress and modified behavioral distress occurred during periods of GHT when compared with the B and PT periods. No differences were noted on outcome variables between the experimental and control group infants.

Findings from the studies of GHT suggest that this type of touch has no adverse effects on mean HR or OS levels, but that such touch resulted in increased respiratory regularity, decreased levels of active sleep, motor activity and behavioral distress, and increased levels of quiet sleep during periods of gentle touch when compared with B and PT periods.[35-41] However, no differences were noted on longer-term outcome measures, such as weight gain, morbidity scores or length of hospital stay, in infants who received the GHT intervention when compared with infants in the randomly assigned control groups.[36,40,41]

These findings from the studies of gentle touch suggest that nurses should encourage parents and other caregivers to use GHT when handling physiologically fragile preterm infants in the NICU. Gentle touch might be a useful intervention to soothe infants who are agitated and stressed.

Studies Examining Preterm Infants' Responses to Stroking Without Kinesthetic Stimulation

Studies examining responses to stroking have focused primarily on both immediate and longer-term outcomes. The findings from these studies have been inconsistent, most likely due to differences in the GAs and morbidity levels of the infants in the studies and differences in the types and amounts of touch provided. Adamson-Macedo and Attree noted that the interchangeable use in the literature of terms such as "massage," "stroking" and "rubbing" has led to confusion and misinterpretation of findings across studies.[42] These authors suggested that the term "massage" implies kneading, whereas the term "rubbing" implies friction. They defined stroking as "…to pass the hand (or the fingertips) softly in one direction."[42]

IMMEDIATE OUTCOMES OF STROKING INTERVENTIONS

Kattwinkel, Nearman, Fanaroff, Katona and Klaus provided an intervention that consisted of rubbing the extremities of 6 preterm infants (26 weeks to 31 weeks GA at birth and 2 days to 35 days of age at the time of the study) for 5 minutes of every 15 minutes for 3 hours.[43] Infants exhibited decreased apnea during the stimulation, compared with control periods. In contrast, McGehee and Eckerman found that preterm infants (27 weeks to 32.5 weeks gestation) exhibited more gasping, grunting, moving and state transitions during periods when they used lighter tactile and auditory/tactile stimulation, compared with periods when they had only visual and/or auditory stimulation.[44] Oehler reported that $tcPO_2$ levels of preterm infants (26 weeks to 30 weeks gestation) tended to decrease during periods of light stroking or stroking/talking, but that these levels remained the same or increased during periods of auditory stimulation only.[45] Oehler, Eckerman and Wilson found that light stroking had adverse effects only for the more high-risk infants, and the authors advocated further research to examine subgroup differences among high- and low-risk preterm infants' responses to touch.[46] Infants' responses to stroking also differed according to their individual behavioral states at the time of the stroking intervention. Light stroking led to increased activity levels when the infants were in a quiet state or were visually alert, but there was no change in activity levels or avoidance cues in response to stroking when they were in an active state.

Adamson-Macedo, de Roiste, Wilson, Hayes, Eaton and de Carvalho evaluated the immediate responses of 11 ventilated preterm infants to 3 minutes to 4 minutes of a systematic, light-stroking intervention called Touching and Caressing, Tender in Care (TAC-TIC) therapy.[47] There were no significant decreases in $tcPO_2$ levels during or after the TAC-TIC sessions. Data were also collected that examined changes in $tcPO_2$ levels before, during and after comparable periods of maternal intuitive touch: Consistent with the findings reported by Harrison and Woods described earlier in this chapter,[29] there were significant decreases in O_2 levels during and after maternal touch.[47] The researchers suggested that patterned sequences of stroking movements might be more soothing than random touching to preterm infants.

Daga, Ahuja and Lunkad studied the effects of maternal stroking of the backs of 7 preterm infants—during alternate gavage feedings—who were less than 32 weeks gestation and weighed less than 1600 g.[48] O_2 saturation levels were significantly higher in infants who received the stroking at 20 minutes and 30 minutes after the feeding, compared with a control group.

Findings from the studies examining immediate responses to stroking/massage are mixed, most likely influenced by the GAs and physiological statuses of the infants who were studied and by the types of stroking that were provided. Beneficial effects have included reduced apnea and increased O_2 saturation levels. Adverse effects have included increased motor activity and increased levels of behavioral distress cues (eg, gasping, grunting and state transitions). Further research is needed to evaluate the immediate effects of massage among infants of varying GAs and to determine whether these effects are influenced by infant characteristics such as GA, morbidity status and behavioral state at the time the touch is initiated.

LONGER-TERM OUTCOMES OF MODERATE STROKING/MASSAGE INTERVENTIONS

Solkoff, Yaffe, Weintraub and Blasé provided stroking to the neck, back and arms for 5 minutes each hour during the first 10 days of life to 10 preterm infants, each of whom weighed between 1190 g and 1590 g at birth.[49] Compared with a control group, infants who received the stroking were more active during the hospitalization period, regained their birth weights faster and had fewer developmental anomalies at 7 months to 8 months postdischarge. Solkoff and Matuszak provided 7.5 minutes of stroking during each of 16 hours per day for 10 days to 6 preterm infants.[50] The infants, who were an average of 14.2 days of age when the interventions began, had a mean GA of 31.2 weeks. Infants in the experimental group demonstrated more rapid habituation to light and sound, improved body tone, increased alertness, more consolability, more state changes and more rapid avoidance of noxious stimuli than did control-group infants.

Kramer, Chamorro, Green and Knudtson provided 2 minutes to 3 minutes of stroking before and after feedings each day for a minimum of 2 weeks—for a total of 48 minutes of extra touch each day—to 8 preterm infants who had a mean GA of 33 weeks.[51] Infants in the experimental group had increased rates of social development at 6 weeks and 3 months after transfer to a crib, compared with control-group infants, although there was no difference in weight gain or plasma cortisol levels following heel sticks.

Adamson-Macedo provided supplemental stroking using the TAC-TIC therapy protocol for 10 minutes twice a day during the first week of life to a group of 31 preterm infants who had a mean GA of 32 weeks.[52] For 15 infants, the tactile intervention began within the first 48 hours after birth. For the remaining infants, the touch began 49 hours to 120 hours postbirth. One week after the intervention, compared with a control group of 35 newborns, infants in both experimental groups lost significantly less weight, and infants in the early-stimulation group lost the least amount of weight. Adamson-Macedo et al reported results of a follow-up study of 8 preterm infants who had received TAC-TIC therapy in the NICU.[53] At age 7 years, these 8 children were compared with 6 matched controls who had received systematic tactile or auditory stimulation. The children who received the TAC-TIC therapy scored higher on tests of mental, sequential and simultaneous processing, and they also scored significantly higher on tests of general intelligence.

de Róiste and Bushnell evaluated the effects of a TAC-TIC intervention on 13 preterm infants who were compared with a matched control group of 13 newborns.[54] The TAC-TIC stimulation was provided for 20 minutes each day, beginning on the second or third day after birth and continuing to the day prior to discharge (mean, 17 days). Infants in the experimental group progressed to total nipple feeding and were discharged earlier, and they had significantly higher Bayley mental development scores at age 15 months.

Harrison conducted a pilot study to evaluate a 2-week GHT plus 2-week massage intervention on 12 infants who were 27 weeks to 30 weeks GA at birth.[55] Infants were assigned randomly and equally to an intervention group and a control group. Infants in the control group received standard care in the NICU. In addition to receiving standard care in the NICU, infants in the intervention group received 10 days of GHT for 10 minutes twice each day, beginning when they were 6 days to 9 days old. These infants then received 10 days of massage intervention for 10 minutes twice each day, beginning at age 20 days to 23 days. Screens were placed around the infants' beds during the interventions so that the research assistant (RA) who collected observational data on infants' behaviors and behavioral states would not know whether the infant was in the touch or control group. Five times during each 10-minute intervention phase, the nurse placed her hands on the infant's bed—whether the infant was in the touch group or control group—and the RA then looked around the screen to observe and record infant behavioral state, motor activity and behavioral distress. The GAs and birth weights of infants in the experimental and control groups were similar, although the mean weight of each infant in the experimental group was 129 g more than each control-group infant.

Infants in the experimental group exhibited lower total and average daily morbidity scores than those in the control group (total score, 25.8 versus 59.3, respectively), fewer days in the hospital (44.0 versus 59.8 days) and on supplemental O_2 (13.4 versus 15.0), lower neurobiological risk scores (0.6 versus 1.2), higher average daily weight gain (18.2 g versus 16.9 g) and more optimal scores on the habituation, orientation and autonomic stability Brazelton Neonatal Behavioral Assessment Scale (BNBAS) subscales.[55] Infants in the control group demonstrated slightly higher scores on the motor, state regulation and range-of-state BNBAS subscales. Experimental-group infants experienced slightly more quiet sleep and slightly reduced levels of motor activity during the massage interventions, while control-group infants experienced slightly less quiet sleep during the intervention (for them, no touch) phase. Few changes were noted in O_2 saturation comparing baseline, touch and posttouch phases for experimental-group infants, but there were slight increases in mean HR (approximately 6 BPM) during the massage interventions. Because of the small sample size, it was not possible to assess the statistical significance of these group differences. However, these findings suggest that adding the 2-week massage component to the 2-week gentle touch intervention resulted in positive middle-term outcomes that were not noted in previous studies that included only a gentle touch intervention.

Findings from studies examining middle- and long-term outcomes of moderate stroking/massage interventions suggest that such interventions have no adverse effects. In addition, these interventions offer other benefits, including increased weight gain, reduced levels of morbidity, reduced lengths of hospital stays, improved behavioral organization and improved mental development and increased activity levels.

Studies of Massage Combined With Kinesthetic or Vestibular Stimulation

Studies examining the combined effects of massage and kinesthetic (passive movement or range of motion) or vestibular (rocking) stimulation have generally included infants who were physiologically stable at the time of the intervention. Researchers have generally provided the interventions,[56,57] although in at least one study the intervention was provided by parents.[58,59]

The intervention protocols used have included stroking and massage combined with passive range of motion of the limbs or rocking.[56,58,61-71] Findings from these studies suggest that providing supplemental tactile and kinesthetic or vestibular stimulation offers middle- and long-term benefits, including the following: increased daily weight gain[63,64]; increased secretion of urinary epinephrine and norepinephrine[62]; increased levels of alertness, and more mature orientation, motor skills and range of state[61,63,71]; and more mature habituation behaviors.[61,73]

Field and colleagues have conducted several studies evaluating the effects of a 15-minute massage protocol on stable preterm infants.[61-64] This intervention protocol consisted of 5 minutes of stroking, 5 minutes of kinesthetic stimulation (passive flexion/extension movements) and then 5 minutes of stroking. The infants were placed in a prone position during stroking and in a supine position during kinesthetic stimulation. The initial study included 40 preterm infants, who had a mean GA of 31 weeks and a mean birth weight of 1280 g and who were equally assigned randomly to an experimental or control group.[61] Experimental-group infants received the intervention 3 times daily for 10 days, beginning when they were considered medically stable and admitted to the "grower" nursery. These infants averaged a 47% greater daily weight gain (mean, 25 g versus 17 g), were more active and alert and had more mature habituation, orientation, motor and range of state behavior on the BNBAS. In addition, they were discharged an average of 6 days earlier than those in the control group, resulting in an average hospital cost savings of nearly $3000 per infant.

In a second report from the same study, Scafidi, Field, Schanberg et al described the responses of 14 of the experimental-group infants to periods of stimulation and to no stimulation and to differences in responses to the tactile and kinesthetic components of the intervention.[63] During periods of stimulation, infants in the experimental group spent more time in active sleep, less time in drowsy wakefulness and more time exhibiting active limb movements. The infants were more active and more likely to be in active sleep during tactile stimulation, compared with the kinesthetic-stimulation phase of the intervention.

Similar findings were published 4 years later from a replication study using similar methods, but with a different sample of 40 stable preterm infants.[64] In this study, infants in the experimental group averaged a 21% greater daily weight gain (mean, 34 g versus 28 g), were discharged on average 5 days earlier and had more mature performance on the habituation cluster of the BNBAS scale. In an associated study, levels of urinary norepinephrine and epinephrine increased from Day 1 to Day 10 for the experimental group, but not for the control group.[62] The authors concluded that the intervention promoted greater maturity of the sympathetic nervous system, as evidenced by the increased catecholamine levels for the experimental-group infants.

White-Traut and colleagues have conducted a series of studies evaluating an intervention that includes auditory, tactile, visual and vestibular (ATVV) stimulation.[66,67,70,71,73] The intervention included 10 minutes of stroking combined with infant-directed talk, followed by 5 minutes of rocking and continuous attempts to initiate and maintain eye contact with the infant. This intervention has been used with stable preterm infants as well as with infants who had periventricular leukomalacia (PVL).

Infants have responded to ATVV stimulation, showing slight decreases in body temperature and slight increases in heart and respiratory rates, "although the changes in physiologic parameters have been within clinically normal limits."[67] In 2 of the studies by White-Traut and colleagues, that included infants with PVL, infants who received the ATVV stimulation program in the NICU were discharged an average of 9 days earlier than were infants in a randomly assigned control group.[70,71] In another of these studies, infants in the experimental group received the ATVV stimulation from a researcher in the hospital and then at home from their mothers until 2 months corrected age.[73] Compared with infants in a randomly assigned control group, experimental-group infants exhibited better mental and motor development scores and a lower incidence of cerebral palsy at 1 year of age. These differences were not statistically significant, perhaps because the 1-year follow-up data were available for only 26 of the original 37 infants who were enrolled in the study.

Morrow et al[62] evaluated changes in $TcPO_2$ across 4, 15-minute stroking/kinesthetic stimulation sessions that occurred on the second and ninth days of the 10-day massage program developed by Field et al.[60] During the first of the

4 sessions, mean $TcPO_2$ levels decreased significantly from baseline to the first tactile period and from baseline to the kinesthetic period, but increased from the stimulation periods to the posttouch period. There were no significant effects caused by the tactile or kinesthetic interventions on $TcPO_2$ during the fourth session. Most of the instances of decreased $TcPO_2$ levels occurred during the kinesthetic portion of the intervention, suggesting that movement and pressure applied to the legs during the range of motion intervention may have resulted in artifactual decreases in $TcPO_2$.

Rose and colleagues assigned 60 preterm infants (28 weeks to 36 weeks GA) randomly to either a control or an experimental group.[74] Infants in the experimental group received 3, 20-minute tactile interventions 5 days per week, beginning within the first 2 weeks after birth and continuing until 1 day to 2 days prior to hospital discharge (mean, 13 days). The tactile interventions consisted of massaging the infant while the infant was in prone, supine and sitting positions. When the infant was stable, one of the 3 sessions consisted of rocking the infant in a rocking chair. Just prior to hospital discharge, experimental-group infants demonstrated significantly greater cardiac responses to stimulation with a plastic filament. The researchers also reported that these infants exhibited improved auditory responsiveness during the neonatal period and improved visual recognition memory at 6 months of age.

Several studies have evaluated tactile and kinesthetic/vestibular interventions provided in the NICU by parents of preterm infants. Whipple assigned 20 parents of preterm infants randomly to a control or an experimental group.[59] Parents of experimental-group infants received 1 hour of instruction on the appropriate uses of multimodal stimulation, including massage and music, and ways to identify and avoid overstimulation of their infants. Parents in the experimental group subsequently demonstrated more appropriate interactions with their infants and visited their infants in the NICU more often. Infants in the experimental group demonstrated fewer stress behaviors, had greater weight gain (7.9 g more per day) and a shorter length of hospitalization (16.1 days fewer) than did control infants, although these differences were not significant.

White-Traut and Nelson evaluated the effects of an ATVV intervention administered by mothers 4 times over the first 3 days postbirth to a group of stable preterm infants who were 28 weeks to 35 weeks GA.[58] Compared with mothers who were asked simply to talk or sing to their infants at comparable times, and compared with mothers in a control group, mothers in the ATVV group enjoyed more positive interactions with their infants, as measured by the Nursing Child Assessment and Feeding Scale (NCAFS) at the time of discharge from the NICU.

Vickers and colleagues published a review of 14 randomized trials of human tactile stimulation provided to preterm infants in which at least one outcome was reported that assessed weight gain, length of hospital stay, behavior or development.[10] These authors reported that most of the subjects in the studies reviewed were 30 weeks to 33 weeks GA and were medically stable before the start of the intervention. Tactile interventions were categorized into “massage” and “still, gentle touch.” The investigators noted that many of the massage interventions also included kinesthetic stimulation, and that although most interventions were provided for 5 days to 10 days, the study reported by Rice[56] included massage provided by mothers for 30 days after hospital discharge. The findings of this review are summarized in Table 1.

Table 1. Findings From Studies on Tactile Stimulation of Preterm Infants[56]

Massage and kinesthetic stimulation enhanced weight gain by 5.1 g/d. (This represents a 15% to 20% increase over the 30 g/d typical weight gain for a growing preterm infant.)

- Hospital stays for infants receiving massage was 6 days less than for infants in control groups. This finding has significant implications for healthcare costs, given the average daily charges for an infant in a NICU. Additional research is needed to determine whether such reduced lengths of stay can be replicated with larger and more-diverse samples.
- Infants receiving massage had more-optimal scores on the BNBAS for habituation, motor maturity and range of state.
- Evidence is insufficient to indicate the effects of massage on other developmental outcomes, such as Bayley exam scores.
- Massage reduced postnatal complications, although 95% of the weighting for this analysis came from a study that had a sample of only 30 infants.
- Gentle still touch had no effect on morbidity or weight gain.
- Massage, kinesthetic stimulation and gentle touch had no adverse effects on the infants studied.

Vickers and colleagues, however, noted that there were methodological problems in some of the reviewed studies, including failures to blind observers who assessed outcomes and to ensure that infants in experimental and control groups were treated similarly in all aspects other than the experimental intervention.[10] Because of these methodological problems, these investigators concluded that there was insufficient evidence to determine whether massage should be provided to infants in the NICU. Furthermore, they advocated additional research to assess the effects of massage interventions on clinical outcomes, controlling for methodological problems by concealing treatment allocation until the subject was entered into the trial, ensuring that infants were treated similarly in all respects other than the experimental intervention, blinding observers assessing outcomes to the treatment assignment, assessing whether there are differences in the withdrawals from the study based on treatment-group assignment and assessing longer-term developmental outcomes.

Studies of Touch in Preterm Infants After Discharge From NICU

Studies of touch in preterm infants following discharge from the NICU have focused on evaluating a massage intervention administered by mothers provided in the home and examining relationships between characteristics of mothers' touch and the subsequent development of the parent-infant attachment relationship and of the infant who is born prematurely. Rice studied the effects of an intervention in which mothers were taught to provide their preterm infants a tactile/kinesthetic intervention at home after discharge from the NICU.[56,57] The sample included 30 infants born prematurely who were assigned randomly to an experimental or a control group. Mothers of infants in the experimental group were asked to provide their newborns the intervention for 15 minutes, 4 times each day, beginning on the day when the infants came home from the hospital. Mothers held their infants during the intervention, which consisted of a sequence of strokes using the fingertips and palms and designed to provide more touching of the head than other body parts. Following the stroking, mothers swaddled their infants and rocked them for 5 minutes. Public health nurses visited the mothers in the experimental group each day for the 30-day treatment period. Nurses visited mothers in the control group only once per week, providing them with infant-care information. Infants who received the massage by their mothers gained more weight, demonstrated greater neurological maturation and had higher Bayley Mental Exam scores at 4 months of age.

Weiss and colleagues[75] videotaped 131 mothers and their low-birth-weight infants 3 months after discharge from a NICU (as a component of a larger longitudinal study). The videotapes were coded using the Tactile Interaction Indicator to describe the types and amounts of touch provided during feedings. Nearly half (47%) of the mothers' touch was coded as "nurturing," but 17% of the mothers provided no nurturing touch. There was a positive relationship between the use of nurturing touch and subsequent development of secure attachment (at 12 months of age) for the less-vulnerable infants. However, more-vulnerable infants, who received more-nurturing touch, were more likely to develop insecure attachments. The investigators concluded that the more-vulnerable infants might be more susceptible to overstimulation.

In a subsequent report from the same study, Weiss and coinvestigators examined relationships between the qualities of mother touch provided during the feeding at 3 months after NICU discharge and the child's development at 2 years of age.[76] Infants whose mothers used more-nurturing touch had fewer behavior problems, such as depression and anxiety, at 2 years of age. The authors concluded that the *types* of mother touch provided during the early months may influence subsequent psychosocial development of low-birth-weight (LBW) infants, and that nurturing touch may provide a protective effect for the infants by helping them develop self-regulatory skills. The authors also concluded that there was a need for additional studies of LBW infants to examine relationships between early mother touch and subsequent child development, as well as to test the effects of different tactile stimulation programs on parent-child interaction and on child development.

Summary and Discussion

Findings from the studies reviewed suggest that infants in NICUs receive relatively little nurturing touch.[12,18] Most of the touch they receive is related to medical or nursing procedures, and much of this touch has adverse effects, including hypoxia, bradycardia, increased ICP and sleep disturbances.[21,23,24] Gentle touch is safe for physiologically fragile infants in the early weeks of life. It also has a soothing effect, as evidenced by decreased motor activity and lessened behavioral distress.[39] Stroking and massage may have adverse effects on physiologically fragile preterm infants.[45,46] However, massage and kinesthetic/vestibular stimulation interventions provided in the NICU or in the home after discharge from the NICU have many benefits for stable, "growing," preterm infants, including enhanced weight gain, improved performance on the BNBAS exam, a reduced length of hospital stay and improved developmental outcomes.[53,54,58,61,64,66,67] Results from some studies suggest that the *types* of touch provided by mothers to their preterm infants may have long-term effects on the quality of the mother-infant attachment relationship, as well as on the child's subsequent behavior and development.[75,76] Findings from studies in which mothers were taught to massage their preterm infants suggest that such interventions benefit not only the infant, but also have positive effects on the mother-infant relationship.[56-58]

Additional research is needed to address the methodological limitations in the studies of tactile interventions provided in NICUs to control for the limitations identified in the meta-analysis by Vickers and colleagues.[10] Studies are also needed to examine the relationships between the *quality* and *quantity* of touch provided by caregivers after the infant is discharged from the NICU, the infant's subsequent development and the caregiver-infant relationship. Lastly, there is a need for research that will examine the mechanisms by which early tactile experience influences infant development.

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CHAPTER 9: PRETERM AND FULL-TERM INFANT MASSAGE IN CHINA

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Abstract

During the current study, 405 healthy and sick term and preterm infants were provided massage 3 times per day, for 15 minutes each, for 10 days. Three different types of massage were compared; including the type discussed by Field and colleagues in their article published in *Pediatrics* in 1986 that involves massaging the entire body (overall body massage), a simpler massage covering the head, abdomen, hands and feet, and a simple massage plus the rubbing of acupressure points. Although no significant differences were noted in formula intake, greater increases in daily weight were noted in the group that received the overall body massage and the group that received massage with acupressure points. No significant differences were noted in head circumference or body length. Preterm sick babies also benefited from the overall massage by showing a lesser decrease in their hemoglobin status than did infants in the other groups.

Introduction

A recent meta-analysis performed by Ottenbacher and colleagues documented positive effects for most infants receiving massage therapy.[1] Most of the studies included in the meta-analysis reported greater daily weight gain and increased performance on newborn assessments and developmental assessments for the infants who received massage therapy.[2,3]

Although practitioners in China developed infant massage many centuries ago, and American massage was derived from massage therapy developed in China and India, Chinese infants of this century have not received massage therapy until very recently. Many hospitals in China—including those in Shanghai, where this study was conducted—now routinely teach parents infant massage.

The China Study

METHODS AND PROCEDURES

The sample of 405 infants came from 6 neonatal clinics, including a large children's hospital and 2 municipal-level and 2 district-level maternal-infant medical care centers. Three different types of massage were assessed, including the procedure developed by Field and colleagues,[2] currently being used in North America, the Philippines, Korea and Israel. This involves massaging the infant's entire body, using moderate pressure. The second method that was tried is called the domestic simple-touch massage, in which the head (namely the forehead and the face), abdomen, hands, ankles and feet were massaged. The third method was the same domestic simple-touch procedure *plus* the rubbing of acupressure points. Each procedure was practiced for 15 minutes, 3 times per day, for 10 days. Of note was that these massages were performed by specially trained physicians and nurses, unlike most other massage therapy studies which have used parents or trained research assistants.

The sample of babies was also different from most other massage therapy studies in that it included *normal* term and preterm and *sick* term and preterm neonates. The infants labeled "sick" had been hospitalized with any of the following diseases to a mild degree: pneumonia, apnea, hyperbilirubinemia and scleroderma without complications. The test neonates and controls were assigned randomly to the following 6 groups: normal term infants and controls who received the overall body massage; sick term infants and controls who received the overall body massage; sick preterm infants and controls who received the overall body massage; normal term infants and controls who received the simple massage; normal term infants and controls who received the simple massage plus the rubbing of acupressure points; and sick preterm infants and controls who received the simple massage plus the rubbing of acupressure points. Several measures were recorded: growth items, hemoglobin status, formula intake and performance on a neonatal behavioral and neurological assessment.

RESULTS

The data analyses suggested that the groups did not differ on the consumption of formula. The groups did differ, however, on a number of growth measures. The full-term infants who received the overall massage, the sick term infants who received the overall massage and the normal preterm infants who received the rubbing of acupressure points showed greater weight gain (49 versus 41 grams per day for the term infants who received overall massage versus their controls; 35 versus 27 grams per day for the preterm infants who received overall massage versus their controls; and 27 versus 22 grams per day for the preterm infants who received the acupressure versus their controls). Body length and head circumference were positively affected but only for the term group who received the overall body massage. Similarly, hemoglobin status was positively affected but only for the sick preterm group who received the overall body massage. This was indicated by a lesser decrease than usually occurs and that occurred for the control group—1.98 versus 5.20 g/dL per 10 days. The cumulative scores on the neonatal behavioral and neurological assessment were affected positively for the preterm infants who received overall body massage (4.16 versus 2.63 for the controls), for the preterm sick infants who received the overall body massage (2.36 versus 1.78 for the controls) and for the term infants who received the simple massage plus acupressure (6.30 versus 5.14 for the controls).

Conclusions

The results of this study, performed on healthy and sick term and preterm infants in China, suggest that daily weight gain, as well as head circumference and body length, is affected positively by massage therapy. The results also suggest that even sick preterm infants can benefit from massage therapy: The infants exhibited a lesser decrease in their hemoglobin status following the massage. Consistent with many other studies, the groups who received overall body massage and massage with acupressure showed significant weight gain. It is also notable that the only procedures that appeared to benefit the infants were the methods that provide *moderate* pressure to the whole body and the method that provided *moderate* pressure to acupressure points on several parts of the body. As suggested by Field,[4] the provision of *moderate* pressure, which appears to show superior results to light pressure,[5] may be stimulating an increase in vagal activity, which, in turn, could be activating food absorption hormones. (Please also see Uvnäs-Moberg in this volume.)

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CHAPTER 10: OPTIMIZING GROWTH AND BONE MASS IN PREMATURE INFANTS: ARE DIET AND PHYSICAL MOVEMENT THE ANSWERS?

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Abstract

Premature infants are at increased risk for developing osteoporosis and subsequent fractures. This chapter describes the results of clinical studies that assessed growth and bone mass in premature infants subjected to daily physical movement performed by therapists or mothers, as well as the effects that diet had on these parameters. Results suggest that daily physical movement of these infants increases bone growth and development in very-low-birth-weight (VLBW) infants. Routine care of these infants, which typically involves limitation of movement, appears to decrease the rate of bone formation in premature, VLBW infants. In infants who have low calcium intake, physical movement may decrease bone accretion during periods of rapid bone growth.

Studies performed by my colleagues and I have examined the effects of daily physical movement (PM) administered by occupational therapists (OT) and infants' mothers (MT) on growth and bone mass in premature infants.

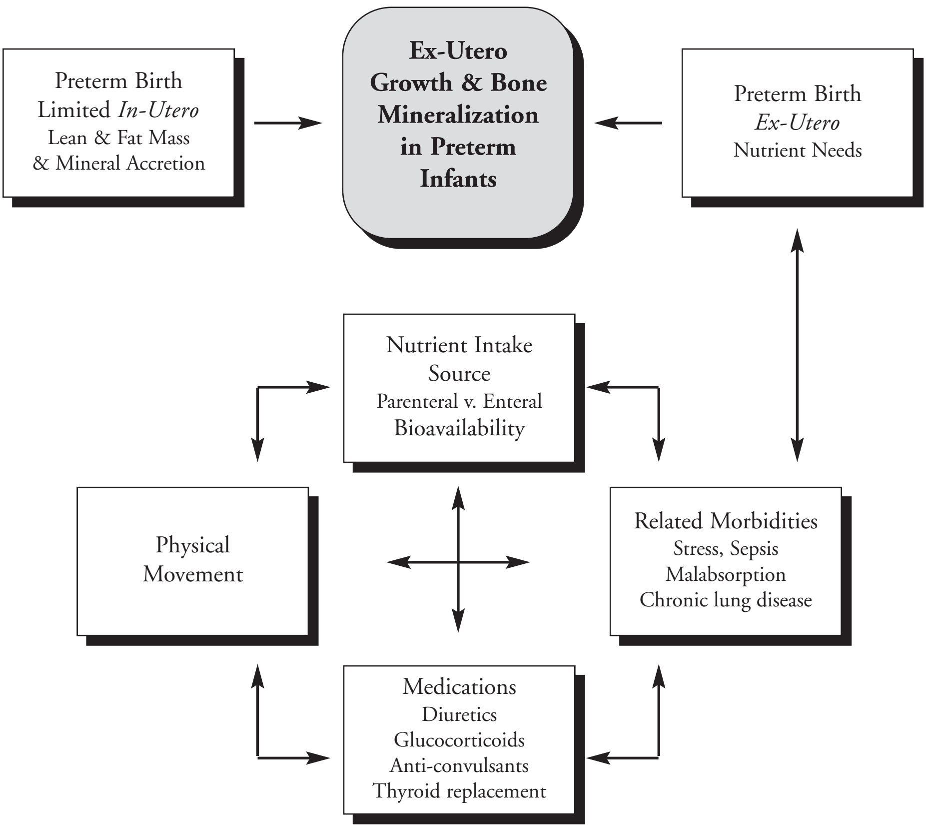
Introduction

Premature infants (<37 weeks gestation), especially those who have gestational ages (GAs) less than 33 weeks and/or birth weights of 1500 g or less, present numerous physiological and developmental concerns, including those involving physical growth and the provision of adequate nutrients to sustain growth. The *ex-utero* growth rate in such infants often lags behind normal *in-utero* growth, especially in very-low-birth-weight (VLBW) premature infants (<1000 g), despite the provision of energy and nutrients at currently advised levels.[1]

Premature infants are also at risk of developing osteopenia (low bone mass) and subsequent fractures due to the following: limited accretion of bone minerals *in-utero*; a greater need for bone nutrients than infants who are delivered at term gestation; and decreased *ex-utero* calcium retention.[1-5] The provision of bone-related nutrients at advised levels increases bone mineralization; however, *ex-utero* mineralization rates do not equal *in-utero* rates, even with gains in normal body weight.[1,3] In addition, bone mineralization in premature infants does not approach normal ranges until after the first year of life,[6] and it may continue to be inadequate into childhood, further increasing the child's risk of fractures.[7]

Several interrelated extrinsic factors have been shown to influence *ex-utero* growth and bone mineralization in premature infants, including the following: energy and nutrient requirements to support the infant's somatic growth rate; the type and quality of dietary and nutrient intake; medications that may alter metabolism or impair renal retention of calcium, such as glucocorticoids, furosemide diuretics and thyroid-replacement preparations; and the multitude of morbidities commonly associated with prematurity (Figure 1).[8]

Fig 1. Extrinsic factors that influence growth and bone mineralization in premature infants.



Mechanical strain on bones and joints stimulates bone formation and growth.[9] Osteoblasts, the cells responsible for bone formation, increase their activity in response to mechanical strain *in vitro*.[10] Weight-bearing physical activity has been demonstrated to increase bone mass in children, young adults and older persons.[11-13] Conversely, the absence of weight-bearing physical activity, such as that observed in immobilized adults or astronauts during prolonged spaceflights, increases bone resorption and renal excretion of calcium and decreases bone mass.[14] Hypomineralized bone, such as that reported in newborn term infants who have neuromuscular diseases, has been attributed to decreased movement *in utero*.[16] Since standard care for hospitalized premature infants includes swaddling or "nesting" and decreased sensory and physical stimulation,[15] these infants receive limited physical movement, which may increase bone resorption and demineralization even when adequate dietary bone nutrients are provided.

Design and Methods

My colleagues and I have conducted several clinical trials to evaluate whether a program of physical movement would promote greater gains in bone mineralization in premature infants[17,18] (also Moyer-Mileur, Ball, Brunstetter & Chan, unpublished data, 2003). The infants enrolled in these studies were healthy premature infants recruited from the newborn intensive care unit at University Hospital, Salt Lake City, Utah. They were eligible under the following criteria: GA of 26 weeks to 32 weeks; appropriate body size; ability to feedings of at least 110 kcal/kg body weight/day; an absence of medications other than appropriate vitamin supplements; and informed parental consent. The University of Utah Institutional Review Board approved these studies.

The infants were matched by birth weight and GA and were fed either mother's milk with powdered fortification (Enfamil® Human Milk Fortifier; Mead Johnson® Nutritionals, Evansville, Ind, USA) or premature infant formula (Enfamil® Premature LIPIL®; Mead Johnson® Nutritionals) at an equal caloric density of 24 kcal/oz.

In the first 2 studies,[17,18] infants were assigned randomly to either physical movement (PM) or control groups. In the third study (Moyer-Mileur, Ball, Brunstetter & Chan, unpublished data, 2003), infants were assigned randomly to PM provided by either an occupational therapist (OT) or the infant's mother (MT). The PM consisted of range-of-motion exercises with gentle compression and extension and flexing of both upper and lower extremities. Each movement was done 5 times each at the wrist, elbow, shoulder, ankle, knee and hip 5 times per week for 4 weeks. (Figure 2). Since tactile stimulation may have influenced growth and development (GD), control subjects were given a daily interactive period of holding and stroking, but no PM activities. Daily body weights and lengths and head circumferences, as well as feeding intakes and outputs, were recorded. Serum and urine samples were collected and analyzed at baseline and study completion to determine markers of growth and bone turnover. A summary description of the 3 clinical studies is provided in Table 1.

Figure 2A (left) demonstrates extension of infant's arm by occupational therapist (OT) against infant's own resistance to the movement.

Figure 2B (right) shows extension and stabilization of infant's leg as gentle decompression is applied by OT to ankle, knee and hip joints.

Table 1. Summary of Clinical Trials of Physical Movement in Premature Infants[17,18]

	MOVEMENT PROTOCOL	MEASUREMENTS
Study 1[17]	Randomized to physical movement (PM; n=13) or tactile stimulation (n=13)	• Daily body weight and nutrient intake and output • Weekly body length and occipitofrontal circumference (OFC) • Baseline and at 4 weeks: bone mass of distal one-third radius by single-photon absorptiometry (SPA), and blood and urine measures of bone mineral status
Study 2[18]	Randomized to PM (n=16) or tactile stimulation (n=16)	• Daily body weight and nutrient intake and output • Weekly body length and OFC • Baseline and at 2-kg body weight: bone mass of forearm by dual-energy X-ray absorptiometry (DXA) and blood and urine measures of bone mineral status
Study 3	Randomized to PM provided by occupational therapist (OT; n=16) or the infant's mother (MT; n=16) (LJ Moyer-Mileur, SD Ball, VL Brunstetter, GM Chan, unpublished data, 2003)	• Daily body weight and nutrient intake and output • Weekly body length and OFC • Baseline and at 2-kg body weight: bone mass of forearm by DXA and blood and urine measures for growth factors and markers of bone mineral status

Results

There were no differences in mean baseline body weights at study entry or at study completion among any of the infants in the 3 clinical studies (Table 2)[17,18] (also Moyer-Mileur, Ball, Brunstetter & Chan, unpublished data, 2003). The rates of change for body length and head circumference were similar and indicated an overall positive trend for all infants. Despite equal energy and nutrient intakes, infants who received PM in both Study 1[17] and Study 2[18] had greater increases in average daily weight than did the control infants. In Study 3 (Moyer-Mileur, Ball, Brunstetter & Chan, unpublished data, 2003), infants who received daily PM by the OT experienced greater rates of daily weight gain than did the control infants,

Table 2. Subject Characteristics and Nutrient Intake During Clinical Trials of Physical Movement in Premature Infants[17,18] *(also LJ Moyer-Mileur, SD Ball, VL Brunstetter, GM Chan, unpublished data, 2003)*

	STUDY 1		STUDY 2		STUDY 3		
	PM n=13	Control n=13	PM n=16	Control n=16	OT n=16	MT n=16	Control n=16
Gestation (wk)	28.2 (1.3)	28.9 (1.5)	29.6 (1.6)	29.8 (1.5)	28.4 (1.0)	28.9 (1.5)	29.8 (1.5)
Birth weight (g)	1207 (172)	1240 (182)	1258 (230)	1283 (199)	1188 (276)	1252 (232)	1283 (199)
Gender	7M/6F	7M/6F	7M/8F	10M/6F	10M/6F	6M/10F	10M/6F
Adjusted age study: Day 1 (wk)	30.0 (1.4)	31.3 (0.9)	31.9 (1.5)	31.9 (1.1)	31.6 (0.8)	32.3 (1.4)	31.9 (1.1)
Days on study	28	28	27	24	29	27	24
Feeding	10HMF/3PTF	9HMF/4PTF	8HMF/7PTF	9HMF/6PTF	6HMF/10PTF	16HMF/0PTF	9HMF/6PTF
Energy (kcal/kg/d)	128 (6)	126 (8)	115 (12)	120 (7)	124 (10)	123 (11)	120 (7)
Protein (g/d)	3.4 (0.2)	3.4 (0.3)	3.3 (0.3)	3.5 (0.3)	3.7 (0.3)	3.7 (0.3)	3.5 (0.3)
Calcium (mg/d)	135 (7)	133 (7)	167 (17)	174 (18)	173 (15)	172 (15)	174 (18)
Phosphorus (mg/d)	68 (2)	67 (2)	84 (7)	88 (7)	88 (7)	87 (7)	88 (7)
Vitamin D (IU/d)	380 (15)	377 (15)	312 (14)	323 (24)	368 (14)	367 (13)	323 (24)

Values presented as the mean (±SD). HMF = Human milk with fortifier. PTF = Premature infant formula fed at 24 kcal/oz. There are no differences in the infants' characteristics or nutrient intake within or between the 3 studies. In Study 3, however, all infants randomized to the MT group were fed HMF.

while no significant differences were found between OT and MT infants or between MT infants and controls (Figure 3).

In addition to greater weight gains found in infants who received PM, significant differences in forearm bone mass were found between Study group 1 and Study group 2 (Figures 4, 5 and 6). At baseline, there were no between-group differences in distal one-third radius or total forearm bone mineral content (BMC; mg), bone area (BA; cm^2) or bone mineral density (BMD; mg/cm^2). After approximately 28 days of intervention, however, my colleagues and I observed significant gains over

Figure 3. Despite similar energy and nutrient intakes, rate of growth (g/kg body wt/d) significantly greater in infants who received daily OT-administered PM vs those randomized to control group (P≤.01, MANCOVA). No differences in growth rates between maternal administered (MT) PM and OT or controls. (Moyer-Mileur, Ball, Brunstetter & Chan, unpublished data, 2003).

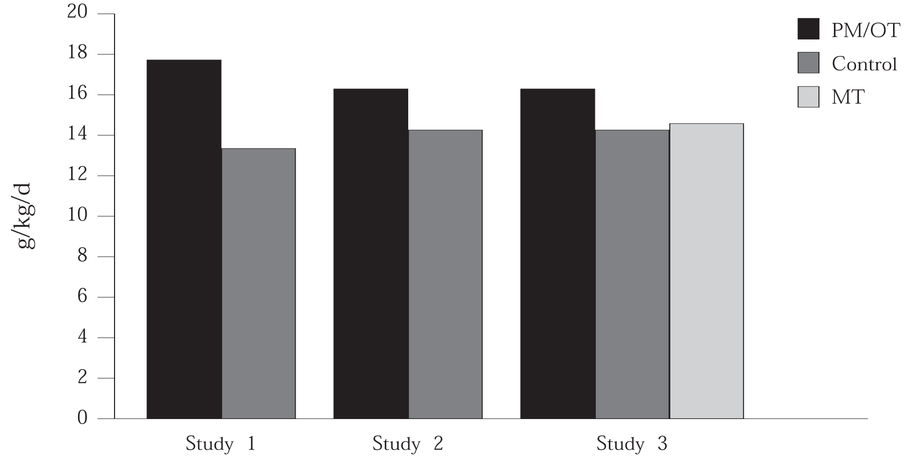


Figure 4. Bone mineral content (BMC; g) change (%) in distal one-third radius, as measured by single-photon absorptiometry (SPA; Study 1[17]*), and total forearm, as measured by dual-energy X-ray absorptiometry (DXA; Studies 2*[18] *and 3*[LJMM, unpublished data, 2003]*), significantly greater in infants who received daily PM administered by OT or MT versus control infants (P≤.02, MANCOVA).*

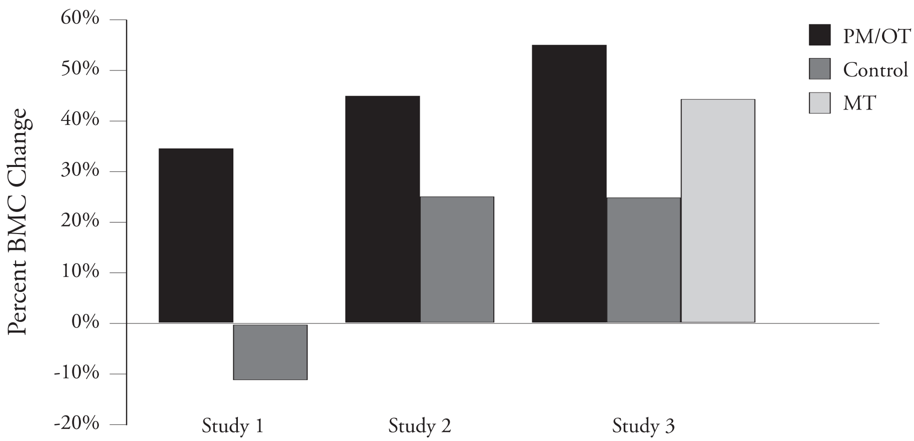


Figure 5. Bone area (BA; cm^2) change (%) in distal one-third radius, as measured by SPA; Study 1[17]*), and total forearm, as measaured by DXA; Studies 2*[18] *and 3.*(LJMM, unpublished data, 2003) *Percent changes in BA were significant only for OT and MT infants versus control infants in Study 3 (P≤.03, MANCOVA).*

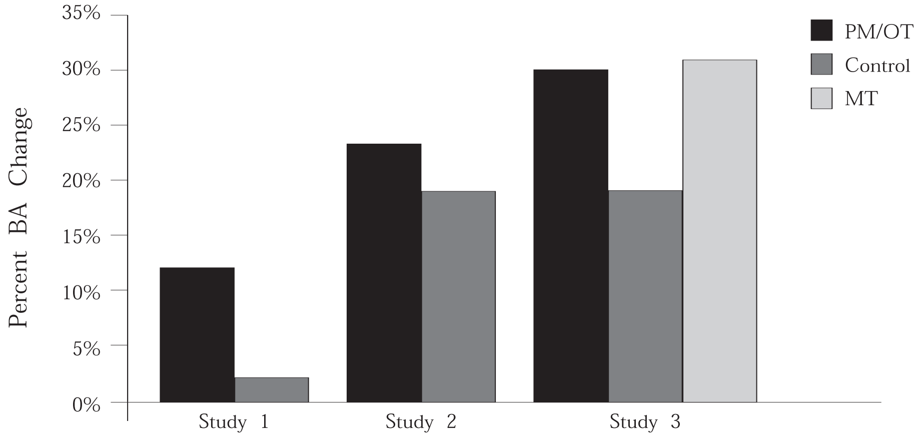
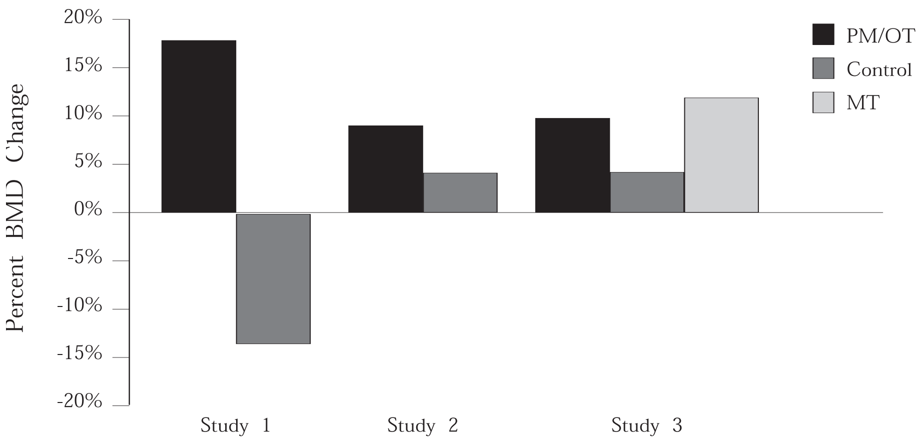


Figure 6. Bone mineral density (BMD; mg/cm^2) change (%) in distal one-third radius, as measured by SPA; Study 1[17]*, and total forearm, as measured by DXA; Studies 2*[18] *and 3*(LJMM, unpublished data, 2003) *significantly greater in infants who received daily PM administered by an OT or the MT versus control infants (P≤.03, MANCOVA).*



time for BMC (*P*<.02; Figure 4) and BMD. The type of feeding source—fortified human milk or premature infant formula—was not found to be a significant cofactor for changes in bone mass over time.

In Study 3 (Moyer-Mileur, Ball, Brunstetter & Chan, unpublished data, 2003), the gains in total forearm BMC, BA and BMD were similar for infants in the OT and MT groups but greater than for control infants (*P*≤.03) (Figures 4, 5 and 6). Although 100% of infants in the MT group received fortified human milk, versus 38% of the infants in the OT group, the feeding source was not found to be a significant cofactor in regard to growth or bone mineralization.

Serum and urine markers of bone activity did not differ between groups in Study 1. However, levels of serum parathyroid hormone (PTH), responsible for regulation of serum calcium homeostasis, were found to be related inversely to BMC at study completion (r=–.83, *P*=.01). In Study 2, PTH levels were greater in infants receiving PM (*P*=.03), although the change from study entry to study completion did not differ statistically and were within normal limits for age. In Study 3, my colleagues and I found that levels of bone alkaline phosphatase (BAP), a marker of bone formation, increased approximately 15% from baseline in MT and OT infants, but decreased approximately 20% from baseline in controls (*P*<.05). Urine calcium to creatinine excretion was similar and within normal limits for all groups.

Discussion

My colleagues and I conducted the first longitudinal, randomized studies to describe the effect of daily PM on growth and bone mass in hospitalized, premature infants[17,18] (also Moyer-Mileur, Ball, Brunstetter & Chan, unpublished data, 2003).

Previous longitudinal studies, using single-photon absorptiometry (SPA) of the distal radius, confirmed the need for higher intakes of dietary calcium, phosphorus and vitamin D to improve bone mineralization in hospitalized, premature infants.[19,20] My coinvestigators and I have also used SPA to assess bone mineralization in premature infants: We found a greater response when a program of daily PM was provided in addition to an adequate intake of bone nutrients.[17] The use of dual-energy X-ray absorptiometry (DXA) in the latter 2 studies allowed for bedside evaluation of a daily program of PM for site-specific bone mineralization in premature infants[18] (also Moyer-Mileur, Ball, Brunstetter & Chan, unpublished data, 2003). Results of these 3 studies provide support for the premise that a program of daily PM enhances bone GD in premature, VLBW infants[17,18] (also Moyer-Mileur, Ball, Brunstetter & Chan, unpublished data, 2003). Although all indices of bone mass increased for all groups, infants receiving PM had consistently greater gains in BMC and BMD. This was true whether an OT or the infant's mother administered the PM.

Bone growth and development is a dynamic process initiated by an increase in bone surface area or matrix and completed by the binding of calcium salts into hydroxyapatite, which fills in to mineralize the bone matrix. Once the bone matrix is formed, an additional 10 days is required for mineralization.[22] An investigator would expect to see, therefore, an increase in BA *before* an increase in BMC or BMD during periods of rapid growth. My colleagues and I suggest that PM maintains bone GD, while routine care, which limits movement, slows the rate of bone formation in premature, VLBW infants. The rise in activity of PTH in infants who received PM in Study 2[18] may have contributed to bone growth and mineralization, since PTH levels increase following physical activity in adults,[23] while therapeutic administration of PTH has been noted to stimulate bone formation.[24] Increases in the activity of BAP associated with PM in Study 3 (Moyer-Mileur, Ball, Brunstetter & Chan, unpublished data, 2003) also indicate enhanced bone formation. The data found by myself and my colleagues support the positive effect that a daily program of PM has on forearm growth and mineralization.

Infants in these studies[17,18] (also Moyer-Mileur, Ball, Brunstetter & Chan, unpublished data, 2003) were fed energy and nutrient intakes at recommended levels.[1] Greater rates of weight gain during the studies, despite similar energy and nutrient intakes between groups, was an unexpected finding. Initial weight loss after birth and the rate of weight gain from birth to study entry did not differ between groups. Weight gain accelerated in infants who received OT-administered PM versus control infants in all 3 trials, although energy and nutrient intakes did not diminish or differ between groups. Current work by my colleagues and myself and others to examine the interaction between PM and growth hormones and mediators and their effect on growth in premature infants may provide answers to this unexpected outcome.

In 1985, the American Academy of Pediatrics stated that the nutritional goal for premature infants is to provide optimal nutrition to support growth equivalent to *in-utero* gain during the third trimester.[25] Nutritional intervention, while helping to promote adequate weight gain, offers variable effects on postnatal bone mineralization in premature infants. Multiple factors influence bone growth and development including diet and PM. Although we have demonstrated the positive effects of PM on bone mineralization in premature infants, a program of PM may prove inappropriate for infants who have poor nutrient intake. Specker, Mulligan and Ho[26] reported on the effects of a 1-year program of PM on BMC in older infants. They found that BMC is related to calcium intake. Randomized PM and control infants who had moderately high calcium intakes had similar BMCs, but low calcium intakes in infants in the PM program resulted in lower BMCs. These investigators speculated that participation in a program of PM during rapid bone growth may lead to reduced bone accretion in the presence of a low intake of calcium. Thus, caution should be used before starting a program of PM in infants who have limited nutrient intake; for example, premature infants fed unfortified mother's milk or standard infant formula, or infants who have a chronic illness or are taking medication that interferes with the delivery of bone nutrients.

Conclusion

In the 3 studies reviewed, my colleagues and I have shown successfully that bone mass indices increase when premature VLBW infants receive daily PM in addition to recommended levels of energy and nutrients. More importantly, we have demonstrated that a program of PM administered by the infant's own mother is equally as effective as a therapist-administered program of PM in promoting greater bone mineralization in premature infants.

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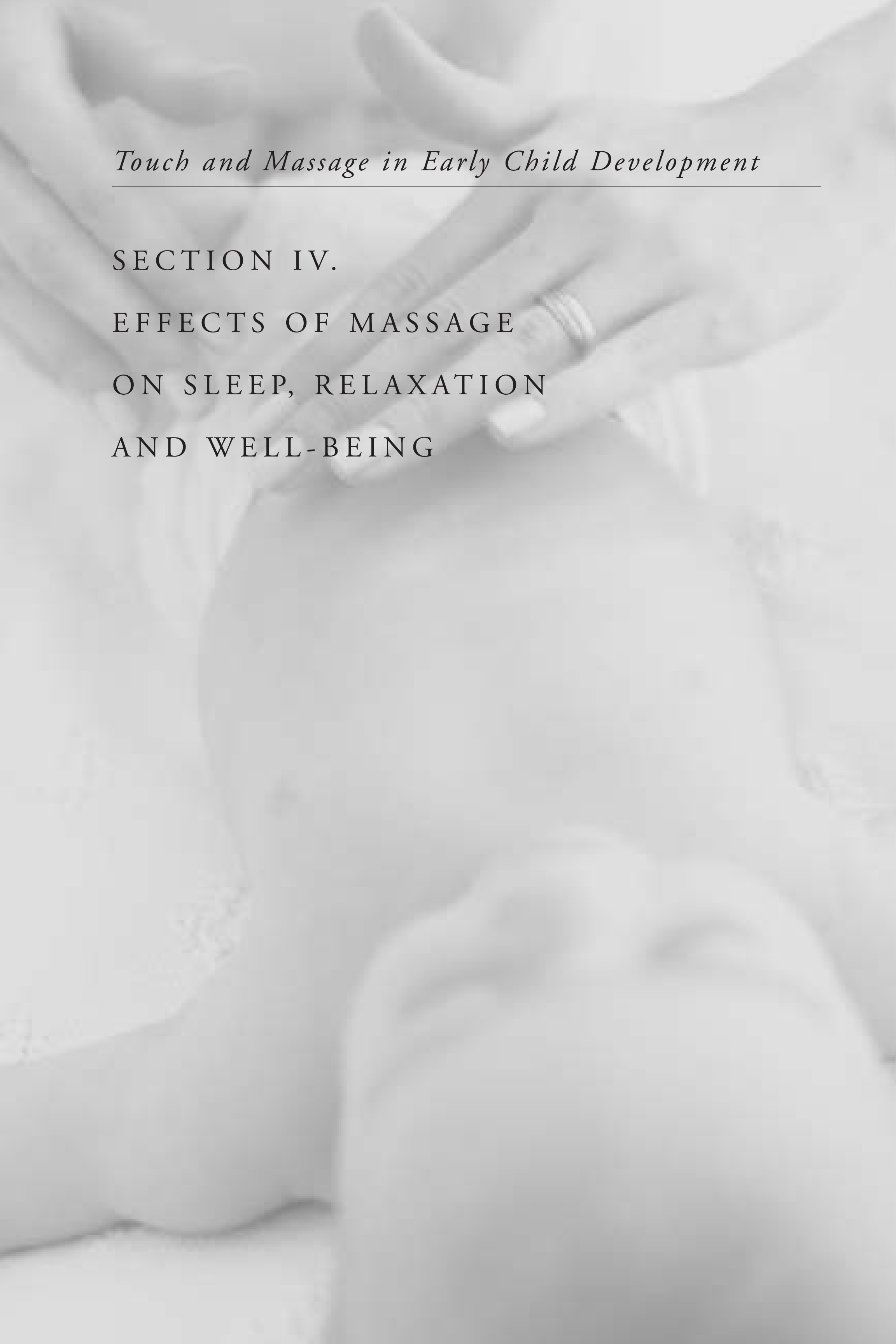

SECTION IV.

EFFECTS OF MASSAGE ON SLEEP, RELAXATION AND WELL-BEING

CHAPTER 11: MASSAGE THERAPY AND SLEEP-WAKE RHYTHMS IN THE NEONATE

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Abstract

The neonate spends most of the perinatal period sleeping. Whereas the full-term neonate sleeps 70% of the 24-hour period, the preterm infant sleeps up to 90% of a full day.[1] Since self-regulation and growth occur during sleep, enhancing sleep and assuring undisturbed sleep by the caregiver are of great importance. In addition, one of the natural and immediate ways to comfort an infant is by holding, touching, stroking and keeping the infant in close physical contact with a caregiver. This chapter provides empirical evidence for the benefits of touch by a caregiver on sleep. The infant's sleep and adjustment to the day-night cycle are described, and the effects of massage therapy are illustrated by empirical data.

The neonate's behavioral states have been considered an expression of neurobehavioral organization.[2] State regulation reflects the infant's capacity to control responses and to adjust to the new environment outside the womb. The night-day, sleep-wake cycle develops before birth. As early as the third trimester of pregnancy, fetal diurnal rhythms are already in tune with maternal day-night rhythms.[3,4] During the first weeks of life, social time cues gain importance, while only at a later stage does light become a dominant environmental cue that entrains the infant's cycles to the 24-hour period.[5-8] Recent studies of full-term Japanese infants showed that the sleep-wake rhythm emerged approximately 1 month after birth.[9] In contrast, studies of European infants have shown that sleep-wake rhythms are organized in infants much later, at approximately 3 months to 4 months of age.[10,11]

Neonates exhibit a greater amount of activity during the night than do older infants.[12-15] Therefore, it is not surprising that considerable maternal distress is associated with infants' disrupted night sleep.[16] Consequently, practitioners have sought methods to enhance the development of sleep-wake rhythms in infants.[12,17]

Melatonin and Social Cues

Melatonin, a naturally occurring hormone released at night and ceased by exposure to light,[18] acts as a sleep regulator and time cue.[19] It also plays a role in visual, cerebrovascular, reproductive, neuroendocrinological and neuroimmunological functions.[20] The melatonin rhythm develops during the first months of postnatal life, from low basal levels at 6 weeks to 8 weeks to maximum capacity at 12 months.[21]

Although bright light is an important time cue, social cues are also important for the entrainment of sleep-wake rhythms. Social cues—including social demands or tasks, such as regularly timed meals and sleep-wake schedules—have been shown to entrain sleep-wake rhythms.[22]

Support for the role of the caregiver in the infant's modulation of states comes from a study conducted by Thoman, Davis and Denenberg in which a group of full-term infants were observed at home at 2 weeks to 5 weeks of age.[23] Data were obtained in 2 social contexts: when the baby was alone and when the baby was with the mother. Fewer state-modulated relationships were noted when the babies were with their mothers than when they were alone. The investigators concluded that the mother is probably acting as a social cue, influencing the infant's adaptation to the day-night environment.

When the infants were with their mothers they were awake most of the time. Their waking states were more numerous and less sustained and the infants were more susceptible to environmental influences than when they were in their sleeping states.[24] Thus, the mothers' activities with their infants appeared to have more effect on the infant during the daytime.

Massage Therapy Enhances the Development of Sleep-Wake Cycles in Full-Term Infants

We conducted a study on the effect of massage therapy on sleep-wake cycles in full-term infants.[24] The objective was to determine if mothers who provided massage therapy as a bedtime routine could affect their infants' sleep-wake cycles. A motion-sensing device measured the rest-activity cycles of these infants before and after 14 days of massage therapy and at 6 weeks and 8 weeks of age. Levels of melatonin were assessed in urine samples at 6 weeks, 8 weeks and 12 weeks.

Mothers in the experimental group were instructed to prepare their babies for sleep following the evening meal and bath, between 8:00 pm and 9:00 pm and to provide 30 minutes daily massage therapy for their infants for 14 days, starting on Day 10 of life. These mothers were instructed to relax, sit comfortably on a sofa and hold their babies in their laps or lay them on the sofa next to them. Mothers were then instructed to roll their infants on their sides and perform massage therapy in a rhythm of 3 movements per second. This massage therapy involved touching the infant's head with one hand and lightly stroking its back in a circular motion under the bedclothes with the other hand. Mothers in the control group performed their usual bedtime activity, but without the massage therapy.

The massaged infants, versus the control infants, achieved more favorable adjustments of their rest-activity cycles at the age of 8 weeks and a higher nocturnal melatonin production at the age of 12 weeks. At 8 weeks, melatonin levels in the control infants reached a peak of activity at about 12:00 midnight and again at approximately 12:00 noon, whereas in the massaged infants, a major peak was reached early in the morning, with a secondary peak in the late afternoon (Figure 1). As indicated in Figure 2, nocturnal melatonin levels at 12 weeks were significantly higher in the massaged infants (1346 nanog/night versus 823 nanog/night, respectively; $P<.05$). Total movement was not affected by treatment. The shift in melatonin peaks towards the early-morning hours in the massaged infants most likely represents an adjustment to the nocturnal period at an age earlier than in the control infants. We concluded that massage therapy given during infants' bedtime routines could be a strong social cue that can affect the development of sleep-wake cycles.

Figure 1. Rest-activity cycles during night and day comparing treatment and control groups at age 8 weeks. Treated subjects displayed delayed primary and secondary peaks of melatonin activity (P<.05).

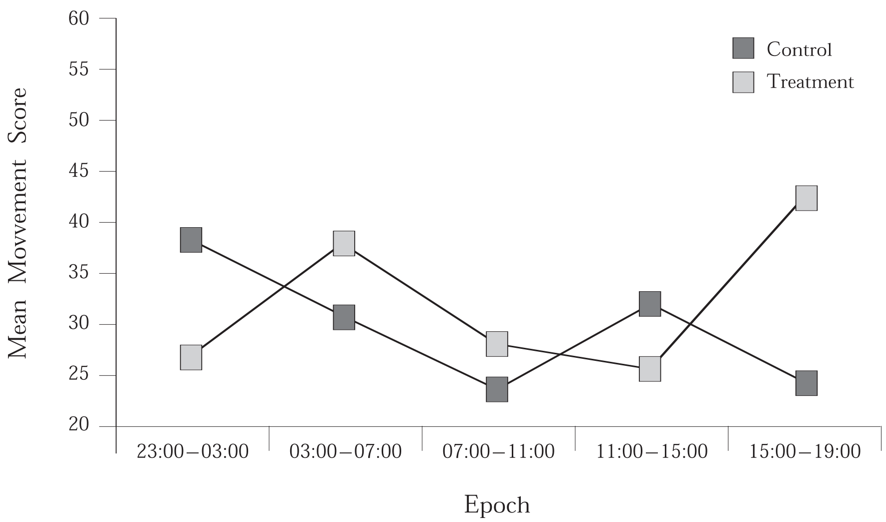
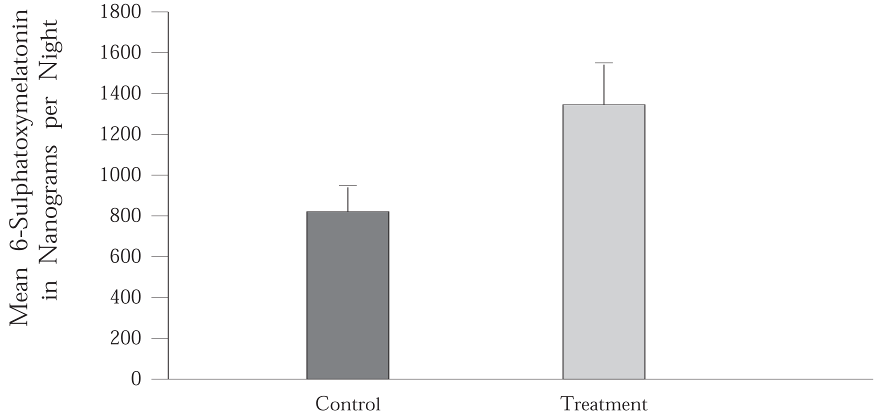


Figure 2. Comparison of levels of 6-sulphatoxymelatonin secretion in treatment and control subjects during the night at age 12 weeks. Levels in the treated subjects were significantly higher (P<.05).



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CHAPTER 12: MASSAGE, RELAXATION AND WELL-BEING: A POSSIBLE ROLE FOR OXYTOCIN AS AN INTEGRATIVE PRINCIPLE?

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Abstract

Massage has been shown to decrease cortisol and anxiety levels. Reduced anxiety is accompanied by an increased sense of well-being. This chapter examines the effects of massage on promoting relaxation, on enhanced sense of well-being and positive social interaction. Oxytocin—a pituitary hormone that stimulates the contraction of uterine muscle and the secretion of breast milk—may play a pivotal role in producing these responses to massage. Studies are reviewed that show increased oxytocin levels in animals, as well as in humans, in response to physical contact between mother and child, such as skin-to-skin contact during breastfeeding. Research has also exhibited decreased gastrin levels in response to massage, suggesting a possible marker of increased social interests and skills.

Introduction

Massage has been used since ancient times to relax muscles, cure disease and promote general well-being. In spite of this, few studies exist that document the positive effects of massage in a controlled scientific manner. In addition, there are only a few studies that attempt to delineate the mechanisms underlying the beneficial effects of massage. Field and colleagues,[1] who represent an exception in this regard, have performed extensive clinical studies on the effects of massage, ranging from studies on premature infants to the effects on patients who have various psychiatric disorders (also see chapter by Field et al, this volume). Most of these studies have demonstrated that massage offers undeniable beneficial effects. In addition to demonstrating the alleviation of specific symptoms, they have typically found decreased cortisol levels. Anxiety levels have also been reduced, and the resulting sense of well-being has increased.[1-3] Massage has also been noted to increase growth hormone, with positive effects on cellular growth.[4]

One of the aims of this chapter is not to summarize the clinical effects of massage, but rather to suggest that massage, in part, exerts its beneficial effects by activating a psychophysiological system that acts in opposition to the "fight-or-flight" system and which therefore promotes relaxation, well-being and positive social interaction. Oxytocin is suggested to be a major organizing principle of these effects at the hypothalamic level.

The "Fight-or-Flight" Response

The "fight-or-flight" response, described by Cannon in 1932, is induced by acute stress, which may be of psychological (perception of fear or threat) or physiological (response to pain or trauma to the body) origin.[5] This response is characterized by behavioral arousal, anxiety, defensive aggression and a physiological pattern consistent with fighting or fleeing. The corresponding neuroendocrine pattern involves activation of the hypophyseal-pituitary-adrenal (HPA) axis and the sympathetic nervous system (SNS). Hypothalamic corticotropin-releasing factor and vasopressin, together with the brain-stem noradrenaline (NA) system, play important regulatory roles.

The hypothesis presented here is that there is an analogous unified pattern characterized by well-being, calm and positive social interactions. The corresponding physiological pattern consists of the relaxation of muscles, decreased cortisol levels and cardiovascular (CV) activity, and enhanced activity in the gastrointestinal (GI) tract that promotes digestion. This pattern, which will be referred to as "relaxation and well-being," can be triggered by environmental and psychological calm as well as by calming physiological stimuli, such as touch and warmth. The vagal parasympathetic nervous system (PNS) (the "physiological slowing system") is activated and sympathoadrenal activity (the "fight or flight system") is shut down. At a central level, hypothalamic oxytocin plays an important integrative role.[6-8]

In contrast to the rapidity with which the fight-or-flight response develops, the state of relaxation and well-being develops slowly. The subjective signs of the latter are subtle and sometimes more easily defined by their *absence*. Yet, relaxation and well-being have distinct psychophysiological patterns, and their expressions can be demonstrated experimentally in several behavioral and physiological model systems. Pulse rate and blood pressure (BP) are kept at a low, healthy and balanced level, and the GI tract, which is controlled by the vagus nerve, is activated, promoting digestion and the storing of nutrients. Energy would rather be used for growth and restorative processes than for muscular or thermogenic activity. Behaviorally, reduced arousal and the development of calm prevail. Subjectively, this might be related to a sense of well-being and relaxation. This state should not, however, be confused with euphoria, which is a more intense feeling of joy and reward.[6-8]

Guido Reni's painting of *Madonna and Child* (Figure 1) captures some of the most significant features of the state of relaxation and well-being. The painting illustrates that this state contains both an individual and an interactive component: The Madonna appears relaxed, calm, content, happy, peaceful, warm, open, generous, empathic and friendly. In the interaction with the child, she displays closeness, trust, loyalty, giving and receiving, as well as love. Individual boundaries are erased, and a sense of unity prevails. The *Madonna and Child* depicts just one example of this state of relaxation and well-being, which can be experienced in a variety of situations, independent of gender and age. Such situations range from the well-being and physiological relaxation induced by a hot bath, by being part of a social group or by receiving massage.

Figure 1. The Madonna with child as an expression of the individual and the interactional aspects of eustasis (Madonna and Child by Guido Reni, 1575-1642).

relaxed
calm
content
happy
peaceful
warm
open
generous
empathic
friendly

closeness
trust
loyalty
giving
receiving
love
unity

Oxytocin as an Agent Behind Relaxation and Well-Being: the Evidence

Since we are suggesting that oxytocin is an important integrating factor in the mediation of relaxation and well-being, oxytocin, as well as its physiological effects, will be described in greater detail. Oxytocin is produced in the paraventricular nucleus (PVN) and in the supraoptic nulceus (SON) of the hypothalamus. Magnocellular oxytocinergic neurons in these nuclei project to the posterior pituitary, from which oxytocin can be secreted to exert its well-known hormonal effects during labor and lactation. Parvocellular oxytocinergic neurons of the PVN, on the other hand, ramify within the brain to reach limbic, medullary and spinal areas: For example, oxytocinergic fibers reach the amygdala, the nucleus tractus solitarius (NTS), the vagal motor nucleus (DMX), the locus ceruleus (LC) and the raphe nuclei of the brain stem.[9] Oxytocin, therefore, acts as both a hormone and a neuropeptide, and the spectrum of effects of oxytocin is much broader than thought previously[10]: For example, it has been shown that oxytocin stimulates various interactive behaviors, such as maternal, sexual and other social behaviors.[11,12] Oxytocin may also produce anxiolytic-like or sedative effects and increase the pain threshold. It also influences CV and GI functions.[13-18] In response to repeated administrations, oxytocin induces long-lasting antistress and growth-promoting effects. In several studies, 5 daily injections of oxytocin induced effects lasting for up to 3 weeks, including anxiolytic-like actions, the lowering of BP, the elevation of pain thresholds and a decrease in plasma corticosterone levels.[19-22] Learning deficits due to high stress levels are improved markedly by pretreatment with oxytocin. It has also been shown to possess antidepressant-like properties in animal models.[23-25] Lastly, this treatment regimen stimulates digestion and anabolic processes, as well as weight gain, growth and healing.[26,27]

Results from neurophysiological and pharmacological experiments as well as results from autoradiography, suggest that the long-lasting effects of oxytocin are related to adaptive changes in central neurotransmitter systems.[20] Increased opioid-like activity is the basis behind the prolonged elevation of pain thresholds.[28] An enhanced α_2-adrenoceptor function, for example, in the amygdala, hypothalamus, LC and NTS, is related to the long-term antistress-like effects of oxytocin.[20,28-30] The NA system, emanating in the LC, which is related strongly to mechanisms of arousal, is inhibited by α_2-adrenoceptor activation, as is the function in the SNS, whereas parasympathetic tone is increased.[31] Consequently, treatment with oxytocin results in an attenuation of arousal and stress levels. In addition, energy conservation will be stimulated.

For the purposes of this chapter, it is important to note that oxytocin is released not only in response to suckling during breastfeeding and in response to labor, but it is also released by nonnoxious stimulation—such as by touch, warmth and stroking—applied to other parts of the body.[14,18,32] Levels of oxytocin rise in plasma as well as in cerebrospinal fluid (CSF) in response to these stimuli. A release of oxytocin in the amygdala has been demonstrated after suckling in sheep[33] and rats,[34] which suggests that oxytocin is released from nerve terminals in the specific brain regions receiving oxytocinergic nerve projections.

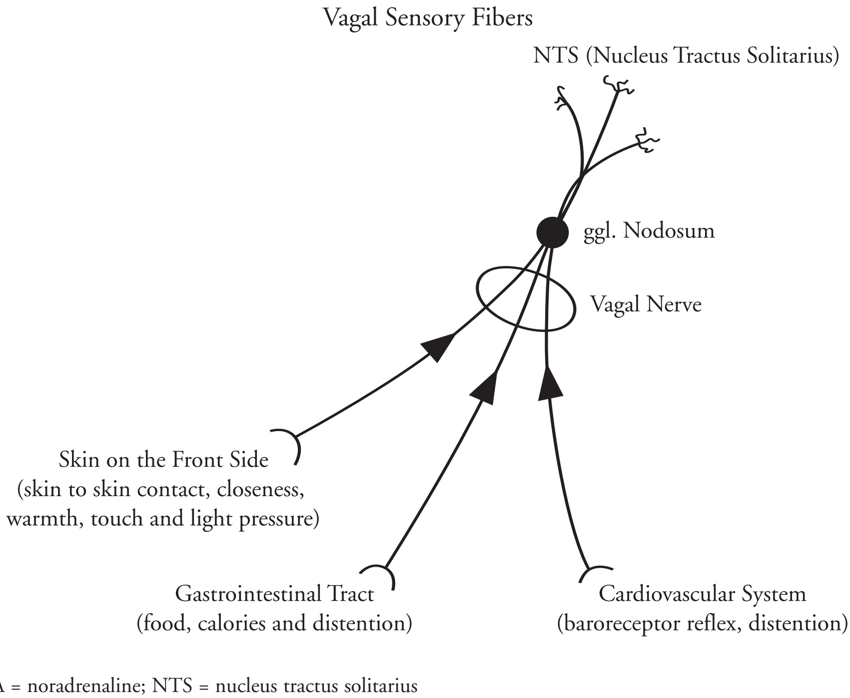
Physiological Mechanisms in the Induction of Relaxation and Well-Being in Response to Physical Contact Between Mother and Child

In their most basic forms, relaxation and well-being are induced by warmth, touch and light pressure. This may occur in noninteractive situations, such as during ingestion of food and exposure to warmth, as well as in interactive situations, such as during closeness, breastfeeding or sexual interactions.[35] The sensory fibers involved include thick myelinated fibers of the A_β type as well as a subpopulation of slowly conducting C-fibers.[36] In addition, some cutaneous afferents originating from the ventral side bypass the spinal cord to reach the vagal sensory area of the NTS via the nodose ganglion.[37] This latter type of sensory fiber should be of particular importance for the induction of well-being and relaxation in situations of close individual physical contact. It should be noted that the effects discussed here are not related to the cortical somatotopic representation of sensory afferents, but rather to effects exerted at limbic or lower brainstem levels.

To elaborate the processes by which touch, warmth and stroking and oxytocin may take part in inducing relaxation and well-being, their roles in the mother-infant interaction are described. This is a situation during which mother and child, via close physical contact, induce relaxation and well-being in each other. When the mother and child are allowed skin-to-skin contact after birth, the newborn baby exhibits a spontaneous breast-seeking behavior. Before he/she starts suckling, the newborn infant massages the mother's breasts with his/her hands.[38] During this period, a pulsatile release of oxytocin is induced in the mother. Interestingly, there is a strong positive correlation between the maternal rise of oxytocin levels and the number of infant hand movements, suggesting that it is the *massage* that induces the release of oxytocin.[39,40] Circulating oxytocin released from the mother's posterior pituitary during this period not only causes milk ejection, but it also induces vasodilation in the skin of the mother's chest.[41] The mother experiences this vasodilation as warmth, which enhances her sense of relaxation and well-being and her interactions with her child. After birth, the child, in turn, responds to the physical contact with the mother by becoming calmer, as expressed by less crying.[42] The child also becomes more relaxed physically, which is evidenced by a higher foot temperature as a result of decreased peripheral vasoconstriction.[43] Interestingly, there is a strong positive relationship between maternal breast temperature and the baby's foot temperature: The warmer the mother's breasts, the warmer the baby's feet, which suggests that maternal temperature influences the sympathetic nervous tone of the baby. In this way, the mother and child in our example are interlocked in a feed-forward process of well-being and relaxation.

At a purely mechanistic level, simple hormonal neurogenic reflexes, as well as more-complex central mechanisms, take part in the mediation and expression of well-being and relaxation when induced by ventral physical contact between the mother and the newborn. In addition to the ordinary sensory fibers that mediate the senses of touch, light pressure and warmth, the cutaneous vagal afferents, which project to the NTS, are activated. At the level of the NTS, sensory stimuli induce a physiological relaxing effect by decreasing sympathetic nerve activity and increasing parasympathetic tone. This results in a lowered BP, increased peripheral circulation and activation of the endocrine system of the GI tract. In a second step, NA pathways that project from the NTS to the hypothalamus are activated. As a consequence, the HPA axis is inhibited, as evidenced by a decrease in plasma cortisol levels. In addition, the secretion of oxytocin is stimulated not only from the pituitary but also from the nerves that project to different areas of the brain. Oxytocin has been shown to exert anxiolytic-like and sedative effects by way of central mechanisms, in part by actions in the amygdala and in the LC. This may, therefore, mediate the calming effect of physical contact. It also elevates the pain threshold by an action in the periaqueductal gray and in the spinal cord (Figures 2A, 2B and 2C).

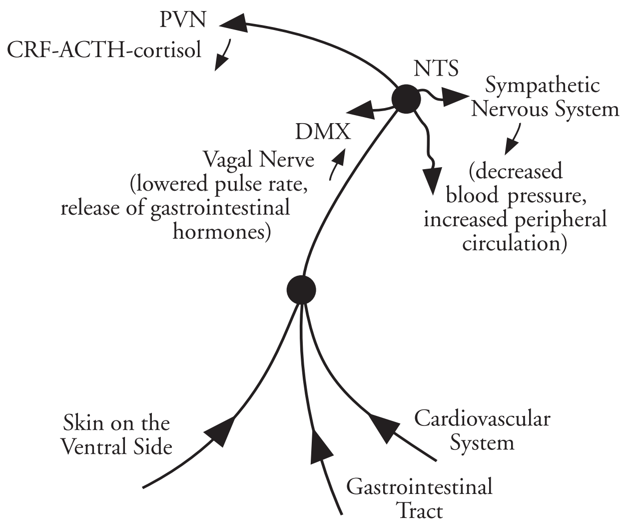
Figure 2A. Schematic illustration of nervous system connections between the skin and the brain: A) vagal afferents.



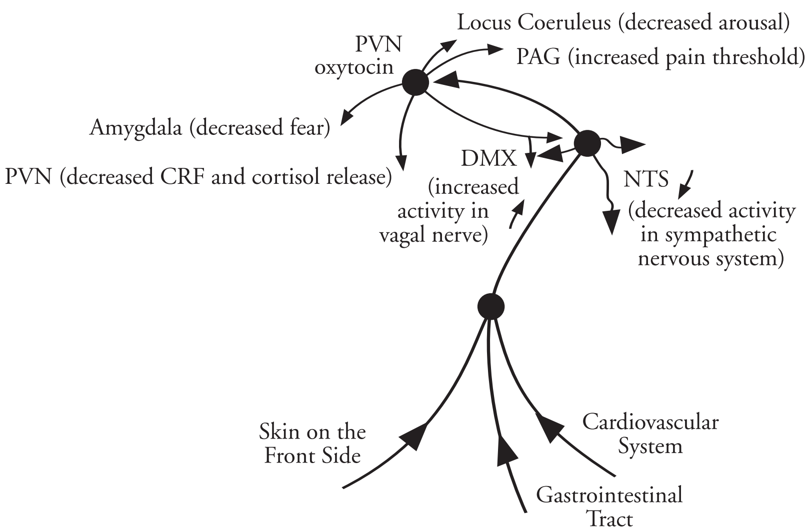
NA = noradrenaline; NTS = nucleus tractus solitarius

Figures 2B and 2C. Schematic illustrations of nervous system connections between the skin and the brain: B) consequences of activation of NA mechanisms in the NTS; and C) consequences of activation of oxytocinergic neurons originating in the hypothalamus.

Effect of Vagal Sensory Stimulation via Reflexes in the NTS



Effect of Vagal Sensory Stimulation via Release of Oxytocin in the PVN



NA = noradrenaline; NTS = nucleus tractus solitarius

Each breastfeeding session has been shown to be related to an induction of calm, decreases of BP and cortisol levels and to an influence of the levels of GI hormones in the mother.[8] In the newborn, suckling is accompanied by a release of GI hormones, such as insulin, and by the expressions of mental calm and increased pain thresholds.[44] Interestingly, premature babies who are placed in skin-to-skin contact with their mothers have not only exhibited lower levels of cortisol but have also shown lower levels of the vagally controlled GI hormones gastrin and cholecystokinin (CCK), thereby suggesting that vagal nerve activity is influenced by ventral physical contact.[45] The implications of this finding are discussed in more detail later in this chapter.

Long-Term Effects of Early Skin-to-Skin Contact and Breastfeeding

Many different sources of information have shown that early skin-to-skin contact between mothers and infants offers long-term benefits.[46] If allowed skin-to-skin contact after birth, mothers interact more frequently with their babies and have more milk and lower gastrin levels 4 days later.[47] In addition, they present a more pulsatile pattern of oxytocin. The number of pulses is related to the sociability of the mothers and how much milk they give their babies.[39,48] In addition, continued breastfeeding is known to be related to sustained beneficial psychological and physiological effects.[8] According to personality trait scales, these mothers are more calm in the sense that they prefer a calm and regular lifestyle.[8] They have also proved to be more interested in social interactions,[49,50] have lower BPs and react with lesser levels of cortisol in response to physical stress.[51]

Taken together, these data indicate that mothers who are breastfeeding and who are exposed to repeated releases of oxytocin develop a psychophysiological pattern characterized by increased social competence, as well as by relaxation and calm—exactly the effect pattern caused by repeated administrations of oxytocin in rats.[15] Although not yet described in the literature, it is possible that endogenous "opioidergic," as well as α_2-receptor, function has been increased as a result of repeated treatments with oxytocin. In support of a role for oxytocin in creating long-term antistress effects in mothers who are breastfeeding are the findings of positive correlations between plasma oxytocin levels and calm personality traits, socialization and social dependency in individual mothers.[48-50]

Effects of Massage: A Possible Role for Oxytocin?

Clinical data suggest that massage given to humans produces many of the physiological signs characteristic of relaxation and well-being, as seen in mothers who are breastfeeding.[8] Furthermore, experimental data obtained from rats suggest a direct link between enhanced levels of oxytocin due to massage and the psychophysiological state of relaxation and well-being.[51] Each rat (both males and females) was stroked on their ventral side for 5 minutes at a rate of 40 strokes per minute, the frequency found to be the most effective.[51] This treatment lowers BP, causes sedation, elevates pain threshold and influences the release of GI hormones.[18,26,52] In support of a role for oxytocin in the coordination of the massage-induced effects, levels of oxytocin were enhanced in the circulation, as well as in the cerebrospinal fluid, in response to this treatment.[51] Furthermore, an oxytocin antagonist blocked some of the massage-induced effects, such as an elevated pain threshold.[18] Interestingly, a sustained anxiolytic-like effect enhanced nociceptive threshold, lowered BP and decreased fasting levels of the vagally controlled hormone gastrin in response to repeated massage-like treatments.

Recent experiments also showed that rats learned conditioned avoidance more quickly and were more interactive socially after being given this massage-like treatment.[53] The rats treated with the massage-like stroking also gained more weight than did the control rats.[53] These effects on the rats are, in fact, exactly the same as those described previously, which occur in response to repeated injections of oxytocin.[15] Also, the administration of an oxytocin antagonist counteracts most of these effects. Taken together, these data support the idea that oxytocin released by the massage-like stroking may be involved in the effects induced by this treatment in adults.[8]

The fact that gastrin levels decreased in response to the massage-like treatment warrants some comments.[8] The hormone gastrin is well-known for its role as a stimulator of secretion.[13] It is released in response to the presence of food constituents in the stomach and by vagal nerve activity. In fact, the vagal nerve serves dual roles, as it may stimulate as well as inhibit gastrin release. The latter "inhibitory" effect is mediated via a cholinergic mechanism.[13] Oxytocinergic neurons project from the paraventricular nucleus to the vagal motor nucleus[9] and intracerebral administration of oxytocin may influence the release of gastrin, suggesting that oxytocin may influence the levels of gastrin via central mechanisms.[54] As mentioned previously, levels of gastrin are lowered not only in response to the massage-like treatment, but also by other types of nonnoxious stimulation of somatosensory afferents, such as by warm temperature and touch.[13] The release of gastrin caused by these stimuli is likely to involve the central oxytocinergic pathway described previously.[8]

Effects of Massage on Hormone Levels in Humans

In the studies performed by Field and colleagues, massage was delivered to humans of different ages who had different types of disease.[1-3] In addition to a reduction of the intensity of specific symptoms found in these studies, more general findings were that massage reduced the levels of cortisol, it decreased BP and it induced an anxiolytic-like effect. All of these effects are consistent with the hypothesis presented previously in this chapter that nonnoxious sensory stimulation promotes social interaction and reduces the levels of anxiety and stress.

We have suggested that oxytocin plays an integrative role in this system.[14] Very few studies, however, have actually demonstrated a release of oxytocin in response to massage in humans. The study mentioned previously in this chapter, in which infant massage released oxytocin in mothers, represents an exception in this regard,[40] as does a study by Turner and colleagues, who also demonstrated the release of oxytocin in some adults following massage.[55] In a recent study undertaken with several of my colleagues, a clear rise was observed in the levels of oxytocin in 10 humans following massage that involved stroking of the shoulders, chest and the abdominal area (Uvnas-Moberg et al, unpublished data). The response—values of oxytocin that were approximately doubled (Figure 3)—which was transient, appeared 10 minutes or 20 minutes after the start of the massage. In another recent study performed with 30 humans—in which no stroking was applied, but muscles were relaxed by applying light pressure—my colleagues and I also observed a significant release of oxytocin in the massage therapist, particularly at the beginning of treatment (Uvnas-Moberg et al, unpublished data). Those who *received* massage in this study displayed clear declines in the levels of GI hormones, especially gastrin, but also in the levels of cholecystokinin (Figure 4). Thus, results of this study indicate that the effects of massage on hormone release are *bidirectional*, since both the massage therapist and those receiving massage were affected. In addition, these results demonstrate that oxytocin is released following various types of massage. In the studies described previously, the rise in the levels of oxytocin was observed in response to stroking movements and following touch and light pressure.[40,55]

Figure 3. Levels of oxytocin in 10 humans before and after receiving stroking and light-pressure massage.[57]

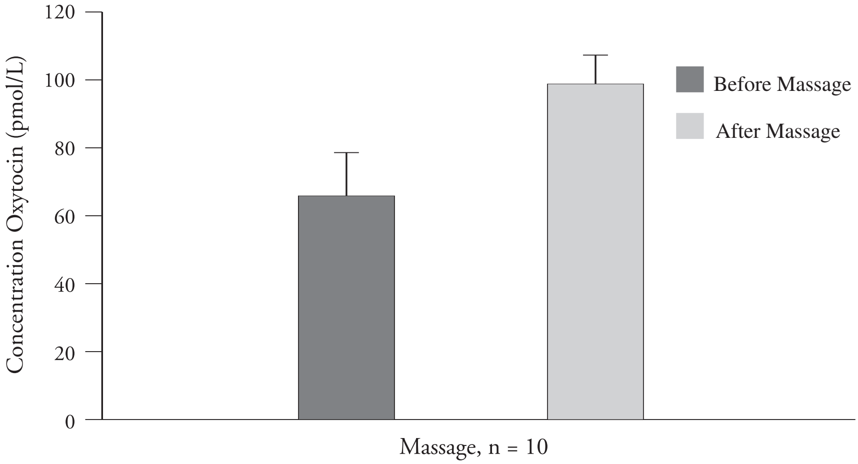
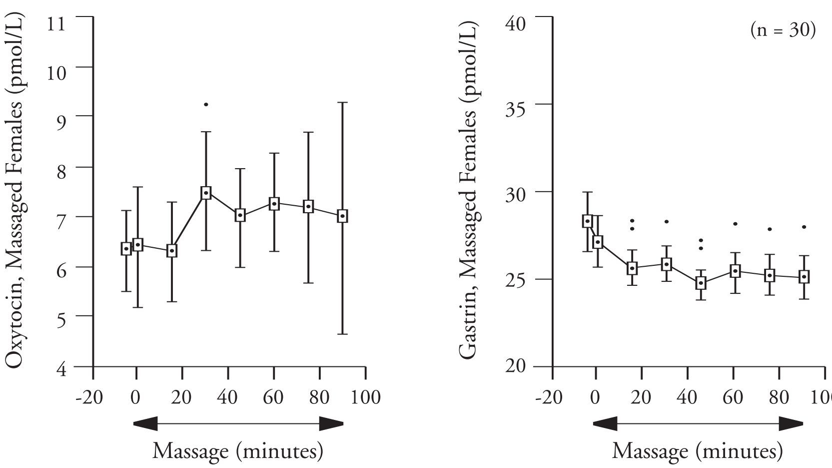


Figure 4. Levels of A) oxytocin and B) gastrin in 30 humans receiving massage consisting of holding and light pressure, but no stroking.[58]



The finding of elevated levels of oxytocin in response to massage supports the hypothesis that oxytocinergic mechanisms may be involved in some of the effects induced by massage. It should be noted, however, that the stress-relieving effects of oxytocin are exerted by release of this hormone within the central nervous system. Therefore, ideally, oxytocin should be measured in specific brain regions to determine the relevance of these effects. However, no such studies have been performed to date, although oxytocin has been shown to be released into the cerebrospinal fluid by massage-like stroking in rats.[15] In addition, a release of oxytocin into the amygdala of lactating sheep[33] and rats[34] has been demonstrated in response to suckling. Since oxytocin that is released in the brain decreases activity in the HPA axis, decreased levels of cortisol may be used as an indication of the oxytocin-induced stress-relieving effect.

Interestingly, the decreased levels of gastrin observed following massage (Uvnas-Moberg et al, unpublished data) may be used as an indirect measurement of oxytocin release in the DMX area, which controls vagal nerve activity, but may also reflect oxytocin-mediated stimulation of social interaction. As noted previously, the levels of gastrin and CCK can be decreased following stimulation of sensory nerves in rats and humans.[45] Levels of gastrin and CCK in rats may be lowered by touch, warmth and stroking via a cholinergic inhibitory vagal mechanism.[56] When premature babies are placed in the “kangaroo” position—ventral skin-to-skin contact with their mothers—levels of CCK fall.[45] During feeding, the response is facilitated.[45] Levels of gastrin decrease only 4 days after birth in women who are breastfeeding who have also been allowed to have skin-to-skin contact with their babies during the sensitive period immediately after birth.[46] These women also have more-pronounced pulsatile oxytocin release in relation to their breastfeeding. In addition, these women have been noted to increase their social interactions with their children.[39,49] Since oxytocin decreases gastrin levels and increases social competence, low fasting gastrin and/or CCK levels may be an indirect reflection of high social interests/skills. Interestingly, such a relationship is supported by, and may explain the unexpected finding of, a strong negative (ie, inverse) correlation between the personality trait “socialization” (as measured by the Karolinska scale of personality) and levels of gastrin in 2 independent studies involving lactating[48] and nonlactating women.[57]

As discussed previously, a subset of sensory nerves, which join the sensory fibers of the vagal nerve, can stimulate the CNS from the skin of the chest and the abdominal area.[41] Ventral physical contact is followed by an immediate state of relaxation and well-being, often in combination with increased social activity. Levels of gastrin and CCK, the vagally controlled hormones, decrease. This effect is caused by activation of inhibitory vagal nerve fibers. Contrastingly, the stimulatory vagal fibers are activated during food intake. In this situation, the levels of gastrin and CCK rise to promote the digestion of food and subsequent anabolic metabolism. From a simplistic physiological point of view, it might be assumed that low levels of gastrin, as a general trait, reflect a stronger mental representation of the skin and "external world" and a consequent activation of the inhibitory vagal fibers. Contrastingly, individuals who have higher basal levels of gastrin might be more influenced by a stronger representation of the GI tract and an "internal world" that might be connected to a higher tone in the stimulatory vagal fibers. The former, externally oriented group of individuals is likely to score higher in the personality trait "socialization" than is the latter, more internally oriented group of individuals. Interestingly, massage may modify these patterns.

Summary

Hormone levels are used to evaluate the effects of massage on humans. Cortisol levels in humans have been noted to decrease following massage and are assumed to reflect an antistress effect caused by the massage. Increased oxytocin levels following massage may be related to antistress-like effects and sociability, whereas lowered levels of gastrin following massage may be a marker of a massage-induced increase in social interests and skills.

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SECTION V.

MASSAGE THERAPY FOR ORPHANS AND PEDIATRIC PROBLEMS

CHAPTER 13: MASSAGE THERAPY WITH PRETERM INFANTS AND CHILDREN WITH CHRONIC ILLNESSES

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Abstract

Research on massage in the Philippines has revealed its positive effects on many functions in infants and children. These findings have led to widespread support of massage therapy in the local pediatric community. This chapter focuses on the results of studies from research in the Philippines on the effects of massage therapy on infant behavior, weight gain, arterial oxygen tension, pain reduction, stress hormones and immunoglobulins, asthma and labor. Massage therapy research on neglected and abused children and burn management is also reviewed.

Introduction

Touch therapy is quickly becoming an integral part of modern pediatric practice. As pediatricians, we have always been cognizant that tactile stimulation exists throughout life, but that it appears to be most intense and crucial during infancy. Several investigators have cited tactile stimulation as playing a very significant role in the growth and development of the infant. For example, Ribble theorized that the infant has inborn "stimulus hunger" for various types of stimulation, including gentle touch, body contact, body positioning and sound.[1] Without regularly available maternal stimulation, the premature infant may consequently be expected to suffer from stimulus deprivation. This consequence eventually affects the neurodevelopmental outcome of these babies. My colleagues and I have investigated the notion that massage therapy, as a medical intervention, would have both physiological and psychological effects on the infant.[2] In studies we have conducted, massage therapy was found to affect metabolism, intestinal motility and glandular, biochemical and muscular function.[3] Psychologically, massage promotes relaxation in infants. As a result of these findings, massage has gained significant support and popularity in our local pediatric community.

As noted by leading neonatologists and gastroenterologists who advocate breastfeeding and essential nutrition for optimal growth and development, breastfeeding needs to be augmented by other kinds of touch, whether through kangaroo care, grooming or massage therapy.[4] Thus, massage therapy has a definite function in a child's nutrition. This is achieved by promoting a relaxed state that is beneficial to preterm infants. Enhancing the level of relaxation of preterm infants during feedings results in greater weight gain, thereby shortening the length of hospital stays.

The massaging of infants provides a gentle and positive stimulus for newborns. This touch therapy is a significant way to maintain and enhance the attachment process between parents and baby. One of the major goals and concerns of pediatricians in the Philippines has been to heighten the neurodevelopmental outcome of children. The value of touch has been supported by several clinically significant studies that highlight the benefits of this relatively inexpensive medical intervention. In many countries, therapeutic massage has been supported by numerous scientific studies, including those conducted at the Touch Research Institute of the Philippine Children's Medical Center. In these countries, massage therapy is no longer an alternative medicine, but rather is now part of routine health care and mainstream medicine. The increasing number of extremely immature and sensitive—*but viable*—newborns constitutes a growing challenge to provide an adequately appropriate extrauterine environment during and immediately following hospitalization. Numerous studies have explored the benefits of providing tactile stimulation for these preterm newborns.[5] This intervention appears to facilitate the recovery of small, sick babies who find themselves in incubators.

Performance on the Brazelton Neonatal Behavioral Assessment Scale

In her award-winning paper on perinatal care, Pablo demonstrated clearly how massage improved performance on the Brazelton Neonatal Behavioral Assessment Scale, especially for those newborns who were not delivered spontaneously and thus did not experience the massage of normal delivery through the birth canal.[6] These babies delivered by cesarean section (C-section) who were massaged also experienced a greater incidence of breastfeeding and rooming-in.[7]

Weight Gain

In an initial study undertaken by Jinon et al, preterm babies exhibited a 45% greater weight gain following 15-minute massages, 3 times per day, for 10 days (Table 1).[8] These babies also were discharged earlier than those who were not given massage. Further, the massaged infants were observed to be more active during the stimulation sessions than during nonstimulation sessions. Following publication of these findings, additional researchers were inspired to explore different aspects of health and development in preterm infants.[9]

Arterial Oxygen Tension

Tirador et al demonstrated the beneficial effects of massage therapy on intubated infants.[10] He reported the lowering of arterial oxygen (O_2) tension among stable babies who were given 15-minute massages, once daily, for 3 consecutive days. The functional, inspired O_2 required to maintain optimal O_2 saturation in "graduates" of the neonatal intensive-care unit (NICU) was reduced notably. The study also revealed that massaged babies experienced significantly higher transcutaneous O_2 levels and a lower fractional concentration of O_2 in inspired gas and pressure requirements compared with control babies who did not receive massage therapy (Table 2).

Table 1. Mean and Standard Deviations for the Formula Intake and Weight Gain

	Massage Group (n = 20)		Control (n = 20)		
Measures	M	SD	M	SD	*P* Value
Average daily weight gain prior to study (3 days) (g)	40	4.2	36	3.7	NS
Average daily weight gain during study (g)	89.7	62.4	61.4	51.8	<.5
Number of feeds/day	12	0	12	0	NS
Average Fluid Intake					
Cc/k/day	17.5	11.5	176.1	12.5	NS
Calories/kg/day	123	11.3	122.6	11.4	NS
Calories/oz	20	0	20	0	NS

NS = not significant

Table 2. Effect of Massage Therapy on Intubated Infants: Comparison of Transcutaneous PO_2 Levels[11]

	Experimental (n = 15)	Control (n = 15)	*P* Value
1st $TcPO_2$	37.4+/-6.4	38.7%+/-11.8	.7085
2nd $TcPO_2$	40.6%+/-4.5	36.3%+/-7.2	.0756
Mean change	3.2+/-8.4	-2.4+/-14	.223486

Pain Reduction

As early as the moment of birth, the infant can already feel pain. Early studies of neonatal development suggested that the neonate's response to pain was decorticate in nature, and that the perception or localization of pain was not present.[11,12] This supposition was believed for many years and was applied particularly to preterm infants who were thought to be incapable of feeling pain since they lacked the fundamental neuronal pathways to transmit messages regarding painful experiences. However, current evidence suggests that pain pathways and the neurotransmitters involved in the transmission of impulses relating to noxious stimuli are well developed at an early stage in gestation and that infants respond to noxious stimuli in a variety of ways.[13]

Infants in the NICU are handled constantly, and the tactile stimuli they receive are often painful and uncomfortable. Unfortunately, there are innumerable ways in which a neonate experiences pain in a modern NICU: Pain-producing interventions—from intravenous lines to nasogastric tubes, from nasal catheters to indwelling cannulas, and from intubations to ventilations—cannot be avoided completely if seriously ill babies are to survive. It would be beneficial for the infants, of course, if the staff in the NICU was trained in massage therapy techniques and allotted adequate time for this intervention.

Infants in the NICU can benefit from tactile stimuli

In 1998, at the University of the Philippines–Philippine General Hospital, NICU workers provided massages during the heelstick procedure. Now, when babies are touched in this unit, they do not invariably feel the infliction of pain.[14] A study by Dimaano-Aliwalas and Cifra showed that massage applied before, during and after a heelstick reduced the infant's response to pain, including a longer latency to crying, a shorter duration of crying and a faster return to baseline (Table 3).[15] The effect of the massage was comparable to that of sucrose in pain reduction. In a similar study by Jarumahum and Cifra, massage proved as effective as sucrose in reducing pain following heelsticks.[16] The authors noted that massage does not have the known disadvantages of labile sucrose levels inimical to brain and adrenal function.

Table 3. Effects of Massage Therapy and Sucrose on Reducing Pain Following Heel Sticks in Infants[16]

	Group 1	Group 2	Group 3	Kruskal-Wallis
Measures	Massage	Sucrose	Control	1-Way Anova
Median	n = 17	n = 17	n = 17	Results
Before Tx				
Heart Rate (bts/min)	135	139	130	NS
Respiratory Rate (brt/min)	44	44	46	NS
O_2 Saturation (%)	0	0	0	NS
NIPS	97	98	97	NS
After Tx				
Cry Duration (min)	2.67	2.50	4.00	P<.05
Cry Latency (min)	3.00	3.00	1.00	P<.05
Time to Baseline (min)	3.00	3.00	5.00	P<.05
NIPS	1.00	2.00	3.00	NS

Dimaano-Aliwalas et al, UP-PGH 1998
NS = Not significant

In research similar to that done on pain in neonates, Senturias et al showed that delivering massage to just one body site—without whole body massage—reduced the perception of pain in that area as well as the perception of general pain body-wide after a painful intramuscular injection.[17] This study involved pediatric patients receiving monthly penicillin injections at a clinic for rheumatic heart-disease patients. Of the subjects who received massage, 83% reported that they experienced decreased levels of pain compared with those who did not receive massage over the injection site. Some of the study's participants, in fact, requested a massage prior to subsequent injections.

Stress Hormones and Immunoglobulins

The response to stress in humans involves increases in the concentrations of catecholamines, including norepinephrine, epinephrine, adrenocorticotropic hormone (ACTH), cortisol, and thyroid hormones, and a concomitant decrease in the levels of serum serotonin. The levels of these stress hormones have reportedly decreased in several studies investigating massage therapy.[5,18,19]

In a study by Serafica and Cifra involving critically ill infants and children, massage therapy reduced the levels of many stress hormones, including ACTH, cortisol, triiodothyronine (T_3) and thyroxine (T_4) (Table 4).[20] It also increased the levels of IgG, IgA and IgM in ill infants (median age, 4.1 months).

In these studies, which were conducted in the NICU and the pediatric ICU, other positive effects were noted anecdotally: better mother-infant bonding and nurse-patient-family interactions and greater family involvement in childcare. In addition, the incidence of breastfeeding was greater and a better acceptance of rooming-in practices was observed. Nurses also reported feeling greater job satisfaction. Parents who were initially tired and hesitant to touch their babies subsequently became relaxed and happy as a direct result of touching their infants, as did surrogate parents and the extended family of grandparents, uncles, aunts and older brothers and sisters who often substituted for the parents in applying massage.

Table 4. Effects of Massage on Serum Stress Hormones and Immunoglobulins in PICU Patients[22]

		Massage Group ISD (n = 20)	Control Group ISD (n = 20)	*P*-Value
Sex Ratio		9:11	10:10	
Age		3.99+/-5.71	4.30 (+/-4.73)	
Cortisol	Baseline	29.17 (+/-13.03)	19.93 (+/-9.87)	
	After 1 week	15.26 (+/-8.3)	16.98 (+/-8.76)	<.01
	Normal	6-28 ug/dL		
T_3	Baseline	1.11 (+/-0.41)	1.06 (+/-0.36)	
	After 1 week	0.74 (+/-0.31)	0.90 (+/-0.33)	.013
	Normal	1.16-4.00 nmol/L		
T_4	Baseline	89.82 (+/-31.72)	89.14 (+/-22.86)	
	After 1 week	67.81 (+/-32.56)	87.05 (+/-21.2)	<.01
	Normal	3.2 - 12.6 ug/L		
IgG	Baseline	146.45 (+/-62.62)	110.02 (+/-52.13)	
	After 1 week	213.9 (+/-82.22)	148.86 (+/-60.43)	.003
	Normal	176-601 mg/dL		
IgA	Baseline	110.39 (+/-68.47)	94.88 (+/-32.91)	
	After 1 week	142.62(+/-86.62)	108.96 (+/-40.36)	.0047
	Normal	44-840 mg/L		
IgM	Baseline	217.48 (+/-101.57)	192.71 (+/-50.77)	
	After 1 week	310 (+/-104.60)	194.20 (+/- 50.77)	.004
	Normal	170-1050 mg/dL		

P value ≤.05

Healing

Moderate pressure massage can enhance the body's energies to promote healing. In addition to reducing the levels of certain types of pain, particularly acute pain, it can alleviate the anxiety that often accompanies pain as well as alter the perception of pain. The "gate control theory" of pain, a potential explanation for the alleviation of pain,[12] states that inhibitory interneurons that block input from the classic nociceptors to the spinal cord are activated by mechanisms that decrease stress.

Asthma

Massage therapy has been shown to improve pulmonary function in children.[21] Similar data were reported by Balanag et al[22] regarding the improvement of pulmonary function in asthmatic children (Table 5). One notable finding is the improvement in FEF 25%-75%, which is a sensitive measure of airflow through small airways. Attitudes toward asthma also improved, which is an important achievement in a chronic disease like asthma.

Table 5. The Effect of Massage Therapy on Pulmonary Function Test and Patient Satisfaction of Asthmatic Patients[22]

	Massage Group (n = 15)				Control Group (n = 15)			
	Pre	Post	Diff	*P*-Value	Pre	Post	Diff	*P*-Value
Pain Assessment Scale (Guilford, 1990)	0.64	0.48	0.16	<.00001*	0.63	0.56	0.06	<.05†
FVC	52.1	61.7	9.6	.03*	58.5	64.7	6.7	.01*
FEV	57.2	61.7	9.6	.03*	64.6	71.7	7.26	.004*
PEF	47.6	67.3	19.7	<.00001*	56.1	63.1	7.06	.001*
FEF (25%-75%)	86.2	100.8	14.6	.02 *	98.9	102.7	3.8	<.05†

**Significant; †Not Significant; P-value = <.05; FVC= Forced Vital Capacity; FEV= Forced Expiratory Volume; PEV= Peak Expiratory Velocity; FEF 25%-75%= Forced Expiratory Flow at 25%-75% of FVC; (% of Predicted)*

Labor

Support during labor is centuries old. According to Klaus and colleagues,[23] the challenge is to use obstetric technology only when necessary, relying instead on the practice of continuous support during labor to help the birth process follow its natural course. This concept maximizes the importance of the doula (a woman who gives care to a pregnant woman during labor). Studies worldwide have revealed that support given by a doula reduces the use of epidural anesthesia by 60% and the rate of C-sections by 30%.[24] This intervention has been shown to play a significant role in unwanted teenage pregnancies: Sarte and Cifra found that unmarried, teenage mothers who were given care by a doula during labor experienced reduced levels of anxiety and pain, shorter lengths of labor and less need for medication (Table 6).[25] Reduced uses of forceps and oxytocin were also noted.

Table 6. Responses to Questionnaires Within 24 hrs of Birth by Unmarried, Teenage Mothers Given Care by Doula (Expressed as Mean ISE)[25]

Variables	n	Support	n	Control	*P*-Value
State Anxiety Scores	45	28.2 (.85)	45	37.8 (1.10)	.00001*
Present Pain Index	45	2.4	45	3.8	.05*
Pain at time of questioning:					
moderate	45	9.0 (20.7)	45	15.0 (43.4)	.05*
severe	45	20.0 (3.3)	45	11.0 (24)	.00001*
Mother's perception of labor:					
very difficult	45	16.0 (34.8)	45	26.0 (59.4)	.002*
coped well	45	24.0 (58.7)	45	11.0 (24)	.00001*
felt very tense	45	14.0 (30.4)	45	27.0 (59)	.00001*
much worse than imagined	45	17.0 (77)	45	28.0 (61.6)	.003*

*Statistically significant

Infants whose mothers received support from a doula have been found to receive more care and touch in the first 20 minutes after birth.[26] The incidences of breastfeeding and demand-feeding were also higher in the group cared for by a doula. Since health problems in these infants also appeared to decrease, the pediatricians at the Philippine General Hospital are actively promoting the use of doulas to their obstetricians.

Future Directions

Several studies involving touch and massage are in progress or are in the planning stages. Ongoing studies are being conducted on neglected and sex-abused children. It is expected that touch therapy will decrease victims' anxiety, depression and aversion to touch. It may also hasten their ability to establish new relationships. In addition, children with autism are expected to benefit from massage therapy: Massage therapy has improved relationships between these special pediatric patients and their caregivers as well as their social environments.[27]

Touch therapy is being used currently to hasten the return of sensory perception and responsiveness in comatose children (unpublished data). Massage may, in fact, enhance circulation and improve mental functioning. Levels of cortisol have decreased notably in comatose patients during massage therapy. This benefit has been accompanied by heightened alertness, based on electroencephalograms showing a decrease in alpha brain waves and increases in beta and theta brain waves—alterations consistent with heightened alertness. These measures, it appears, will continue to be used on comatose children.

Massage therapy has been shown to reduce the incidence and severity of headache and abdominal colic.[28] Infant colic is a very common complaint presented by parents. Massage of the infant during episodes of colic and prior to bedtime may enhance food absorption, increase positive feeding interactions with caregivers, result in more-organized sleep/wake behaviors and reduce irritability and stress behaviors.

Research shows that the management of burns may improve with massage by raising the threshold of pain.[29] Extensive physical handling of the burn patient causes severe-to-excruciating pain. Ongoing research is assessing the levels of depression, anxiety and pain before and after skin debridement as well as how these parameters are reduced if massage is conducted before the skin-brushing procedure.

Pediatric patients with hematological conditions who undergo painful *lifetime* procedures, as well as who suffer the side effects and complications of their prescribed treatments, are another group of patients that may benefit from touch therapy.[30] In fact, massage therapy is now being tested to determine its benefits on those who have experienced frequent painful procedures as well as on its effects on alleviating depression. Expected benefits include lower stress levels during invasive procedures and reduced feelings of helplessness among parents.[31]

Massage therapy has been shown to alter the levels of stress hormones, such as cortisol,[32] and growth hormones, gastrin and insulin, in urine, saliva and blood.[33] Gastrointestinal (GI) hormones, such as gastrin and insulin, are essential for the process of food absorption, which, when enhanced, leads to weight gain. Previous findings suggest that massage appears to increase vagal activity. This, in turn, stimulates the production and release of the GI hormones.[34] Studies conducted at the Philippine General Hospital determined how touch can alter the level of these hormones.[35]

Also being investigated is the *best way* to apply touch. Investigations are assessing whether whole-body touch, touch of areas specifically related to the condition, or procedure-related touch are indicated in specific situations. Studies are also evaluating the use of oils and other materials as mediators to enhance the applications of touch. Results of these various studies will soon be disseminated to health workers and massage therapists in order to deliver this cost-effective intervention most effectively.

Conclusions

Massage therapy has opened up many avenues in health maintenance, the promotion of health, the prevention of disease and even cure. Such diverse applications of touch therapy have encouraged researchers to investigate further and support such applications with clinical trials. Touch therapy has already been shown to be critical to physiological and social development.[36]

Modern endocrinology, neurology, gastroenterology, immunology and sociology laboratories have supported this work. What were once just conjectures and anecdotal observations have now been substantiated pathophysiologically. Thus, modern scientific evidence is revealing what our ancestors have been telling us for a long time—touch maintains and even enhances health.

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CHAPTER 14:

MASSAGE THERAPY EFFECTS ON ILLNESS SYMPTOMS IN INFANTS LIVING IN ECUADORIAN ORPHANAGES

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Abstract

Studies have documented the positive effects of touch on immune function in animals. Clinical trials have also confirmed the positive effects of massage therapy on the health status of children and adolescents who have various illnesses. This chapter focuses on the health issues of children living in orphanages and reports the results of a pilot study that compared the effects of massage therapy versus play sessions on illnesses in infants residing in 2 orphanages in Quito, Ecuador. Results of this study suggested that infant massage reduced the number of days children in orphanages exhibited illness symptoms. Infant massage also had a positive effect on the symptoms they experienced.

Introduction

"Evidence suggests that touch is involved in immune system function, although it is likely that the relationships are indirect," as was noted by Reite.[1] Over the past few decades, several researchers have investigated the relationship between touch and immune function.[2-6] However, since manipulating the use of touch in humans would be considered unethical, researchers must rely on animal studies to inform practice.

Research involving young, nonhuman primates has indicated that being separated from their mothers has a negative impact on their immune systems.[2,3] An increase in cortisol levels, as well as changes in other behavioral and physiological indicators, accompanies this separation in nonhuman primates, which, in turn, negatively affects the immune system.[4] Some research has indicated *prolonged* negative effects of maternal separation on the immune system of nonhuman primates.[5] Worlein and Laudenslager asserted that interactions between mother figures and their peers are necessary for normal immunocompetence.[4] They also stated that infant monkeys reared in nurseries have different behavioral and immune tendencies than young monkeys raised with their mothers.[4] Even when infant monkeys were raised by humans and were allowed to socialize with other monkeys, their immune systems were compromised, although they did not experience behavioral deficits.[6] These findings may transfer to the human population. Infants who are separated from their parents, such as those living in orphanages where emotional and physical care are often neglectful, may experience behavioral *and* health consequences.

Children adopted into the USA often arrive with very incomplete medical histories. More complete health-status-related information often becomes available about these children *after* their arrival into the USA. Johnson and colleagues found that only 15% of children adopted from Romania were physically healthy and/or developmentally normal when they were examined in the USA.[8] Similarly, Albers and colleagues reported that many children adopted into the USA from the former Soviet Union and other eastern European countries were diagnosed with a variety of conditions, the most common (51%) being intestinal pathogens.[9] These were retrospective studies that occurred *after* adoptions by families in the USA. Even when health-status information exists from the native country, Albers and colleagues stated that it tends to be sporadic and often incorrect.[9] Although only scant information is available regarding the health status of children housed in orphanages, existing retrospective work[7-9] indicates that a substantial number of infants and young children arrived in the USA with health issues, indicating that their health was probably compromised while in the orphanage environment. Since children being raised in overseas orphanages appear to suffer from a variety of health-related problems, developing low-cost interventions to address this problem is necessary.

Studies on human immunodeficiency virus (HIV)-positive adolescents[10] and adults[11] suggest positive effects of massage therapy on the immune system. This is probably attributable to decreased cortisol levels. Cortisol affects the immune system negatively in part by killing immune cells such as natural killer cells. Massage therapy has also been shown to positively affect the health status of premature infants,[12-14] children with diabetes[15] and children with asthma.[16] Because children in overseas orphanages appear to suffer from compromised health, and massage seems to influence health status positively, my colleagues and I assessed the effects of massage on the health of infants being raised in these institutions. We expected that infant massage, as a low-cost intervention, would facilitate better health in these children while they were still living in the orphanages.

Current Study

METHOD/PARTICIPANTS

In 2 orphanage nurseries in Quito, Ecuador, 37 infants, ranging in age from 10 months to 11 months, were randomly assigned to a massage therapy group or a play control group. No congenital birth defects were apparent in any of the infants at the time of assignment. Of these 37 infants, data are presented on 30 infants. Seven infants at Site 1 were dropped from the study over the course of the study: Four infants (one "massage therapy" and 3 "play group") left the nursery to live in another section of the orphanage, one play group infant was adopted during the course of the intervention, one massage therapy group infant was reunited with her family and one massage therapy group infant died due to pneumonia after assignment to a group but before the intervention began. Demographic data on the 30 infants remaining in the study are shown in Table 1.

Table 1. Demographic Information on Infants

	Group				
	Massage Therapy (n = 14)		Play Control (n = 16)		
Variable	Mean	SD(±)	Mean	SD(±)	*P* Value
Age of infants (mo)	10.6	8.2	10.4	5.9	.90
Age at entry to orphanage (mo)	3.1	8.4	2.4	5.9	.77
Infants entering orphanage in first 2 weeks of life (n)	10		10		
Bayley Mental Score (pretest)	67.4	12.7	72.9	13.10	.26
Bayley Motor Score (pretest)	76.4	15.87	81.6	15.09	.36
Percent female	29		63		.07
Infants found abandoned (n)	7		4		.16

INTERVENTION

Infants in the massage therapy group (n = 14) received one, 15-minute massage daily, usually in the morning, delivered by orphanage volunteers or staff, all of whom were trained in infant massage techniques endorsed by the American Association of Infant Massage. Contrastingly, volunteers interacted with infants in the play control group (n = 16) for 15 minutes daily in individual play sessions.

The first day of the intervention for the infants began after assignment to a group and the collection of pretest information: As such, these infants began the study on different days. Orphanage volunteers were instructed to record daily observations, usually each morning, of all visible symptoms of illness experienced by the infants. Symptoms noted included the following: upper respiratory symptoms, including clear-runny or snotty nose, yellow-runny or snotty nose, congestion, cough and crusty eyes or nose; symptoms of infection, including diarrhea and vomiting; and general symptoms of illness, including whining or fussiness that was not considered normal. Symptoms exhibited later in the day were also recorded in each infant's file. Although volunteers were provided with thermometers, no fevers were noted during the first 2 weeks of the study. The orphanage's nurse indicated that fevers were quite infrequent in these children. Due to the amount of time and effort invested in pursuing data on fevers—with little likely return—it was decided to discontinue recording temperatures.

The average duration of this experimental intervention was 53 days. The massage therapy group infants received massage more often than the play control group infants received play sessions during those 53 days (mean, 35.7 days versus 20.4 days, respectively; $P<.001$). The same was true during Day 15 to Day 45 of the study period (mean, 20.7 days massage therapy sessions versus 13.7 days play sessions, respectively; $P<.001$). This chapter reports data from Day 15 through Day 45 of the study period. The first 14 days served as a baseline to establish the typical infant-health status before using infant-illness data to determine whether massage was correlated positively with a decrease in the incidence of illness.

SITE DESCRIPTIONS

Site 1 was a Catholic orphanage that, at the time, had 31 infants living in the nursery. Infants were either brought in by their parents or found abandoned and brought in by the police. The sanitary conditions were optimal, with an emphasis placed on cleanliness in most areas. The floors in the nursery area, which included 6 rooms and one hallway, were mopped twice daily. Infants' clothing was washed on a daily basis, as were their crib sheets; a necessity, since the infants' cloth diapers often soiled both clothing and bed sheets. However, the toys that the infants played with daily were washed on only a monthly basis. Normally, 17 to 26 infants older than 6 months of age played in one large room where they were supervised by 3 to 4 volunteers. On days when the volunteers were not in the orphanage (approximately 1 of every 14 days), infants were often left to play unsupervised in the large room, although nuns and orphanage staff were in the other rooms in the nursery area. Infants younger than 6 months of age were kept in another room and were taken out of their cribs for diaper changes and baths, but not for individual stimulation.

Site 2 was a private orphanage that, at the time, had 8 infants and young children in its care. Infants in this orphanage were brought in by their parents. Sanitary conditions were similar to those found at Site 1. Normally, 2 volunteers supervised 6 to 8 infants and young children during their "playtime." On days that volunteers were not present, the children over the age of 6 months typically played by themselves, although at least 2 staff members were always present. Similar to Site 1, infants less than 6 months of age were normally taken out of their cribs for diaper changes and baths, but not for individual stimulation.

Results

Although both groups of infants experienced similar play or crib-based conditions on a daily basis, children in the massage therapy group experienced more days of wellness and fewer days with symptoms of illness than did infants in the play control group. These results were based on data recorded on Day 15 to Day 45 of the study (Table 2).

Table 2. Number of Days With and Without Symptoms of Illness

Data From Day 15 to Day 45 of Intervention	Group: Massage Therapy (n = 14)		Play Control (n = 16)			
	Mean	SD(±)	Mean	SD(±)	Effect Size	*P* Value
Days without symptoms (n)	7.2	6.3	3.9	3.3	1.00	.08
Days data were missing (n)	8.4	5.8	8.3	5.4	.01	.98

For ease of understanding, individual symptoms of illness have been condensed into categories similar to those used by physicians. Infants in the massage therapy group had a lower mean incidence of infection symptoms and general fussiness (Table 3). When individual symptoms were analyzed, the massage therapy group infants experienced diarrhea less frequently and exhibited a more positive temperament than the play control group infants.

Table 3. Symptoms of Illness Experienced by Massage Therapy and Play Control Groups From Day 15 to Day 45

Symptoms Experienced From Day 15 to Day 45 of Intervention	Group: Massage Therapy (n = 14) Mean	SD(±)	Play Control (n = 16) Mean	SD(±)	Effect Size	*P* Value
Upper Respiratory Tract Symptoms	16.0	12.1	18.1	7.9	.27	.58
Clear-runny or snotty nose	7.4	5.3	9.9	5.6	.45	.22
Yellow/green-runny or snotty nose	1.8	2.1	1.1	1.5	.48	.28
Congestion	0.9	1.1	1.5	1.2	.50	.19
Coughing	0.6	1.2	1.2	1.4	.40	.25
Dried mucous on nose	3.1	2.8	3.6	3.6	.16	.65
Crusty eyes	2.2	4.3	0.9	1.4	.98	.28
Symptoms of Infection	5.3	4.6	8.4	6.2	.50	.14
Diarrhea	4.6	3.9	7.5	5.5	.53	.11
Vomiting	0.7	1.6	0.9	1.4	.12	.78
Whiny or Fussier Than Normal	0.8	1.2	1.8	2.3	.41	.16

Although these findings were not statistically significant at the $P<.05$ level, they did approach statistical significance. Given that this was a pilot study on a small sample, my colleagues and I opted to use "effect sizes" to determine the practical significance of the results. Based on findings reported by Cohen, an effect size of .40 or higher is considered indicative of "practical significance."[17] As can be seen in Table 3, most effect sizes (8 of 11) exceeded this benchmark.

Implications

Results of this pilot project suggest that infant massage may reduce both the number of days that children in orphanages experience symptoms of illness *and* the types of symptoms they experience. The finding that infants in the massage therapy group averaged more days with no symptoms of illness, despite being in the same environment as infants in the play control group, warrants further research on the effects of massage on decreasing infants' susceptibility to illness. Data gathered on the levels of urinary cortisol remain to be analyzed. Because there is an established link between elevated levels of cortisol and compromised immune response, infants who experienced fewer days of the symptoms of illness are likely to have experienced decreased levels of cortisol over time.

With respect to the massage therapy group infants experiencing more yellow/green runny noses and more incidents of crusty eyes (Table 3), a pediatrician colleague (Odell, personal communication) indicated that this, in fact, could have been an indication of the babies getting the infection or illness out of their bodies. However, it would also be imperative to know whether the infants in the massage therapy group experienced a shorter duration of illness each time. It was not possible to conduct this analysis during this study because of the large number of days (mean, 8.4 days) for which we had *no* data during the course of the illnesses (Table 2). Future similar studies would need to have more reliable symptom reporting to allow for this type of analysis.

Another interesting finding was that infants in the massage therapy group experienced diarrhea less frequently than did infants in the play control group. Annually, approximately 2 million children worldwide under the age of 5 die as a result of diarrhea and associated dehydration.[18] However, because this study was a pilot project that enrolled relatively few infants, no conclusions can be drawn. Nevertheless, the effect sizes obtained indicate that further research is needed on the effectiveness of massage in preventing or ameliorating diarrhea.

My colleagues and I are planning to replicate this work in other orphanages, with larger numbers of children, to better understand the effects of massage on children's immediate *and* long-term health outcomes. Several study improvements are necessary, including stricter adherence to the intervention protocol and to daily symptoms recording. Only by designing and following strict research protocols will we, as researchers, be able to disentangle the many factors that might impact the effects of massage on health outcomes of children living in orphanages.

Acknowledgments

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CHAPTER 15:
MASSAGE THERAPY FOR PEDIATRIC PROBLEMS

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Abstract

Numerous studies have reported the benefits associated with massage therapy in children who have various illnesses and conditions. In this chapter studies are reviewed demonstrating improvements in children with medical and psychiatric disorders. The benefits of massage therapy have also extended to those who performed the massages. Conditions discussed in this chapter include attention-deficit/hyperactivity disorder, autism, posttraumatic stress disorder, depression, anorexia, bulimia, cerebral palsy, Down syndrome, various autoimmune disorders, including asthma and diabetes, and immune disorders, including human immunodeficiency virus and leukemia. Potential underlying mechanisms that may contribute to the effects of massage are also discussed.

Attention and Behavior Disorders

ATTENTION-DEFICIT/HYPERACTIVITY DISORDER

Attention-deficit/hyperactivity disorder (ADHD) affects as many as 3% to 6% of children and is characterized by inattention, impulsiveness and hyperactivity.[1] Overactivity is typically the most prominent feature. Although drug therapy has improved the symptoms of ADHD in more than 75% of cases, medications often have undesirable side effects.[1]

In a study on 28 adolescents with ADHD, each participant was provided with either massage therapy or relaxation therapy for 10 consecutive school days.[1] At study completion, those in the massage therapy group, but not those in the relaxation therapy group, rated themselves as "happier," and observers rated them as "fidgeting less" following the sessions. In addition, those in the massage therapy group were reported by their teachers as spending more time on assigned tasks, and they assigned these children lower hyperactivity scores based on current classroom behavior.

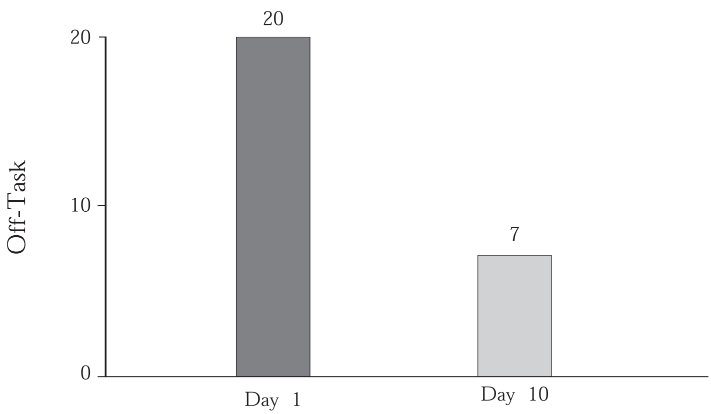
AUTISM

Autism affects 2 to 5 of every 10,000 children. Autism takes many forms with several different degrees of severity and its causes are still unknown.[2] Symptoms of autism include limited language, social communication and ability to develop relationships. Also children with autism show abnormal responses to sensory stimuli (usually sound), atypical movements including immobility and hyperactivity, a limited attention span and excessive off-task behaviors and an aversion to touch.

A variety of therapies have been tried in children with autism, including behavior modification and sensory-integrative approaches. In a recent study we reported that children with autism who were provided with massage therapy showed less inattentiveness (off-task behavior), reduced touch aversion and decreased withdrawal (Figures 1 and 2).[2]

Figure 1. Benefits of massage therapy in children with attention and behavior disorders.[1]

Figure 2. Benefits of massage therapy in off-task behavior in children with autism.[2]



In another study we conducted,[3] 20 children with autism were given daily massages by their parents. Ranging in age from 3 years to 6 years, these children were randomly assigned to massage therapy and reading attention control groups. A massage therapist trained the parents in the massage therapy group. Every night for 1 month, these parents massaged their children for 15 minutes prior to bedtime, while the parents in the attention control group read stories by Dr. Seuss to their children on the same time schedule. Sleep, which is often disturbed in children with autism, was monitored. Teacher- and parent-rated scales, classroom and playground observations and sleep diaries were used to assess the effects of massage therapy on various behaviors, including hyperactivity, stereotypical and off-task behaviors and sleep problems. The children in the massage therapy group showed fewer stereotypical behaviors and more on-task and social-relatedness behaviors during classroom observations. In addition, the massaged children experienced fewer sleep problems at home.

POSTTRAUMATIC STRESS DISORDER IN CHILDREN FOLLOWING HURRICANE ANDREW

Past studies have described posttraumatic responses in children that are similar to those described for adults with the diagnosis of posttraumatic stress disorder (PTSD).[4] Symptoms include reduced responsiveness, increased arousal and conduct problems that persist for several months following the traumatic event.

In a study we conducted following hurricane Andrew in Miami, Florida, 60 grade-school children who showed classroom behavior problems were given massage therapy for 8 consecutive days.[4] Scores on the PTSD Reaction Index suggested that these 60 children were experiencing severe posttraumatic stress. When compared with a video attention control group, the children who received massage therapy reported being happier and less anxious and had lower saliva cortisol (stress hormone) levels posttherapy. In addition, the children in the massage therapy group showed more sustained changes, as manifested by lower scores on the Children's Manifest Anxiety Scale and The Center for Epidemiological Studies Depression Scale, as well as in self-drawings. They were also observed to be more relaxed. These positive results are quite promising, given the persistence of the symptoms of PTSD for children who had not received interventions following disasters such as hurricanes.

CHILD AND ADOLESCENT PSYCHIATRIC PATIENTS

Depression and adjustment disorder are often accompanied by anxiety, increased stress hormones and sleep disturbances. In a past study we determined the effects of massage therapy on child and adolescent psychiatric patients.[5] A 30-minute back massage was given daily for a 5-day period to 52 hospitalized children and adolescents with depression and/or adjustment disorder.[5] Compared with a control group who viewed relaxing videotapes, the massaged subjects were less depressed and less anxious and had lower saliva cortisol levels after the massage. In addition, nurses rated the massaged children as being more cooperative on the last day of the study, and nighttime sleep increased over this 5-day period. Lastly, cortisol and norepinephrine levels were decreased.

ANOREXIA

Anorexia, a body weight disorder affecting women almost exclusively, has increased in incidence over the past 40 years.[6] Symptoms of anorexia are extreme thinness and poor body image. In a recent study we observed adolescent women with anorexia who received massage therapy twice per week for 5 weeks and those who received standard treatment alone.[6] The women who received massage reported lower stress levels and anxiety levels and had lower cortisol levels. Over the 5-week treatment period, these women also reported improved body image on the Eating Disorder Inventory and they experienced increased dopamine and norepinephrine levels.

BULIMIA

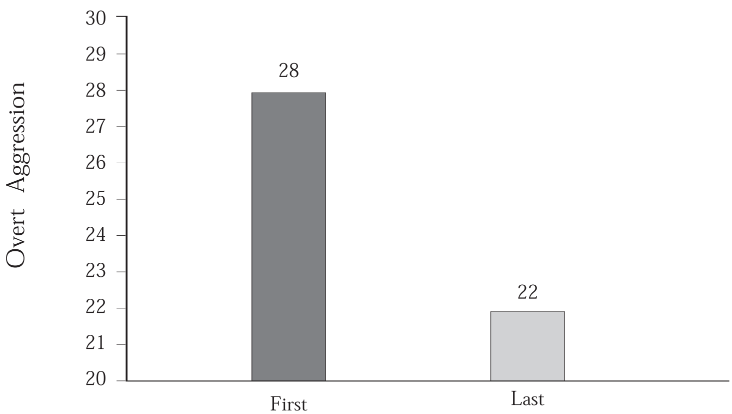
Bulimia is characterized by recurrent episodes of binge eating; self-induced vomiting, the use of laxatives or diuretics and strict dieting; and concern with body shape and weight. In an earlier massage therapy study, 24 adolescents with bulimia were randomly assigned to massage therapy or standard treatment control groups.[7] Results indicated that the women who received massage showed immediate reductions in anxiety and depression, based on self-reports and observed behaviors. In addition, by the last day of therapy, the women had lower depression scores, lower cortisol levels and higher dopamine levels. These findings suggest that massage therapy is effective for adolescent women with bulimia.

AGGRESSIVE/VIOLENT ADOLESCENTS

In 1998 the Centers for Disease Control and Prevention published statistics showing that the violence rate (ie, homicide rate) among adolescent and young adult males in the US exceeded that of any other industrialized country. Excessive violence has been noted in adolescents and adults in primitive countries where young children receive minimal affection. Touch taboos and mandates not to touch children in school may be contributing to the high rates of aggression/violence in the US.

In a study on violent adolescents we attempted to reduce aggression by providing them massage therapy.[8] Seventeen aggressive adolescents were assigned randomly to a massage therapy group or a relaxation therapy group to receive 20-minute therapy sessions, twice a week for 5 weeks. The adolescents who received massage therapy showed lower levels of anxiety after the first and last therapy sessions. By the end of the study, the massaged adolescents also reported feeling less aggressive and were perceived by their parents as being less aggressive than the adolescents who were assigned to the relaxation therapy group (Figure 3).

Figure 3. Benefits of 5 weeks of massage therapy in aggressive adolescents.[8]



POTENTIAL UNDERLYING MECHANISMS

Depressed mood, anxiety levels and stress hormones (norepinephrine, epinephrine and cortisol) were reduced in all of the studies discussed.[1-9] A potential mechanism that might explain these changes may be the increase noted in vagal activity following massage therapy.[9] The nucleus ambiguous branch of the vagus (the "smart" vagus) stimulates facial expressions and vocalizations. This contributes to less depressed affect, which, in turn, could feed back to produce less depressed feelings.[10] Increased vagal activity may also account for the enhanced attentiveness in the children with ADHD[1] and the children with autism.[2]

Musculoskeletal Problems

CEREBRAL PALSY

Symptoms of cerebral palsy (CP) in children include spasticity (rigidity of muscles), impaired motor coordination and deficits in sitting, standing, locomotion and daily living skills. In addition, children with CP may be impaired cognitively, socially and emotionally. As a result of the severity of the disorder, multidisciplinary treatments are often prescribed.

In a study we conducted, 20 preschool-age children with CP were recruited from early-intervention programs to receive 30 minutes of massage twice weekly for 12 weeks or participate in a control group who heard stories.[11] At the end of the study the children who received massage therapy showed reduced spasticity, and improved fine and gross motor functioning. In addition, the children in the massage therapy group received higher cognition, social and dressing scores on the Developmental Profile, and they showed more positive facial expressions and less disorganized limb movements during face-to-face play interactions. These findings suggest that massage therapy attenuates the physical symptoms associated with CP, it enhances development and it should be considered as an early intervention for children with this disorder.

DOWN SYNDROME

Down syndrome (DS), a genetic disorder affecting 1 in approximately 700 children born in the US,[12] is characterized by cognitive deficits, speech problems and motor- and perceptual-development delays. Children with DS also frequently exhibit decreased muscle tone, or hypotonia. Recent research findings from studies of non-DS children have shown that massage therapy may improve muscle tone and enhance motor development.[12]

Twenty-one moderate- to high-functioning preschool-age children with DS already receiving early intervention (physical therapy, occupational therapy and speech therapy) were randomly assigned to receive 30-minute massage therapy or reading sessions (control group) twice per week for 2 months.[12] Based on last-day versus first-day assessment measures, the children in the massage therapy group versus the control group showed developmental gains in fine and gross motor functioning and less severe hypotonicity in their upper limbs.

Autoimmune Problems

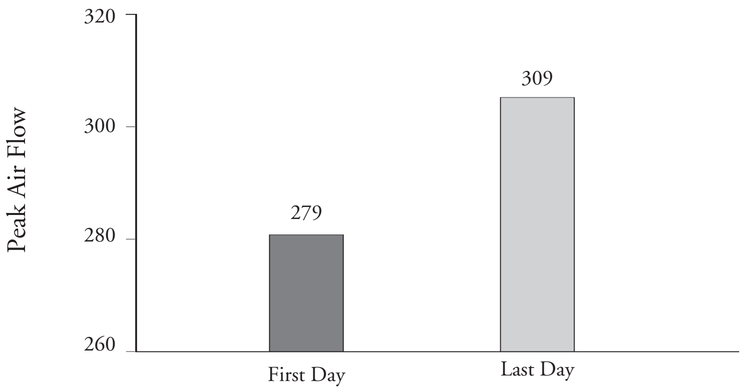
ASTHMA

Complementary forms of therapy are being explored for children with asthma: For example, a study of facial-relaxation training documented increases in immediate peak expiratory flow rates in children.[13] However, these increases fell short of the standard criterion for clinical significance used in evaluating asthma medications—a 15% increase in air-flow rates (Figure 4).

Figure 4. Standard criterion for clinical significance used in evaluating asthma medications is a 15% increase in air-flow rate.[13]

We evaluated massage therapy with children who have asthma because it has lowered anxiety and cortisol levels in children who have other problems.[14] Also, massage therapy requires less compliance from children. Another reason for the effectiveness of massage therapy is that the children's *parents* provide the therapy. Parents of children who have asthma have been shown to experience higher anxiety levels compared with parents of children who do not have asthma—and increased anxiety on the part of the parents can affect the children's health.[14] Giving parents an active coping role in their child's therapy may reduce their own anxiety. In this study, 32 children with asthma were randomly assigned to receive either massage therapy or relaxation therapy (control group).[14] The children's parents were taught to provide the therapy, which was given for 20 minutes before bedtime each night for 30 days. The children who received massage therapy showed immediate decreases in anxiety and cortisol levels. Also, their attitudes toward asthma and their peak air flow and other pulmonary functions improved over the course of the study (Figure 5).

Figure 5. Effect on peak air-flow rates in children with asthma following 30 days of massage therapy given by their parents.[14]



CYSTIC FIBROSIS

Cystic fibrosis (CF) is a chronic, life-threatening disease diagnosed typically in early childhood. The prevalence of CF is approximately 1 in every 3300 live births, making it the most common genetic disease in the US.[15,16] In a recent study we assessed the effects of parents giving massage therapy to their children who had CF.[17] This was done to reduce anxiety in the parents and their children as well as to improve the children's moods and peak air flow readings. Twenty children with CF and their parents were assigned randomly to a massage therapy or a reading control group. Parents in the treatment group were asked to give their children a 20-minute massage every night at bedtime for 1 month. Parents in the control group were requested to read to their children for the same amount of time.

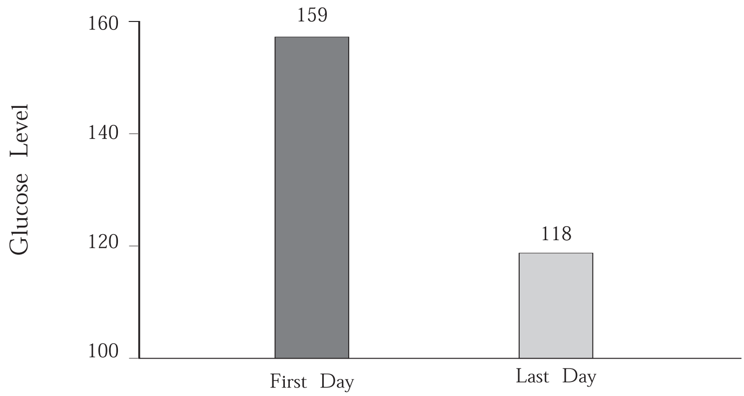
On day 1 and day 30, parents and children answered questions related to their anxiety levels, and children answered questions related to their mood. In addition, peak air flow readings were measured in the children. Following the first and last massage sessions, the children *and* parents reported lower anxiety levels. Mood and peak air flow readings also improved for children in the massage therapy group. These findings suggest that the parents of children with CF may reduce their anxiety levels by massaging their children, and that the children may benefit from receiving the massage by having less anxiety and improved mood, which, in turn, may facilitate breathing.

DIABETES

Parents' involvement in the treatment of their children who have diabetes can be a negative experience; for example, when monitoring dietary compliance, taking blood samples and giving insulin injections. We tried to give parents of children with diabetes a more *positive* role in their children's treatment by being called on to massage their children daily before bedtime for 1 month (Figure 6).[18] Immediately after each massage therapy session, anxiety and depression levels were lower in both the parents and their children. At the end of the 1-month study period, the children's insulin and food-regulation scores improved, and the children's blood glucose levels decreased to the normal range (158 mg/dL to 118 mg/dL; Figure 7).

Figure 6. Massage therapy offers parents a more positive role in the treatment of their child's diabetes.[18]

Figure 7. Effects on blood glucose levels in children with diabetes following 1 month of nightly massage therapy provided by their parents.[18]



ATOPIC DERMATITIS

Atopic dermatitis (eczema) has been related to increased depression,[19] stress and anxiety,[20] which, in turn, lead to increased cortisol levels that then dampen immune function.[21] In a study we conducted, children with atopic dermatitis were treated with standard topical care and massaged by their parents for 20 minutes daily for 1 month.[22] A control group received standard topical care only. The children's affect and activity levels improved significantly, and their parents' anxiety levels decreased immediately after finishing each massage therapy session. Over the span of the 1-month study period, parents of the massaged children reported lower anxiety levels in their children, and the children improved significantly on all clinical measures regarding their skin, including redness, scaling, lichenification (violet patches caused by scratching), excoriation (removal of skin caused by scratching) and pruritus (itching).

JUVENILE RHEUMATOID ARTHRITIS

Juvenile rheumatoid arthritis (JRA), one of the most common chronic diseases of childhood, is the most common rheumatic disease of this period of life.[23] The diagnosis of JRA is based largely on the observation of persistent arthritis (6 weeks or more in duration) in one or more of the child's joints. This disease manifests itself typically before 16 years of age, with peak onset in the following age groups: 1- to 3-year-old children and 8- to 12-year-old adolescents.[24] Common symptoms of JRA include night pain and joint stiffness in the morning and following long periods of inactivity.

In a study we conducted, children with mild-to-moderate JRA were massaged by their parents for 15 minutes each day for 30 days.[23] A control group engaged in relaxation therapy. The children's anxiety and cortisol levels decreased immediately following the massage, and, over the 30-day period, their pain levels "decreased" according to self-reports, parent reports and their physicians' assessments (both the incidence and severity) of their pain and pain-limiting activities.

POSSIBLE MECHANISMS

Autoimmune problems may occur because of an imbalance in the type-1/type-2 immune systems. Regulation by the type-2 system is thought to lead to autoimmune conditions, such as asthma.[23] By decreasing the levels of stress hormones following massage, control by the type-2 system may be "switched" to control by the type-1 system.

Immune Problems

HUMAN IMMUNODEFICIENCY VIRUS

Human immunodeficiency virus (HIV) is a complex retrovirus that affects the human immune system by attacking $CD4^+$ T cells primarily. Despite the fatal prognosis following the contraction of acquired immune deficiency syndrome (AIDS), several treatments are currently being investigated to help enhance immune function. The treatments researched most popularly for HIV-infected individuals include pharmacological and psychological interventions. Pharmacological agents, consisting typically of a combination of antiretroviral drugs, have proven expensive and difficult to adhere to and are often accompanied by severe adverse effects. Psychological interventions have been administered to reduce the levels of anxiety and depression, factors associated with decreased quality of life and diminished immune function.

Preliminary, unpublished data from an Office of Alternative Medicine-sponsored study reveal that up to 60% of those receiving alternative treatments for HIV are receiving massage therapy. In a study we conducted, HIV-positive adolescents were recruited from the outpatient clinic of a large urban university hospital and were randomly assigned to receive massage therapy or progressive muscle relaxation twice weekly for 12 weeks.[25] To evaluate the effects of treatment, the adolescents were assessed for depression, anxiety and immune changes before and after the 12 weeks of treatment.

The adolescents who received massage therapy, versus those who experienced relaxation therapy, reported feeling less anxious. In addition, they were less depressed and showed enhanced immune function by the end of the study. Changes in immune function included increased numbers of natural killer cells (cells that kill viral cells). In addition, the cells that are normally killed by the HIV virus increased for the massage therapy group only.

LEUKEMIA

The outlook for children who have acute leukemia has improved steadily, so that now at least 60% to 70% of children with leukemia achieve long-term cure and survival.[26] We postulated that massage therapy would be indicated for children with leukemia because immune function (eg, natural killer cell number and natural killer cell activity) has been enhanced following massage therapy in HIV-positive adolescents, as discussed previously.[25]

Accordingly, we conducted a study on massage therapy given to children with leukemia.[26] Massage was performed daily by the children's parents. Children who received massage therapy were compared with a standard treatment control group. Following 1 month of massage therapy, levels of depression decreased in the children's parents, and the children's white blood cell and neutrophil counts increased.

POSSIBLE MECHANISMS

Stress hormones (eg, cortisol) have been noted to kill immune cells, particularly natural killer cells (cells that kill viral and cancer cells).[25] Since massage therapy increases vagal activity, which, in turn, decreases cortisol, immune cells can survive.

Summary

We have documented clear improvements in several medical and psychiatric conditions—including depression and eating disorders, musculoskeletal problems, pain syndromes and immune and autoimmune conditions—following the application of massage therapy. Although several potential underlying mechanisms have been explored to explain the improvements seen with massage therapy, including decreased stress (and decreased cortisol) and enhanced immune function, further research is needed in this area.

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